LONGLINE FISHING IN SRI LANKA

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Declaration

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ABSTRACT

Coastal and deep sea fishing are the main sub sectors of Sri Lankan fishery industry. The deep sea fisheries in Sri Lanka have been in existence since the early 1980. Sri Lanka coastal fishing sector mainly uses conventional methods with less capital investments. Dispute of this, coastal fish production of Sri Lanka is higher than the deep sea fish production.

Longline and gillnet are the two widely use fishing methods in deep sea fishing sector. In this paper economic efficiency, Post Harvest Fish Lost (PHFL) of longline fishing are evaluated and identified. Similar evaluation is conducted for gillnet fishing to compare the position of longline fishing in the deep sea fishing sector. Research methodology for economic efficiency and PHFL was developed using the findings of literature survey.

Primary data were collected from 150 deep sea vessels operated in Negombo fishery harbour. 3,346 deep sea fishing vessels are operated in Sri Lanka in the year 2010 according to the fishery statistic 2010, issued by Ministry of fisheries and Aquatic Resources Development (MFARD). Data collection was done during February through October of 2011 in Negombo fishery harbour. Accounting Rate of Return (ARR) measures the net gain from a capital investment. ARR is use to evaluate and identify the economic efficiencies of longline fishing and gillnet fishing. To calculate ARR, capital investments, fix costs, variable costs, revenues, number of fishing trips per years are used.Further this paper investigates the trend of longline fishing in the Sri Lanka. Secondary data from MFARD and FAO were used to evaluate and identify the trend.

Findings indicate that the ARR for longline fishing are attractive and comparatively higher than gillnet fishing. It is found that PHFL of longline Fishing is very less. PHFL of longline fishing is found as around 12.5% of gillnet fishing. Further deep sea fishing sector demonstrates impressive improvement during last few years. Hence the results conclude that high return and high quality standard of longline fishing. This will make longline fishing more popular and attractive in deep sea fishery sector. Further Deep sea fishing will dominate Sri Lanka fishery sector as implied in trend analysis. Hence

longline fishing will be very significant in Sri Lanka fishery sector. It is suggested that in order to improve the fisher sector in Sri Lanka, longline fishing should be promoted by placing right credit mechanism to the fishermen, easy and affordable access to modern technology and right infrastructures for longline vessels in fishery harbours.

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ABBREVIATIONS

Abbreviation	Description
ARR	Accounting Rate of Return
CFC	Ceylon Fisheries Co-operation
CFHC	Ceylon Fishery Harbours Co-operation
CSW	Chilled (iced) Sea Water
DWFN	Distant Water Fishing Nation
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
GDP	Gross Domestic production
GPS	Global Positioning System
GRT	Gross Registered Tonnage
IDAY	Inboard Single-day Boats
IMUL	Inboard Multi-day Boats
IOTC	Indian Ocean Tuna Commission
Kg	Kilograms
MDOV	Multi-day Vessels
MFARD	Ministry of Fisheries and Aquatic Resources Development
MT	Metric Tons
MSL	Mean Sea Level
NARA	National Aquatic Resources Research and Development Agency
NGO	Non-Government Organizations
PHFL	Post harvest fish losses
RSW	Refrigerated Sea Water
SU	Statistical Unit
UN	United Nation
VMS	Vessels Monitoring System
Walala Season	Season of Relatively Rough Sea Condition (Come with North-East and South- West monsoon)
Nautical mile 1	1.852 Km

Chapter 01:-

INTRODUCTION

1.1 Overview of Sri Lanka Fisheries Sector

Fisheries have been identified as an important sector of Sri Lankan day today life. It contributes food security, nutrition, and employment to the Sri Lankan people. Sri Lanka is blessed with 1,700km coastal belt and 517,000 square kilometers of Exclusive Economic Zone (EEZ) (Ministry of Fisheries and Aquatic Resources Development, 2011) with easy accessibility to the international water for high sea fishing. Shallow coastal waters around Sri Lanka have an estimated 680 square kilometers of coral reefs (Rajasuriya, 2007). These shallow coastal waters areas are rich fish grounds. Sri Lanka fishing activities are mostly based on the three sub sectors called Inland/Aquaculture, Coastal and Deep sea (Off Shore).

The country's total marine fish production is 332 260 Metric Tons (MT) in the year 2010. It represents 86.5% of fish production of the country. Even though Sri Lanka has great potential of fisheries sector due to its natural existence, it produces less than 0.2% of world fish production (Statistic; MFARD, 2010). Sri Lanka has 19 main fishery harbours, 40 anchorages and more than 1,500 landing sites scatted along its coastal belt (Harbours; Ceylon Fishery Harbour Coperation, 2011).

1.2 Impact of Fisheries Sector on National Economy

Agriculture is a dominant sector in the Sri Lankan economy. Fishery sector is a main component of the agriculture sector of the country. In 2010, fisheries contributed 1.7 % to the total Gross Domestic Products (GDP) (National Account;Department of Census and Statistics , 2010). Table 1.1 indicates GDP values of last few years

The Table 1.1 indicates the values of fisheries have increased 16 times with in 20 years from the year 1990 to 2010. Further fisheries and agricultural sectors have also increased year by year. But the percentage contributions to the GDPs don't indicate any significant improvement.

Year	Total GDP		Agriculture Livestock, Fisheries		Fisheries	
	Value *(Rs Millions)*	%	Value *(Rs Millions)*	%	Value *(Rs Millions)*	%
1990	317,904	100.0	72,788	22.9	5,859	1.8
1995	662,384	100.0	123,990	18.7	13,309	2.0
1999	1,008,845	100.0	191,577	19.0	22,960	2.3
2000	1,253,622	100.0	200,965	16.0	25,749	2.1
2005	2,452,782	100.0	289,906	11.8	19,227	0.8
2006	2,938,680	100.0	333,137	11.3	35,251	1.2
2007	3,578,688	100.0	418,104	11.7	54,700	1.5
2008	4,410,682	100.0	590,114	13.4	67,934	1.5
2009	4,825,085	100.0	607,788	12.6	79,554	1.6
2010	5,602,321	100.0	716,892	12.8	93,777	1.7

(Year Book 2008; NARA, 2010) *and* (National Account;Department of Census and Statistics , 2010)

Table 1.1 :GDP Values of Agriculture, Livestock, Fisheries in Last Few Years

This is a natural scenario for the developing countries. Because when the economy is developing, the percentage contribution by agriculture to the GDP is decreasing. Therefore the minimizing the agriculture contribution to the GDP is not a bad indication. The most important point is the actual value of the sector. Agriculture, livestock, fisheries total contribution to the GDP is mostly decrease with in past 20 years. However Fisheries has maintained its contribution to GDP nearly constant.

220,960 direct employees are engage in fishery sector. It is around 6.5% of work force of the country. Export value of fish and fisheries products is Rs19,834 millions while the Import value of fish and fisheries products is Rs13,875 millions in the year 2010 (Statistic: MFARD, 2010). Higher export value implies net income to the country by international tread related to fish and fisheries products. Hence fisheries play a significant role in the county's economy.

1.3 Brief introduction of Longline Fishing

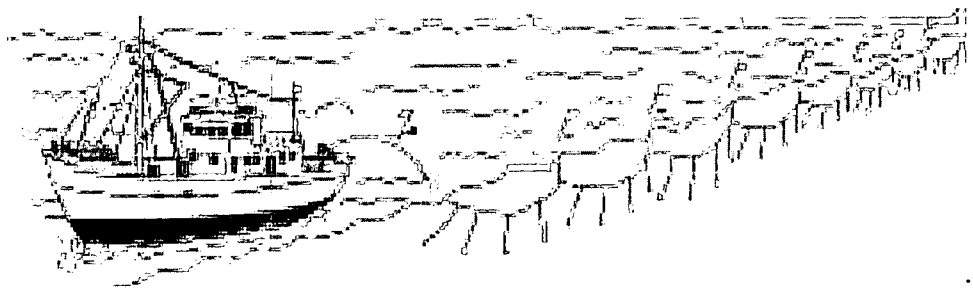


Figure 1.1- Longline boat and fishing line

Longline fishing uses long line attached with hundreds of hooks as fishing gear. Therefore it uses to refer as longline for this fishing method. The bait is attached on a long line held up by buoys. Longline fishing is a world popular commercial fishing technique. Specially developed countries use this technique for mass scale fishing.

Fish attached to the longline fishing gear can survive without dieing for a long time. Therefore longline fishing gear enhances the freshness of its harvest. Longline is a passive fishing technique which the gear is stationary and fish attract to the gear.

1.4 Research Problem

Deep sea sector of the country has a huge potential to develop fishery industry of the Sri Lanka. Still the contribution to the national economy and Sri Lanka fishery sector by the deep sea fishing sector is not significant. The status of our deep sea fishing sector and methods need to be assessed and identified to promote the deep sea fishing sector of Sri Lanka. Longline and gillnet fishing are widely use fishing techniques for deep sea fishing in the country as well as in the world. Economic efficiency, Quality standard and trend of longline and gillnet fishing are assessed and identify in the research to identify the position of longline fishing in the Sri Lankan fishery sector.

1.5 Justification of the Research

National Committee on Livestock Aquaculture and Fisheries (NCLAF) has identified fisheries and Aquaculture sector as one of seven priority areas of implementation an integrated research programme in the country. (National Committe on Live Stock Aquaculture and Fisheries, 2011). Hence the research which is related to the Sri Lanka fishery sector, add value to above NCLAF identification.

Sri Lanka is blessed with a huge coastal and deep sea area. In addition to that it has easy access to the international sea for deep sea fishing. However Sri Lanka Still produces around 0.2% of world fish production. 92.74% from the entire fishing vessels of the country engage in fishing activities in the coastal sector. Coastal sector account only 60.9% of total fish production of the country. 7.26% from the entire fishing vessels of the country engage in deep sea sector. But deep sea sector is accountable for 39.1% of the total fish production of the country. (Statistic; MFARD, 2010). The above facts indicate that the deep sea fishing in Sri Lanka need more attention.

Further food demand of the Sri Lanka has increased with the high rate of population growth. To full fill this demand, performance of fishery sector needs to be enhanced. Today per capital consumption of fish in Sri Lanka is 15.7 kg per person and Ministry of Fishery is planning to increase it up to 21.9 kg/person in year 2013. (Ministry of Fisheries and Aquatic Resources Development, 2011) Therefore improving the performance of deep sea fishing will be a sound solution for this demand and achieving targets.

Authorities also have identified the important of deep sea fishing. They are planning to drag bigger international fishing vessels to Sri Lanka. Fishery harbours are being planned to upgrade for the requirement of bigger vessels. CFHC is planning to build new fishery harbours in North East part of the country. Requirement of longline vessels are accounted for the design of these harbous.

Longline and Gillnet fishing are the widely used fishing technique in the deep sea fishing sector. Longline fishing has more desirable aspects such as high quality, environment friendly and export oriented production etc. Hence it is important to evaluate and

identified the position of longline fishing in the deep sea sector and its future trend for the improvement of the Sri Lanka fishery sector.

1.6 Research Objectives

The research evaluates and identifies economic and quality (PHFL) efficiency of longline fishing in deep sea fishing sector. The economic efficiency of gillnet fishing is evaluated to compare the position of longline fishing in deep sea fishery sector. Further trend of the deep sea sector is evaluated to forecast the future of longline fishing in Sri Lanka.

1. Evaluate and identify the Economic and Quality (PHFL) efficiency of longline fishing in deep sea fishing sector

2. Evaluate and identify the trend of deep sea fishing in Sri Lanka

1.7. Methodology

1.7.1 Outline of Methodology

- Literature Survey.
- Preliminary data collection based on interviewing fishing vessels from Negombo Fishery harbour
- Secondary data collection from MFARD and FAO
- Data analysis

1.7.2 Methodology in Brief

The research has two objectives. In brief their methodologies are as follow.

1. Evaluate and identified economic and quality (PHFL) efficiency of longline fishing in deep sea fishing sector.

Literature survey is conducted to collect necessary research information. The economic efficiency of gillnet fishing is evaluated to compare and understand the position of longline fishing in deep sea fishery sector. The data are collected through interviews with vessels operators of longline and Gillnet vessels. Data collection will be done in

Negombo fishery harbour. ARR is used to evaluate and identify the economic efficiencies of longline fishing and gillnet fishing. Accounting Rate of Return (ARR) measures the net gain from a capital investment. To calculate ARR, capital investments, fix costs, variable costs, revenues, number of fishing trips per years are used.

PHFL occurs throughout catching to consumption process. Research objective is to evaluate the PHFL from fishing method. Mostly PHFL of catch to landing of fish is influenced by fishing method. Hence the research assess the PHFL occur through fish catching to fish landing to the fishery harbour. Data are collected for total catching weigh and inferior quality weigh of fish for both types of fishing vessels.

2. Evaluate the trend of long line fishing in Sri Lanka

This analysis is performed using secondary data from appropriate and reliable sources.To forecast the future of longline fishing in Sri Lankan deep sea fishery sector, past performances of deep sea fishery sector is analyzed. Statistical data from MFARD, FAO are used to analyze following sectors

1. IMUL – (Inboard Multi-day Boats) and IDAY – (Inboard Single-day Boats) Vessels Fleet trend.
2. Production trend.
3. Export trend.
   i, By Weight
   ii, By Value
4. World trend.

1.8 Scope and Limitations

This study covers performance analysis and Identification of longline fishing in deep sea fishery sector of the Sri Lanka. The research is based on vessels operate in Negombo fishery harbour. In addition to that the study covers the trend of deep sea fishery sector of the Sri Lanka.

Literature reveals that there are number of other issues and conflicts in Sri Lanka deep sea fishery sectors such as Poaching of international vessels, detention of fishermen in other country, Market price, environment aspect, Sustainability of deep sea fish stock, and poor service facilities. This research is concentrate to address the investment and quality aspect of longline fishing in the Sri Lanka deep sector only.

Although longline fishing is happening throughout the country, scope of the research is limited to longline operation in Negombo fishery harbour which covers around 160 longline vessels out of around 2,500 longline vessels operate in the Sri Lanka.

There was a difficulty to find out the data related to world fish production after 2008. FAO latest year book was issued in the year 2010. It covers only up to 2008. Data are yet to be released after 2008 from FAO. Data from other internet based sources not consistence with FAO past data. Hence world trend of fish production analysis is limited up to 2008.

During the data collection stuff some fishing vessels operators who had been interviewed were given contradictory data related to cost and revenue. Therefore researcher had to eliminate these exceptions by not considering those data for the study.

1.9 Chapter Breakdown

The first chapter gives an introduction related the study. Overview of Sri Lanka fishery sector, brief introduction of longline fishing, research problem, research methodology, research justification, research scope and its limitation are covered in this chapter.

The second chapter illustrates the literature review related with the research area, where it gives the facts and figures from the Statistic, past researches related to deep sea fishing with theoretical framework in longline fishing industry.

Third chapter elaborates the methodology followed for this study in details explaining the theoretical framework used for analyzes the results, data collection method, sample procedure, Institution and source of information encounter, data collections and analyses method.

The Chapter number Four flows through the Data Analysis & Discussion. Finally, The chapter number Five discusses the researcher's Conclusion and Recommendations.

Chapter 02

Conceptual Frame work and Literature Review

2.1. Overview

Chapter illustrates the facts related to the in the areas of concern in the research. The literature review is focused on giving an understanding to the Sri Lanka fishery industry, deep sea fishing and longline fishing. The research frame work can be illustrated as figure number 2.1.

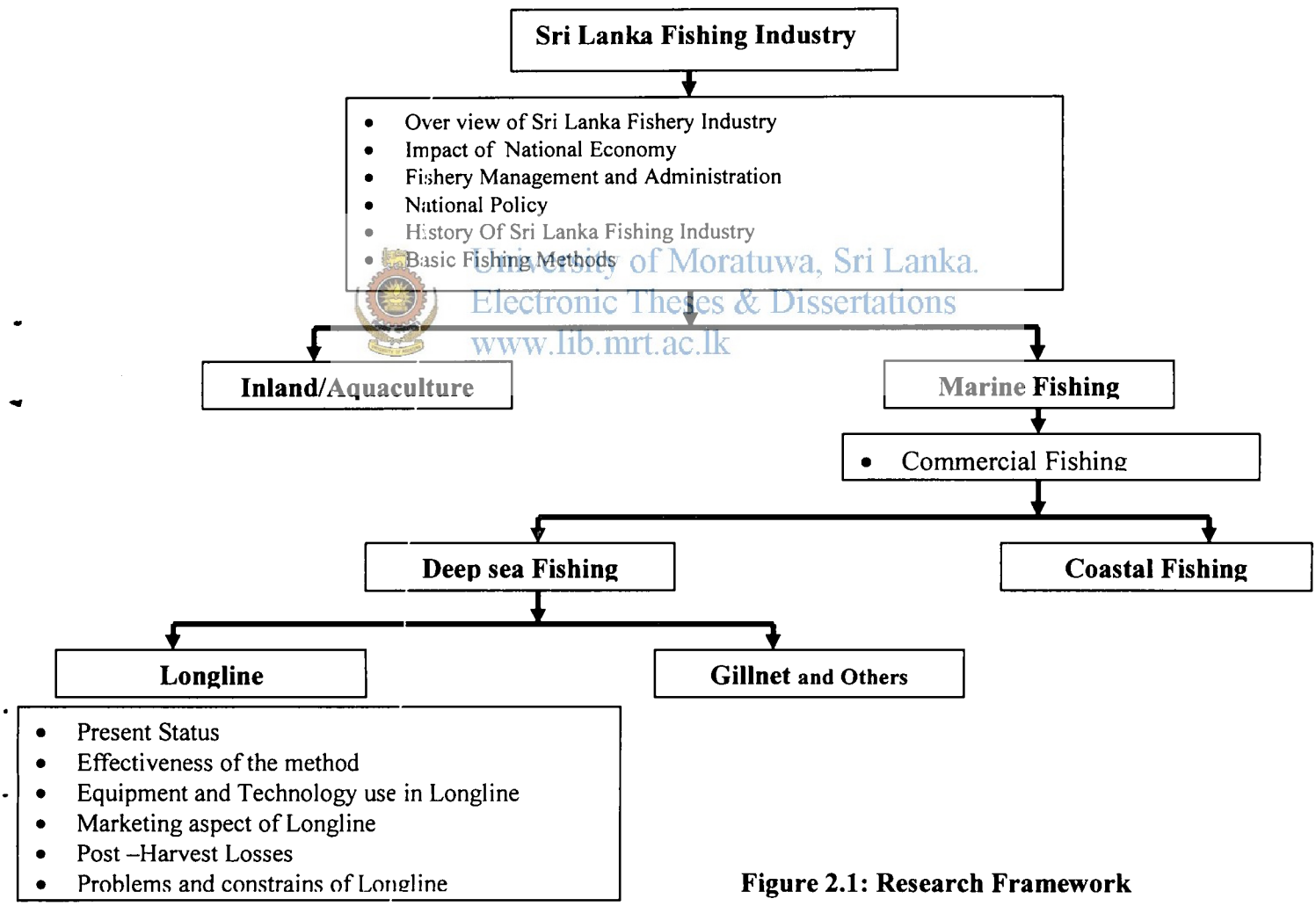


Figure 2.1: Research Framework

As shown in figure 2.1, Sri Lanka fishery industry can be divided as Inland/Aquaculture and Marine sectors. Further Marine sector can be divided as deep sea and coastal fishing. Longline is a widely use fishing method in deep sea sector.

Sri Lanka blessed with huge sea area for marine fishing. Sri Lanka is located as an Island in the Indian Ocean with 200 nautical miles of Exclusive Economic Zone (EEZ) . Further the country has extended sea bed of 10-12 times of its land area. It is approximately 0.8 million square kilometers (Jayasinghe, 2001). Moreover it consists of 158,000 sq km of lagoons & estuaries which are the rich fish breeding grounds.

Marine fishing affects by seasonal variation of wave conditions. This is occur due to monsoons. Amarasooriya and Maldeniya (1998) describe is as " Oceanographic conditions around Sri Lanka are driven by bimodal pattern of monsoonal winds. These monsoons give rise to two periods of fishing operations, the North-East one from December to February and South-West one from May to September (Amarasooriya & Maldeniya, 1998)". Coastal fishing is affected by wave and wind climate driven by the monsoon. Fishermen generally name this time as " Varakan" Season. It is difficult to engage coastal fishing during Varakan season. But in deep sea fishing, there is no significant impact from these monsoons . Hence as an important tool of harvesting fishery ground, it is important to review the operation aspects of longline fishing in the Sri Lanka fishing sector.

2.2 History of the Sri Lanka Fishery Industry :-

Sri Lanka fishing industry has a long history. It can be broadly categorized in to two segments based on their time lines. They are pre-independent era and post independent era.

(i)Pre-Independence Era: Sivasubramaniam, (1997) provided some vital information about fishing operation in Pre-independent era in his book of "One hundred years of Fisheries Management In Sri Lanka: lessons for the Future ". According to him fishing vessels operate only in shallow water in small scale with traditional methods during this era. Basically demand came from around the coastal area due to transport issues with row

fish. During the colonial time there is less support from colonial governments to fishery industry of the country.

(ii)Post-Independence Era: The fisher population was not evenly distributed along the coastline of the country prior to the 1950s. Fishermen migrated place to place to avoid wave climate variation. Beach seine fishery (in coastal zone) was dominated in 1950s and 1960s that contributed over 40% to the marine fish production and continuously declined. In the year 1984 the production was only 7.6% (Hewagama & Amaralal, 2004).

Ceylon Fisheries Corporation (CFC) was established in the year 1964 and actively involved in purchasing and selling fish in different parts of the country. The sole authority was under the state control.

Ceylon Fishery Harbours Corporation was established in the year 1972, which is responsible to provide harbour facilities, ice plants and boats repair facilities and other facilities, most of the fishery harbours were established during this period.

Since 1982 due to civil disturbance situation, migration to north and east from other areas was stopped and fishermen were forced to operate in their home areas, resulted in more pressure in coastal habitats and low fish production (Hewagama & Amaralal, 2004). Before the civil disturbance situation, North-East area of the country accounted for significant amount of fish production. This part covers more than 60% of Sri Lanka coastal belt. Therefore civil disturbance was major setback for the Sri Lanka fishery industry. However with the ending of war in the year 2009, fishery industry of North-East part is recovering.

Today, Sri Lanka fishery sector is well managed through Ministry of Fisheries and Aquatic Resource Development (MFARD). It framed national fishing policies and development objectives. Around 19 major fishery harbours, 40 anchorages and over 1,500 landing sites are operated throughout the country. Moreover after ending the war, dramatically recovering of fishery sector is visible in North-East region of the country. Fish production in Jaffna and Mannar districts indicates 59.7% and 32.7% of increases in

2010 compare to 2009 due to relaxation of the limitations for fishing in Northern region (Statistic; MFARD, 2010).

In the Year 2010, Sri Lanka total fish production was 383,650 MT and around 85% of this comes from marine sector. Sri Lanka fish production indicates good improvement during last few years as shown in figure 2.2.

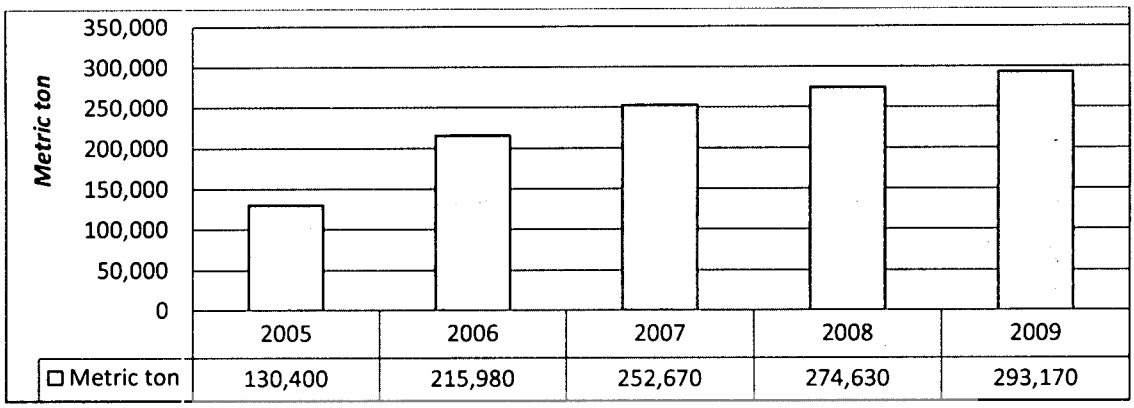
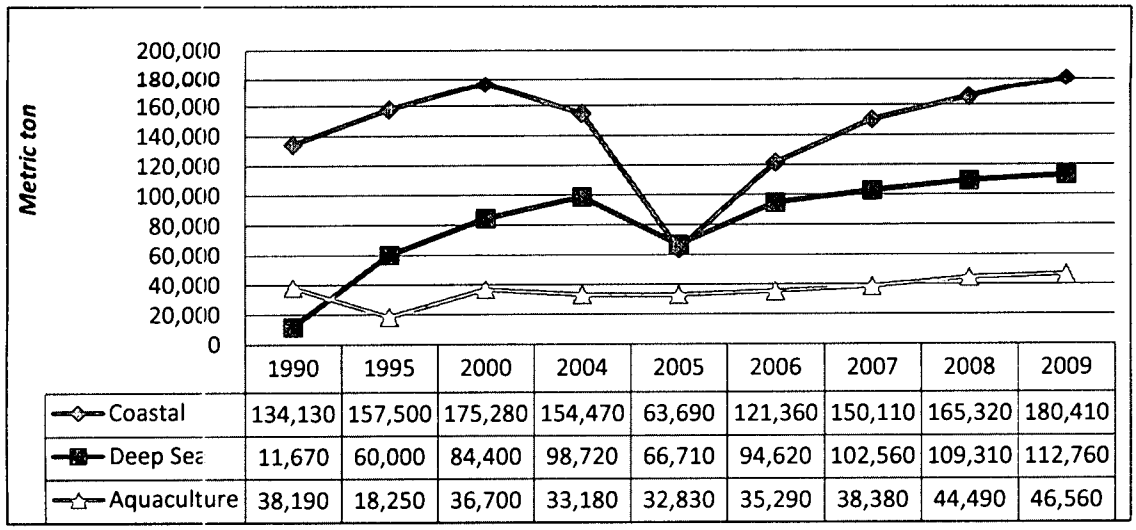


Figure 2.2: Annual Marine Fish Production of the Sri Lanka (Statistic; MFARD, 2010)

Per Capital annual fish consumption is 15.7 Kg per person. Around 17,568 Metric tons of fish and fishery products which valued Rs.20,023 millions were exported in the year 2010. Total Number of registered fishing vessels operate in Sri Lanka is 46,138. Direct employees with fishery sector are 220,960 which represented around 6.5% of work force of the country. (Statistic; MFARD, 2010)

2.3 Fisheries Sub-Sectors

There are three main sub-sectors within the fisheries sector. They are Coastal, Offshore, and Inland /Aquaculture Fisheries. During the last few years production of these sectors are as of figure 2.3



	1990	1995	2000	2004	2005	2006	2007	2008	2009
Coastal	134,130	157,500	175,280	154,470	63,690	121,360	150,110	165,320	180,410
Deep Sea	11,670	60,000	84,400	98,720	66,710	94,620	102,560	109,310	112,760
Aquaculture	38,190	18,250	36,700	33,180	32,830	35,290	38,380	44,490	46,560

Figure2.3: Annual Marine Fish Production by Fishing Sub-Sectors,

Data Source: (Statistic; MFARD, 2010)

Coastal Fisheries are taken place within the continental shelf. Coastal fisheries continue to be the dominant sub-sector in terms of its contribution to production and employment. In the year 2010, this sub-sector accounted for 60.9 % of the total production of Sri Lanka. 42,792 fishing crafts which is 92.74 % of the entire fishing vessels of the country were deployed in this sub-sector (Statistic; MFARD, 2010). Figure 2.3 shows that there was a highly significant impact on coastal fishery by the year 2004 tsunami disaster. Moreover effect of monsoon is highly significant in coastal fisheries in Sri Lanka.

Deep Sea fisheries are taken place outside the continental shelf, extending up to the edge of the Exclusive Economic Zone and even in the high seas by multi-day boats. It is the fastest growing sub-sector in the country. In the year 2010, this sub-sector contributed 39.1 % (Statistic; MFARD, 2010) to the total fish production of the country. The subsector has huge potential for the enhancement of fishery industry in the Sri Lanka.

Inland /Aquaculture Fisheries are taken place in irrigation tanks and reservoirs gives lot of benefits to the rural community. It provides cheap protein, incomes and employment opportunities. In the year 2010 the subsector produced around 51,390 MT. It is 13.4% of total fish production of the country (Statistic; MFARD, 2010). Figure 2.3 indicates that,

there is no significant improvement of the sector with respect to other two sub sectors during last few years.

Ministry of fisheries has taken several steps to improve the sector recently. They are Introduced fish culture in 280 seasonal tanks, Fresh water prawn fishery in 198 tanks, Introduced Best Management Practices (BMP) for fishermen and strengthened the fisher organizations (Ministry of Fisheries and Aquatic Resources Development, 2011).

2.4 Fisheries Administration

In place of proper administration structure is very important in longline vessels operation. Good harbour facilities need for longline vessels. Further international code of conduct should be follow when operating in the high sea.

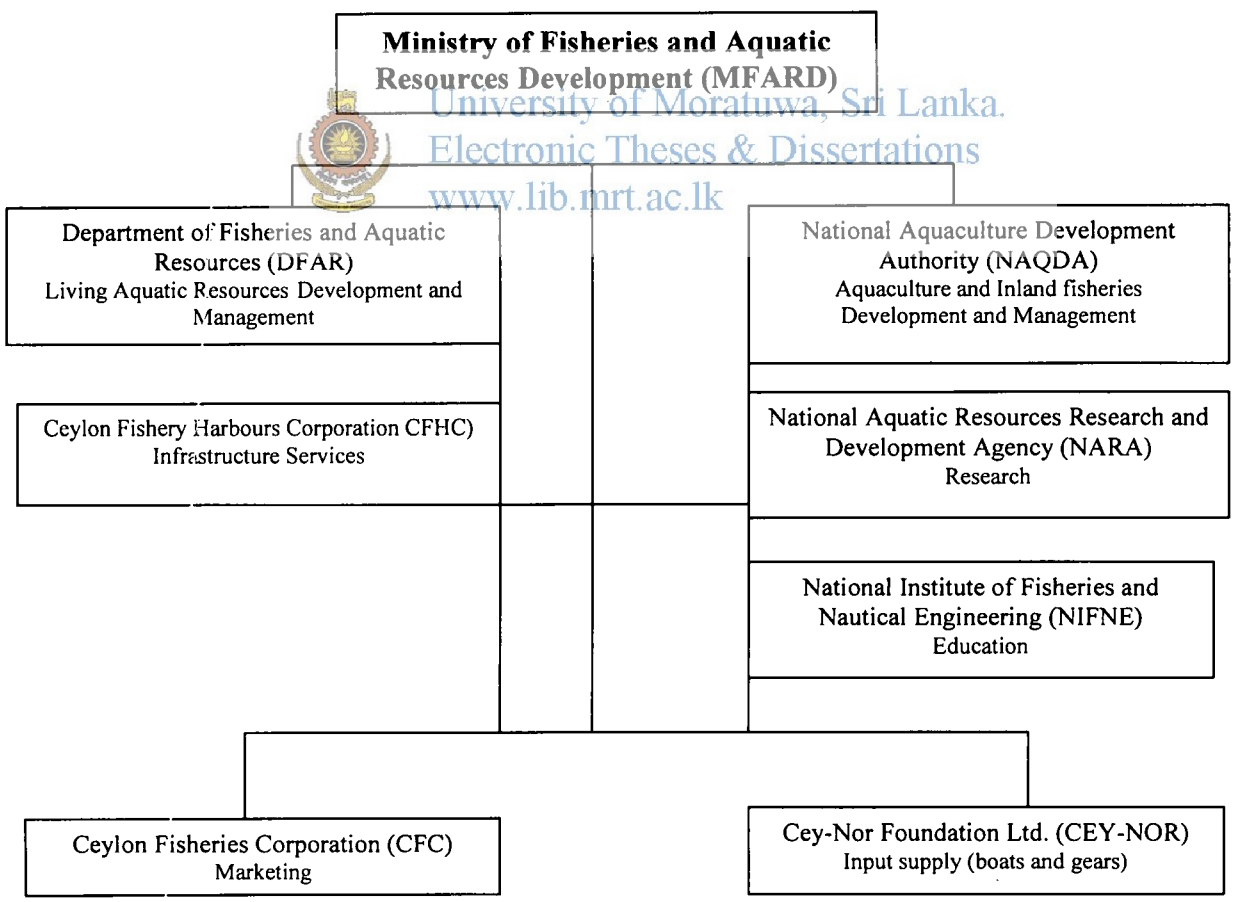


Figure 2.4: Main Institutions Under the MFARD

In addition to that there must be rules and regulations need to be established and implemented to avoid Illicit, Unregistered and Unreported (IUU) fishing with in the Sri Lanka water.

The main administrative and policy making organization for fisheries in Sri Lanka is the Minister of Fisheries and Aquatic Resource Development (MFARD). The functions of the Ministry are to promote the development of the fishing industry, regulate fisheries activities and look after the welfare of those engaged in fishing.

In addition, there are 7 other national institutions under the Ministry of Fisheries as in the above figure 2.4, (Ministry of Fisheries and Aquatic Resources Development, 2011). From these institutions, Ceylon Fisheries Corporation (CFC) and Ceylon Fishery Harbours Corporation (CFHC) are more relevant to longline fishing.

2.4.1 Ceylon Fisheries Corporation (CFC)

The CFC was established to take up the commercial activities carried out at the time by the Department of Fisheries and the Ceylon Cooperative Fish Sales Union. The operational centre for the CFC is the Mutwal Fishery harbour. Main business activities of Ceylon Fisheries Corporation at present are the purchase of fish directly from fishermen through its regional offices, Import of fish, distribution and sale of fish at a reasonable rate to the consumers through CFC retail fish outlets. Foreign longline vessels are approached to Mutwal fishery harbour to land their harvest. Mostly these vessels catch fish in Sri Lanka water with the license from MFARD. CFC takes 10% of their harvest as taxes. Further they buy non export quality fish from these vessels and distribute them in their market channel.

The Corporation operates 99 retail sales outlets in Colombo and other regions as of October 2011. Further the CFC performed it's retail operation through Mobile Sales, Lak Sathosa, C.W.E. Sales Outlets, Economic Centers at. Rathmalana, Narahenpita, Nuwara-Eliya and Walisara

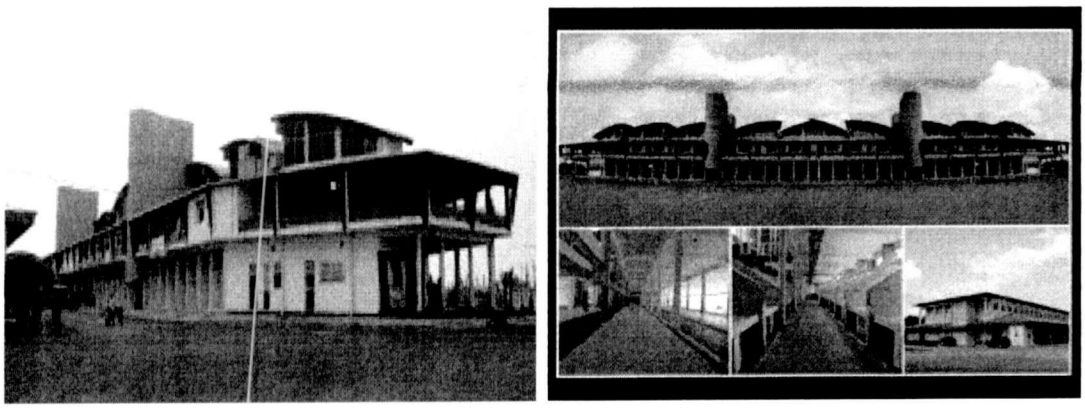


Figure 2.5: Paliyagoda Fish Market Complex

The Fisheries Corporation is the main administrative body of the new Central Fish Market Complex of Paliyagoda (PCFMC). The new complex was built at a cost of Rs.3.8 billion. The Government and Asian Development Bank (ADB) provided the funds for the complex. The market consists of , 148 wholesale, 126 retail shops, 25 MT ice factory (flake ice), three cold storages, and also a Quality control room (Operation: Ceylon Fisheries Coperation, 2011). Fish market practices of Sri Lanka need to improve lots. In such circumstance PCFMC acts as a model fish market to the country.

2.4.2 Ceylon Fishery Harbours Corporation (CFHC)

The role of CFHC is very important for longline fishing in Sri Lanka. Because longline vessels can be launched only from CFHC harbours. Moreover they are maintaining necessary services and infrastructure for longline fishing such as, mooring and service jetties, fuel and water bunkering facilities, Ice plants and Cool Stores etc. The tasks assigned to the CFHC are the establishment, construction, maintenance, operation and management of fishery harbours, anchorages and shore facilities of the country.

CFHC manages eighteen fishery harbours throughout the country (Operation: Ceylon Fisheries Coperation, 2011). Locations of these fishery harbours are as of figure 2.6. One additional harbour is being constructed at Dickowita, Colombo. After completion the work in the beginning of the year 2012, it will be the biggest fishery harbour in the south Asia. It has been planned to construct with -5.0m from MSL which can cater services of modern longline vessels. CFHC has identified 11 new fishery harbours to be constructed

in former war zone. Most of these new harbours will be constructed with -5.0m depth which can be provided services for bigger longliners. In addition to that, CFHC has identified 6 existing fishery harbours to upgrade and provide effective services for modern fishing vessels specially longline vessels.

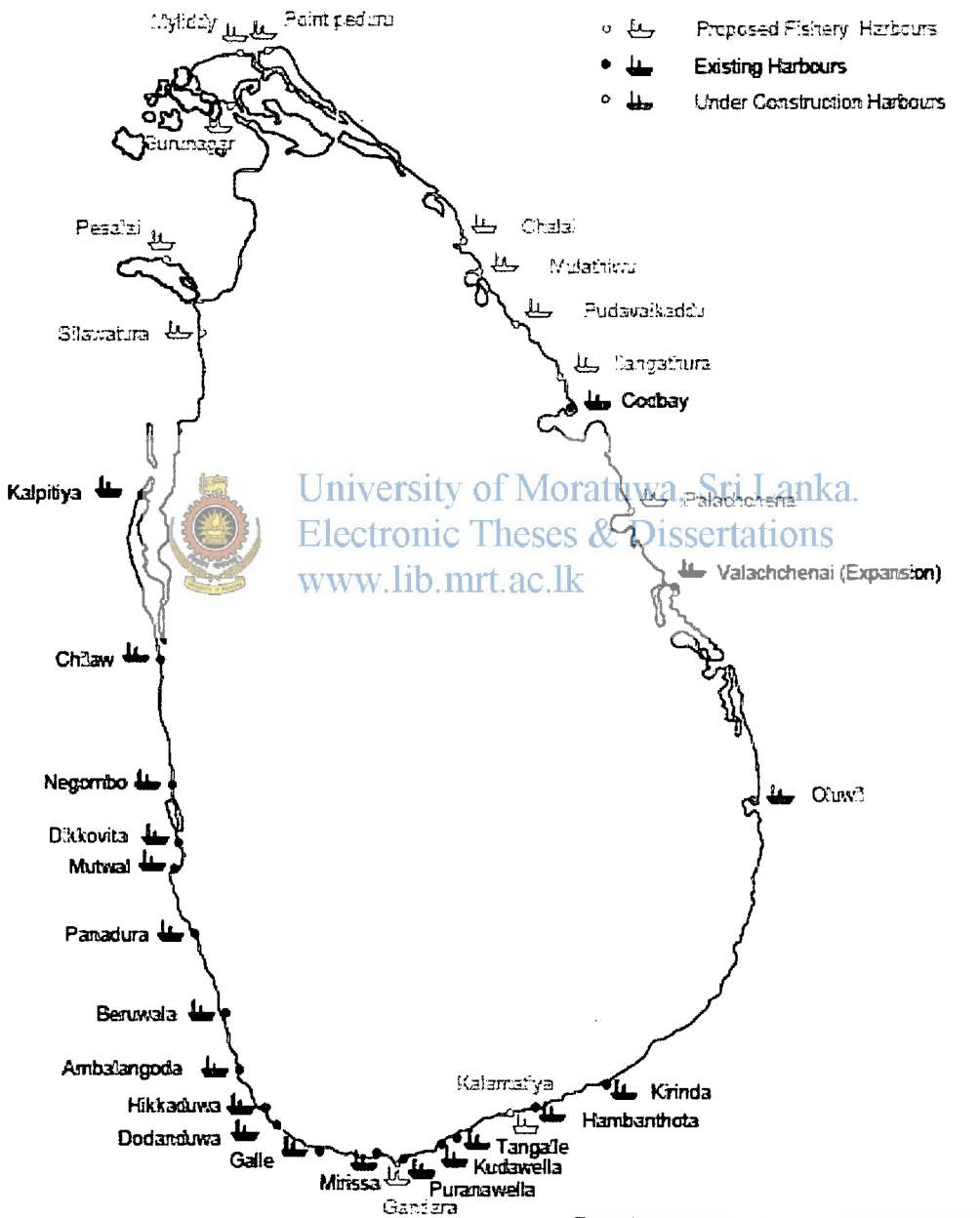


Figure 2.6: Locations of Fishery Harbours in Sri Lanka

Source: (Harbours; Ceylon Fishery Harbour Coperation, 2011)

2.5 National Policy of Fishing Industry

National Policy is very important to achieve sustainable development of the fishery industry. MFARD has prepared the national fishing policy to achieve its main objectives. These policies are

1. Improvement of Nutritional status and food security of the people by increasing the national fish production
2. Minimization of post harvest losses and improve quality and safety of fishery products to acceptable standards
3. Increase employment opportunities in fisheries and related industries and improve the socio- economic status of fisher community
4. Increase foreign exchange earnings from nontraditional fishery products exports
5. Conservation of the aquatic environment

These polices are more relevant to longline fishing. Polices related to Improving national fish production, Increase employment opportunities, Increase foreign exchange earning is vital to improvement of longline fishing in the country.

Ministry has frame work for these policies to achieve the following objectives

- Consumer Protection: To provide quality fish at affordable prices by expanding the CFC marketing channel and elevation of malnutrition through increased fish consumption
- Development of the Fishing Industry: Development of infrastructure facilities (Harbours, Landing sites, Ice supply etc), Introduction of Tuna fishing vessels with RSW/CSW (Refrigerated Sea water/ Chilled Sea Water) facility and Vessel Monitoring System (VMS) for offshore/Deep sea fishing vessels in compliance with international standards.
- Social security for Fishers and fisher community: Organize and strengthen the fisher community to increase the income and living standards
- Sustainable use, Conservation and Management of Resources: Introduce Best Management Practices (BMP), Implement the Management plans, prohibition of destructive fishing methods and encourage the environmental friendly methods,

enhance the aquaculture fisheries, strengthen the legal coverage. (Ministry of Fisheries and Aquatic Resources Development, 2011).

Fish requirement for the minimum nutritional level is 22 kg per person (Ministry of Fisheries and Aquatic Resources Development, 2011). By targeting this level, MFARD has planned to produce 685,700 MT in the year 2013. This strategy has summaries in table 2.1.

		Unit	2010	2011	2012	2013
1	Per Capita Fish Consumption targets (kg)	kg/ person	13.4	15.7	18.5	21.9
2	Mid-year population	Million	20.56	20.68	20.8	20.92
3	Fish requirement to meet the above consumption levels	Mt	274,890	325,390	385,840	458,290
4.1	Marine Fish Production	Mt	339,300	416,200	495,900	590,900
4.2	Inland Fish Production	Mt	55,500	66,400	79,300	94,800
4.3	Total fish Production targets	Mt	404,800	482,600	575,200	685,700

Source: (Ministry of Fisheries and Aquatic Resources Development, 2011)

Table 2.1: Fish Consumption and Production Targets of MFARD

The fisheries sector improvement has been spread over three different phases named, Short term over three years (2007-2009), Medium term over four years (2010-13), and Long-Term over three years (2014-16).

In the view of above fishing polices and planned achievements, deep sea fishery sector will be highly significant in the near future of the Sri Lanka fisheries industry. As the method of enhancing deep sea fishery sector longline fishing can play a vital role.

2.6 Basic Fishing Methods:-

Longline is a one of the fishing method in Deep sea fishery sector. It is important to review the basic fishing methods in fisheries sector for better understanding the longline fishing.

Fishing techniques are methods of catching fish. Fishing techniques include hand gathering, netting, angling and trapping. According to the perforce of fishing, it can be categorized as recreational, commercial and artisanal fishers. Recreational fishers are the fish for pleasure or sport, while commercial fishers are the fish for profit. Artisanal fishers use traditional, low-tech methods, for survival in third-world countries. Some time it can be cultural heritage in some countries. Mostly, recreational fishers use angling methods. Commercial fishing uses netting in gillnet fishing and angling in a longline fishing.

Hand fishing, Netting, angling, trapping are the basic fishing methods. Hand fishing gathers many sea foods with small equipment by using the hands. Gathering shellfish by hand, collecting crabs are the examples of hand fishing. Netting is the principal method of commercial fishing, though trolling, dredging and traps are also used. Netting uses in trawling fishing which is widely use fishing technique in the past. However it has been banded in many countries. Sri Lanka also restricted to use trawling fishing due to its harmful nature of sustainability of fishery industry. However, restriction of trawling is lifted in several months in the year.

Angling is a method of fishing by means of an "angle" (hook). The hook is usually baited with lures or bait fish. Angling is the principal method of sport fishing, but commercial fisheries also use angling methods involving multiple hooks, such as longline. Trapping was very popular methods in artisanal fishing, dam fishing, lobster traps. There are essentially two types of trap, a permanent or semi-permanent structure placed in a river or tidal area to catch the fish. Net also can effectively use to tapping the fish.

Fishing vessels either used basic/modified methods or with combination of several methods for effective catching process. There is a complicated link between various fishing techniques and knowledge about the fish and their behavior including migration and habitat. The effective use of fishing techniques depends on this additional knowledge. Which techniques are appropriate is dictated mainly by the target species and by its habitat. Understanding of appropriate technique is very important for the successfully commercial fishing operations.

2.7 Commercial Fishing Techniques:-

Many different methods of fishing and types of fishing gears for catching commercially important fish have appear over the centuries. Their continue development of fishing gear happed to meet the local conditions in many parts of the world. As a result sophistication fishing gears were developed which is use in modern commercial fishing. In early 1996 Ramakrishnan pointed out that Conservation of natural resources, Prevention of economic waste, protection of investment, prevention of conflict, protection of environment, increasing employment opportunities, promotion of social welfare, enhancement of public revenue were the challenges of commercial fishing (Ramakrishnan, 1996). These are applicable to present situation also. Diminishing of fish stock due to overfishing, conflict between fishermen in various countries are the major concerns today. Some of the popular commercial fishing techniques are as follows.

The widely use commercial fishing techniques are combination of basic fishing methods and technology. They are known as longline, Gillnet, and trawling. Some of these fishing methods such as trawling have been banned due to their harmful and distinctive nature. Below are the some facts related to destructive fishing techniques.

2.8 Destructive Fishing Techniques

Destructive fishing practices are practices that easily result in irreversible damage to aquatic habitats and ecosystems. Destructive techniques challenge sustainability of fishery industry as well as the aquatic habitats and ecosystems. On the other hand, overfishing by modem technology is challenging the sustainability. Fishing industry of all around the globe is facing extended threat due to efficient technologies and practices are increasingly being used.

Many fishing techniques can be destructive if used inappropriately, but some practices are particularly likely to result in permanent damages. Some of these practices are, dynamite fishing, Cyanide fishing, coral crushing fishing (Nicolae, 2008). In fact deep sea fishing can be destructive when it affects the sustainability of deep sea fish stocks. Multiday gillnets and longline fishing are the widely used deep sea fishing techniques in Sri Lanka.

2.8 Gillnet Fishing

Gillnet Fishing is a common fishing method used by commercial and artisanal fishermen of all the oceans and in some freshwater. Gillnet fishing is a method of fishing with a specific mesh size net to catch fish of a specific size range. The fish can swim part-way but not all the way through the net. When it tries to back out, it becomes catch on its gill covers. Mesh size, twine strength, as well as net length and depth are all closely regulated to reduce unwanted size fish. Smaller fish pass harmlessly through the mesh, and larger fish are not trapped. In bigger gillnet vessels; there is a special hydraulic or mechanical arrangement to drag the net as shown in figure 2.7.

Figure2.7: Drag arrangement of a Gillnet Fishing Vessel

Negombo is a famous destination for gillnet fishing in Sri Lanka. There offshore fleet consists of around 60 registered multiday gillnet vessels. Many of the multiday gillnet boats have bigger hull. However draft height of a bigger gillnet vessels is a challenge to move from Negombo lagoon mouth.

Koriya (2007) conduct study in fishing industry of the India. He stated that most gillnet vessels were converted from trawling vessels which were band to use due to its harmful nature of fishing (Koriya, 2007). It is also similar to the Sri Lanka. Trawling fishing has been banded in the Sri Lanka. Further most of the Sri Lankan gillnet vessels are not properly design and they don't have good preservation and storage facilities.

Sainsbury, (1996) pointed out the effect of some type of nets which account for wide range of fish by-catch because of their fishing action. True gill nets are effective in harvesting a select range of fish sizes by adjusting mesh size.

2.10 Logline Fishing

To get better understanding of literature review related with the longline, it is important to get some basic theoretical understanding of longline fishing. Longline fishing is a leading deep sea fishing techniques. It is defined as passive fishing method. That means fish moves towards the stationary gear.

As indicated by the name of the gear, the main part of it is a long (main) line to which branch lines with baited hooks are attached. The basic longline gear unit consists of four parts as indicated below

1. The mainline is the "backbone" of the longline gear to which the branch line and hooks are attached at intervals
2. The Branch line
3. The Hook
4. The Bait.

Longline fishing uses a long mainline which are attached hundreds or thousands of branch lines, each with a single baited hook. The mainline can be from 5 to 100 nm (nautical mile) long. The line is suspended in the water by floatlines attached to floats. Longlines are usually set and hauled once daily and are allowed to drift freely, or soak, for several hours while fishing. Longlines are set, either by hand or mechanically.

The history of longline fishing in Sri Lanka is go back early 1980. According to Amarasinghe, (2001) beginning of deep sea fishing can be found as follow.

After experiments conducting the late 1950s by the state using One-Day Operating Crafts (ODOC) with inboard engine for deep sea fisheries for facilitating fishing up to 40 km from the coastline that type of fishing became popular among fisher folk. However, these types of boats were not equipped with facilities to chill or freeze the fish and therefore they had to confine their fisheries only one day. By the late 1980s as a solution

to mitigate this problem the fishers started introducing an ice compartment to their existing one-day crafts. These became very popular as *tank boats or tanki boattu*. These tank boats were later replaced by multi-day deep sea operating vessels which were longer and with more sophisticated equipment, fishing gears, an ice hold and a cabin for the crew members (Amarasinghe, 2001).

However world fishery industry is far ahead from us specially. Japanese and European countries. Therefore it is reasonable to assume that these modifications and introduction have been done with the influence of exposure to the oversees fishery industry.

Asmund & Svein (1996) provided some basic principles of the longline fishing in their book of *Longlinning*. Today longline fishing use different technology than in early 1996. However basic principles of longline fishing are unchanged. According to nature of vessel operate longline operations can be divided in to two categories.

• Large (typically >250 GRT, Gross Registered Tonnage) Distant Water Fishing Nation (DWFN) freezer vessels which undertake long voyages of several months and operate over large areas of the region. Sri Lanka doesn't have DWFN vessels. However few foreign vessels come to Mutwal international fishery harbor at Colombo for acquire services and unloading the fish

• Smaller (typically <100 GRT) offshore vessels, usually domestically based, with ice or chill capacity, and serving fresh or airfreight sashimi markets, which operate mostly in tropical areas (Asmund & Svein, 1996). Most of the longline vessels operate in Sri Lanka belong to this category.

With the globalization and more commercialization of fishing industry, today above categorization is emerged more than in early 1996. However most DWFN vessels belong to developed countries. They enjoy the benefit of most deep sea fish stock of the ocean. Longline fishing operates in difficult platform than coastal fishing. Moreover Sri Lanka blessed with huge fishing area in the sea and easy access to the international water. However Sri Lanka fishery industry still not benefitted from that blessing. Hence it is better to review the problems and facts related to longline fishing

2.10.1 Problems of Longline Fishing

Deep sea fishing is one of the most dangerous occupations in the world. Every year, hundreds of fishermen lose their lives at sea or are injured while working. It can be due to natural situations, such as cyclones or other weather conditions. Most losses of lives and accidents at sea are due to human error. Accidents often occur because of poor watch keeping or carelessness. Further accidents can also happen because fishermen use older vessels which are not acceptable for long trips. Lives are sometimes lost because when disaster strikes the boat and crew are not prepared. But these risks can be minimized with basic common sense principles and adding latest technologies for their fishing. Weather conditions should be checked prior to departure. Further weather should be monitored on a daily basis throughout the fishing trip.

Difficulty in conducting an effective Monitoring, Control and Surveillance (MCS) programme for the Sri Lankan deep sea vessels is a biggest problem in the industry. As a result Illicit, Unregistered and Unreported (IUU) fishing are happened in Sri Lankan water. Specially poaching in Sri Lankan waters by South Indian fishermen is a biggest problem in the fishery sector of the country. Hettiarachily, (2007) describe the conduct of Indian fishermen effect on our fishery industry. Fishers in the districts of Jaffna, Kilinochchi and Mannar face severe competition from Indian fishers who were crossing the maritime boundary and poaching resources on the Sri Lankan side. The Indian fishers were using craft of 28 – 46 ft. long with mostly inboard engines when local fishers were using mostly 17 – 23 ft craft with outboard engines. Indian fishers were using bottom trawls when local fishers were using gillnets; and the Indian fishers massively outnumbered the local fishers. Many incidents where fishing nets of local fishers were damaged or lost as a result of Indian trawlers running over them were reported (Hettiarachchi, 2007). Hettiarachchi gave this commend during the peak time of war where Sri Lankan fishing activities are mostly restricted. Today this situation is more severe than 2007. Everyday Medias carry news related to issues with the Indian fishermen.

Lack of capital is another major challenge for longline fishing. It needs more capital-intensive than fisheries in shallower waters on the continental shelf. It has been highlighted in a research conducted on Sri Lanka fishery sector by Banks, Gunawardena, Abeysekera, Fernando, & Joseph, (2007)." The Banking sector regards fisheries as high risk because of the historic nonpayment of debts. Vessels are also regularly subject to detention, arrest and loss of valuable assets when confiscated for fishing in other country jurisdictions. Investments in the small scale coastal sector have suffered owing to restrictions in access to credit or limited ability to manage cooperative credit schemes. Nevertheless, smaller scale fishers tend to have a better record in debt repayments" (Banks, Gunawardena, Abeysekera, Fernando, & Joseph, 2007). According to them credit problem is severe for deep sea sector then coastal fisheries. High risk, bigger capital requirements, bad record are the main courses of lack of credit facilities to the deep sea fishing sector of the country. Specialy detention of vessels, arrest and loss of valuable assets when detention by other countries are the major concerns of getting credit facilities for longline fishing.

Inadequate infrastructure facilities for longline vessels are another problem. Depths of most fishery harbours in the Sri Lanka are not attractive for bigger vessels. This discourages operation of longline fishing in mass scale. Moreover mooring of bigger vessels of these harbours can disturb the existing coastal vessel fleet. Further these harours equipped with outdated or inefficient harbour facilities for mooring of vessels, bunkering of fuel, water and ice.

Longline vessels often prefer to sell their harvest in deep sea for attractive price. Some Foreign vessels engage in longline fishing in Sri Lankan water under the licence of MFARD. They are bound to unload their catch to our harbours and then taxes will be calculated according to their catch. To avoid these taxes these vessels sometime prefer to sell their catch in deep sea. Therefore it is really difficult to get exact figure of total annual catch of longline fishing in Sri Lanka.

Further there is no proper data recording systems in regional harbours. Statistics are essential material for planning modelling the policies. IOTC in 2007 has identified

statistical problems of Sri Lanka fishery sectors. Data collection and processing (Non-functional institutional linkages, Incomplete data collection, Incomplete vessel activity record, Species identification is uncertain, Insufficient data on catches, Insufficient verification of field monitoring, Inaccurate data used to estimate production),Poor data processing, Data not distributed or was out of date were the major problems of Sri Lanka fishery statistics. These problems were highlighted by IOTC Comprehensive Report 2007 with necessary recommendation to improve the problem.

2.10.2 Status of Longline Fishing in Sri Lanka Today

Sri Lanka has 3,346 registered numbers of multiday boats (IMUL) (Statistic; MFARD, 2010). Around 70% of these vessels engage in longline fishing. There are 18 fishery harbours operate all over the country. from them around 14 fishery harbours successfully providing service facilities to multiday vessels. In the year 2010 Sri Lanka has exported 1,411 MT of Fresh/chilled tuna to the international market. The value of this export was Rs.4,799 Millions (Statistic; MFARD, 2010).

Deep sea fisheries in Sri Lanka operate mostly in specific areas. Research on Deep Sea Fisheries in Sri Lanka by Amaralal, Helgi, & Ögmundur (2010) give some facts regarding these vessels operating areas. It is shown in figure 2.13.

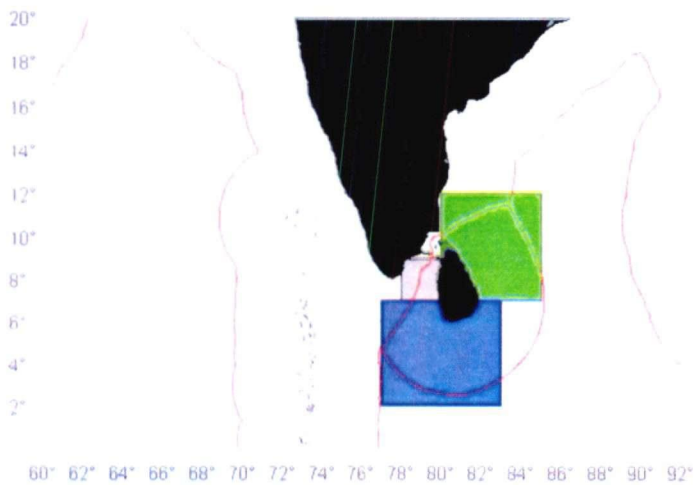


Figure 2.8: Operation Areas of Multiday Vessels in the Sri Lanka

It indicates that these areas of multiday vessels operating regions intersect with territorial water of both India and Sri Lanka. This enhances the problem of fishermen between two countries due to cross boundary issues.

There is a scope for increasing fish production by exploit resources in the deep sea area as well as in the high seas (beyond the EEZ). Sri Lanka has not been able to make effective use of the high value tuna and other resources in the international waters due to the non-availability of enough fishing vessels with the necessary capabilities. Hence it is planned by MFARD to introduce 100 units of a new class of boats of over 24 meter length complete with line haulers, refrigeration equipment/storages, safety/navigation,

Communication equipment, accommodation and facilities for crews in line with international regulations (Ministry of Fisheries and Aquatic Resources Development, 2011). It indicates that the today authorities are more concern about longline fishing.

2.10.2.1 Mutwal Fishery Harbour

Mutwal fishery harbour can be considered as the core fishery harbor of longline fishing in the Sri Lanka. It is located in Colombo with in CFC/CFHC main compound. However it doesn't represent the culture of Sri Lankan longline fishing. Because more than 85% of vessels approach to Mutwal Fishery harbour belong to other countries or local and international joint ventures which consist of different, advance technological and marketing strategy. Harbour has impressive logistical network and right depth (4m to -5m from MSL) for bigger longline vessels.

More than 80% of catch landing to Mutwal fishery harbour is exported to foreign market. 10% of the landing amount of fish is taken by CFC as fishing charges/taxes of catch in Sri Lankan sea area. There are 8 fish export companies involve with fish export operation in Mutwal.

Unloaded fish from Foreign Fishing vessels are exported to the Sashimi and European Market. Moreover CFC buys fish from them and distributes to the local market. Table

2.2 show the export performance of longline operations in Mutwal fishery harbour during last few years

Mt Market	2005	2006	2007	2008	2009
Shasimi Market (Grade 1)	1388	3331	1837	528	601
European Market (Grade 11)	1085	3041	4909	3720	6761
Total	2473	6372	6746	4248	7,362

(Operation: Ceylon Fisheries Coperation, 2011)

Table 2.2: Trans-shipments of Fish Landed by Foreign Tuna Longline Vessels

The table no 2.2 indicates that after 2006, there is a sudden improvement of trans-shipment of fish landed by foreign vessels in Mutwal fishery harbour. Lack of export in the year 2008 was happen due to influence by political factors. Line minister of fisheries was changed in the year 2008.

Physical features of Mutwal fishery harbour is as of table 2.3. Mutwal fishery harbour consists with 2.3 Ha harbour basin area and 130m long quay wall. Existing depth of the harbour is 4 to 5 m which is very attractive for bigger international vessels. Dredging operation is carried out once a year to maintain this depth. In addition, it consists with 230m long breakwater to stabilize the basin.

Table 2.3: Details of Mutwal and Nigombo Harbours

Harbours	District	Basin Area (HA)	Break Water (m)	Land Area (HA)	Dredged Depth (m)	Quay-wall Length (m)	Jetty Length (m)	Ice Plant (t)	Cold Storage (t)
Negombo	Gampaha	Lagoon	-	0.42	3	80+87+100	-	-	10-CFHC
Mutwal	Colombo	2.3	219	0.92	4 to 5	128.7	64	-	100x8+200+50x4-CFC

(Harbours; Ceylon Fishery Harbour Coperation, 2011)

2.10.2.2 Negombo Fishery Harbour :

More than 1000 fishing vessels are operated in Negombo fishery harbour which is located at Nigombo lagoon. It is a very convenient location for fishermen to launch their vessels for offshore fishing. Moreover Negombo lagoon has attractive depth to approach bigger vessels. 220 multiday vessels are registed with Negombo fishery harbour. Physical features of Negombo fishery harbour is as of table 2.3.

Even thought Negombo fishery harbour doesn't have an Ice Plant, lots of private ice plants operate around Negombo lagoon. Vessels are reached to Negambo fishery harbour from other local harboure to sell their harvest. Because, Negombo is a attractive market for local and international selling. It is very close to Katunayaka international airport and Colombo international commercial harbour for export oriented fishing.

Most of the lagoon based fishery harbours faced severe problem of often blocking of their lagoon mouth. It disturbs the bigger vessels movement. However due to natural existence , there is no such issue in Nigombo lagoon mouth. Hence natural existence and market demand of Negambo are very important for longline fishing there.

As per this research design, It has been selected longline and gillnet fishing at Negombo Fishery harbour to evaluate the economic efficiency and Quality of harvest between two methods. The Negombo fishery harbour has a long history. As well as the deep sea fishing, Negombo is very famous for coastal and Lagoon fishing. Fishing statistic indicates that the Negombo accounted for 8.4% of countries fish production which was around 28,250 MTS in the year 2010 (Statistic; MFARD, 2010).

2.10.3 Fish Catch of Longline Vessels

The Catch of loneline vessels can be divided into three distinct categories. They are target, byproduct and bycatch. Tunas are the most important target species of longline fishing.

Main catch species of longline fishing in the Sri Lanka have been described by Amaralal, Helgi, & Ögmundur,(2010) in their reserch on Deep Sea Fishing In Sri Lanka as follow."Deep sea fisheries mainly target by medium and large tunas with skipjack (Katsuwonus pelamis) and yellow fin (Thunus albacares) dominating the catches while sailfish (Istiophorus playtypterus), swordfish (Xiphias gladius) and marlin are also common in the catch. Many species of sharks are also a part of the deep sea catches" (Amaralal, Helgi, & Ögmundur, 2010). There is an internationally recognize code and scientific name for fish for easy identification in the international fishery sector. These details are included in Appendix 04.

Byproduct are species that are caught incidentally (not targeted) during longline fishing. Some of them have a commercial value and are retained for sale. These species include *opah, black marlin.* A range of shark species are also taken as byproduct, although they are mainly prized for their fins.

Bycatch are the unwanted species that are taken incidentally during longline, and are discarded as they have no commercial value. These species include *snake mackerel*, seabirds and sea turtles and fish of small in size.

Davies, (2009) highlighted the adverse effect of bycatch in his "Defining and estimating global marine fisheries" paper. According to him, one of the most urgent threats to the world's remaining fish stocks is commercial fishing, specially the indiscriminate capture of non-target organisms, typically referred to as 'bycatch'. Whilst bycatch may be sold, it may also be unusable or unwanted for a variety of regulatory and economic reasons and subsequently thrown back to sea, often dead or dying (Davies, 2009). Therefore bycatch is a serious issuer with commercial fishing, like longline fishing

Beverly, Chapman, & Sokimi, (2003) defined bycatch in another way. According to them fish, both target and byproduct species, which have been damaged by sharks or other big fish may be retained for crew consumption or sale if the damage is limited. However, when toothed whales take fish, they only leave the heads, and these are discarded. Some Pacific longline fishermen are releasing, alive, small target species as their value is low at

a small size, and they have a chance to grow and become more valuable to the fishermen. Technically these released fish are also considered bycatch. (Beverly, Chapman, & Sokimi, 2003). Their definition is very broad and covers all the aspect of bycatch or unwanted catch during the longline fishing.

2.10.4 Bait Used in Longline Fishing

A passive fishing method uses in long liners. That mean gear is stationary and fish should be attracted to the gear. Therefore success of longline fishing entirely depends of attractiveness of bits. Many commercial longline vessels operate in mass scale fishing; use high quality, expensive imported bits. However medium and small scale fishing vessels operators prefer locally available verities.

In Sri Lanka, squid, Sauri are the most common baits. The problem is to achieve a constant supply since these species are only available seasonally. The cost of imported squid is given as Rs 400-700 per kg by one of the importers (As of October 2011). Imported baits are economical to use, if the yellowfin and bigeye tuna are exported at a considerable higher price than local market price. As a solution to constant, quantities supply of bites for longline fishing Syntactic/Artificial bites have reached to market. They are comparatively expensive and hence not popular among the local operators. These synthetic bites are produced with visible colours and smell (As shown in Figure 2.8) which are effectively capable to attract targeted groups.

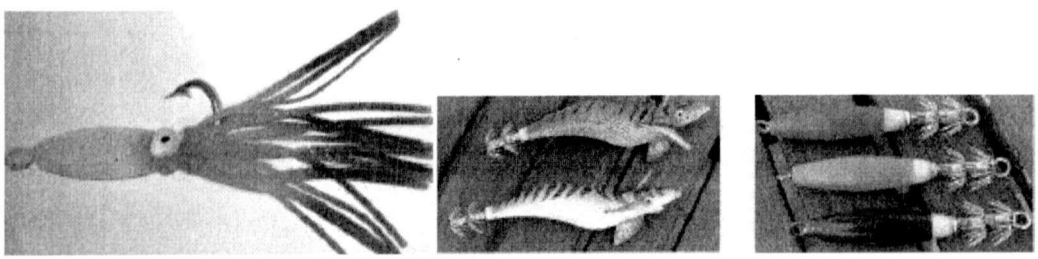


Figure 2.9: Synthetic Bites use for Longline Fishing

Source: (Long Line: Artisan Fisheries Consultant, 2011)

2.10.5 Longline Boats

Beverly, Chapman, & Sokimi, (2003) use basic categorization of longline vessels for their report of "Horizontal Longline Fishing Methods and Techniques" based on vessels

length and weight. These are: small-scale (under 15 m and less than 20 GRT (Gross Registered Tonnage)), medium scale (15 to 25 m and less than 100 GRT), and large-scale (over 25 m and over 100 GRT).

From these three categories small and medium scale longline vessels are widely operate in Sri Lanka. Medium-scale longline vessels have greater operating ranges and fish holding capacities than small-scale longline vessels. They are able to fish within the Sri Lanka entire EEZ and even outside the EEZ on the high seas. Medium scale longline vessels can stay out for one to three weeks and have operating ranges of up to 6000 nm. They are capable of setting and hauling between 1200 and 2500 hooks per day and can make about 10 or 12 sets per trip. For these reasons, they are the most popular size of vessel in Indian Ocean countries including Sri Lanka. The average medium-scale longliner is capable of holding from 10 to 20 MT of fresh chilled fish (Asmund & Svein, 1996) . The crew complement on a medium-scale longliner might range from four to eight fishermen.

In 2006 and 2007, a sharp increased in numbers of registered deep sea vessels were taken place. It was estimated that 195 deep sea vessels were destroyed and 402 vessels were damaged (Census of fishing boats 2006/2007 Sri Lanka, 2008) due to the tsunami disaster. The main reason for this can be attributed to vessel donations by governmental and nongovernmental organizations under the programme of restoration of fisheries, which were affected by tsunami devastation. It was found that the registered number of MDOVs' has increased by 66% in 2007 compared to the year 2004. (Census of fishing boats 2006/2007 Sri Lanka, 2008).

MFARD conduct two island wild census for the fishing boats in the year 2003 and 2007. There are identified deep sea fishing vessels as IMUL which includes longline vessels. But there is no data regarding the exact number of longline vessels operate in Sri Lanka. In 2010 Number of IMUL operate in Sri Lanka are 3,346 (Statistic; MFARD, 2010). According to fishery harbours souses, number of longline vessels operate in Sri Lanka is around 2,500.

There is no record with MFARD that the registration of large scale longline vessels (over 25 m and over 100 GRT) in Sri Lanka. But there are very few international longline vessels under this category approach to Mutwal international Fishery harboure for unloading and get necessary services. Moreover sometime these vessels act as mother vessels. Mather vessels are approached by collective vessels to collect their harvest around once a moth.

2.10.6 Fishing Gears Use in Longline Fishing

Sainsbury, (1996) Stressed the important of choose right fishing gear for the job. Species being fished, Individual Value of fish, depth of water, sea bed characteristics, Selectivity required are the important aspect of selecting fishing gears (Sainsbury, 1996). In fact longline fishing gears comply with most of these requirements. It can target specific verity and size of fish according to their living depth.

Fishing gears are often classified into two main categories. They are passive (stationary or fixed) and active (mobile) gears. Trawls, seine nets and purse seines are the most important gears in the active category. Longlines fishing gear is classified as passive gears. With active fishing gears the fish are chased by the moving gear. In contrast, capture of fish with passive gears is based on active movements by the animals towards the gears.

Horizontal Longline Fishing Methods and Techniques written by Beverly, Chapman, & Sokimi gives some vital information about longline fishing gears. According to it, there are two basic types of gears in longline Fishing. Basket gear is a traditional method, particularly use in most vessels in Sri Lanka. Monofilament gear develop in the 1980s and revolutionized longline fishing by offering a less labour intensive and more efficient method of catching fish. Fundamentally, however, the two systems are similar (Beverly, Chapman, & Sokimi, 2003).

However basket gear make easy and affordable for local fishers for longline operation. In this nature of fishing basket gear take less time and less complicated to install. Therefore it has been popular in small scale and medium scale longline fishing.

2.10.7 Important of Vessels Electronics

Longline vessel needs electronic for safe navigation and fishing purposes. Koriya ,(2007) stressed the important of vessels electronic for marine fishery. The application of technologies like, GPS, Fish Finder, Eco Sounder, VHF set also helped these units to do fishing more efficiently, accurately and safely. Any unit, if met with accident or any emergency situation, can seek the help of others by informing them the GPS points that indicate the location of the unit. GPS also help to locate the fertile fishing grounds accurately (Koriya, 2007). However impact of vessels electronic are more important for deep sea fishing due to nature of its operations.

Further CFHC intends to implement fishing Vessel Monitoring System (VMS) as a cost-effective tool for the successful Monitoring, Control and Surveillance (MCS) of fisheries activities. VMS can effectively use to reduce pouching in Indian vessels in Sri Lankan water. Hettiarachchi, (2007) pointed out that mass scale poaching of fishery resources by Indian fishers on the Sri Lankan side of the bay resulted not only in significant losses to the economy of the country, but also in severe political problems to the Government (Hettiarachchi, 2007). He has made this statement during the civil disturbance time of North-Eastern part of the country where fishing was restricted from Sri Lanka site. Then the Indian fishermen sole benefited from fish stocks in these areas. Even after the war restrictions are lifted for Sri Lankan fishermen, still Indian fishermen continue their practices. VMS can be effectively used to restrict these poaching.VMS provides a fisheries management agencies with accurate and timely information about the location and activity of day today fishing vessels. In this regards vessels electronic is an important element.

SSB (Single Side Band) or HF (High Frequency) Radios, VHF (Very High Frequency) Radios are very important for efficient longline operations. SST (Sea Surface Temperature) monitors need for longline fishing, as some fish verities are often associated with temperature fronts.

Today most of the longline vessels equip with GPS receivers. It gives vessel position in latitude and longitude at intervals of every second. GPS is a good tool to avoid entering Indian water. Therefore it can reduce Sri Lankan fishermen getting detention in foreign countries. Moreover Fishermen can improve their efficiency with the NARA information forecasting system.

2.10.8 Demarcation of Fishing Sites

Effective demarcating of fishing sites is essential for longline fishing. In general Sri Lanka fishing trip durations are not very much depending on catch. Most fishermen prefer to return back to shore after completing their intended days in Sea either with sufficient catch or not. Sometime their onboard resources (Fuel, food, Ice,) run out after expected days of fishing.

At the beginning of a trip, vessels operator has to decide which direction to go. This decision is usually based on where he fished during the last trip, where the rest of the fleet is fishing, and where there were catches for the same season in the past.

NARA fishery forecasting system is widely used for deep sea fishing in Sri Lanka. It is recently developed and reasonably accurate fishery sites demarcation Systemr. Up to some level, it has helped to reduce the technological gap of the Sri Lanka deep sea fishery sector. The system started as ICEIDA (The Icelandic International Development Agency) funded research project. It delivered impressive result and depend on its finding NARA gives update on potential fishery area and depth map once a week.

Tuna and swordfish generally tend to stay within a range of temperatures. Remote sensing data in the form of maps showing sea surface temperature (SST), sea surface colour and sea surface height are useful in deciding where to fish. SST maps made from data obtained from satellites. The maps show continues lines connecting points with the same temperature. This can be displayed with continue lines or with colour. Sea surface colour is an indication of how much microscopic life (plankton) is in the water. Green colour, for example, indicates the presence of an abundance of plankton. Baitfish and

larger predator fish (the target species of longline boats) are likely to be found around green colour. Moreover NARA uses past log sheet information and real-time information from fishermen to improve the accuracy of the method.

NARA fishing forecast can be obtained any vessels by calling 0112520367 or by contacting 6213.5 kHz freely. NARA forecasted recommendation is valid only 5-7 days duration. Forecast is given as general, good and best fishing ground. Also NARA expects feedback on their forecast from fishermen to improve their system. A such forecast is shown as figure 2.9. Not only the longitude and latitude of the position, it also gives the appropriate depth for longline.

Figure 2.10: A Sample of NARA Fishing Forecasting System

The best source of information about how, when, and where to catch tuna or swordfish is by talking to other longline fishermen. This concept based on knowledge sharing. Even NARA fish forecasting system use real time feedback from fishermen to increase the accuracy of their forecasting. Fishermen who have spent years at sea have gained a great

deal about the fish they catch, about the sea , weather, and about fishing boats and gear by being directly they involved

Fleet fishing is probably one of the best ways to find fish. Five or six boats searching for fish are much more effective than one boat. They stay in daily contact and share position and catch information. Safety is also increased when vessels operate as a fleet. Some fleets report daily to a land base and giving catch data and position. The fleet manager on shore then passes information on to other boats in the fleet, especially those just leaving port.

Moon phases affect longline fishing. Moon Phases are illustrated in figure 2.10. It has been documented that swordfish catches are better on the full moon. François, Jean, Taquet, & Keith carried out a reaserch in 2010 to assess the impact of Moon Phases on longline catch.There finding are as follow

"Our results indicate that swordfish and bigeye tuna exhibit active predation when lunar illumination is weak. These results are consistent with the findings of Fristches (2005), who showed that retinas of swordfish and bigeye tuna provide visual acuity and sensitivity to blue-green light and thus these apex predators are efficient visual hunters in dim light (François, Jean, Taquet, & Keith, 2010)."

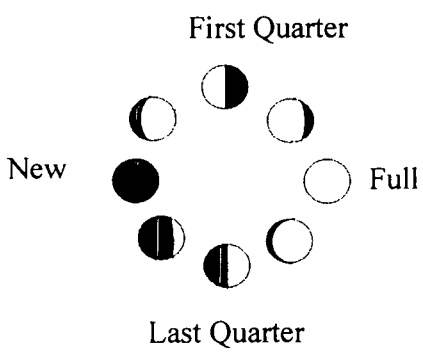


Figure 2.11 : Moon Phase Effect for Longline Fishing

According to their finding some species are active in dim light. These active species are easy to catch in such environment. Dim light create my full moon phase. However,

according to Sri Lankan religious culture most of the fishermen are willing to come back to land before the full moon , specially fishers from in down south part of Sri Lanka.

However when demarcating a fishing sides or travel to particular location it is very important to consider weather forecast also, Specially Northern part of Sri Lanka. Because typhoons frequently occurrence in this part. The weather forecast chart should be examined and taken into consideration when setting out on a longline trip.

2.10.9 Preservation Practices and Longline Fishing

In longline operation on board fish preservation is very important. Because qualities of longline catch sustain with preservation. In modern longline vessels instead of ice cube preservation, they are equipped with chilled bath system which is more economical and effective. However there were no boat found in our research which use chilled bath system in Negombo fishery harbour.

Peter, (2004) has documented "Project proposal improvement fisheries sector in Sri Lanka". He has highlighted the important of preservation practice to improve the fishery sector of the Sri Lanka as follow.

"To preserve the quality of the fish block crushed or flake ice should be used, but this is not always the case. The ratio ice to fish needed is around 3:1 (Weight of Fish: Weight of Ice). The fish/ice mix is stored in the hold in bulk. The main factors contributing to the high post-harvest quality losses in the multi-day offshore fishing boats are nets , gear soaked for a long time, not maintaining chilling temperatures around sub zero temperature in the fish hold, overstocking of fish in shelves of the fish hold (causing crushing and deformation of fish at the bottom), extended storing time of fish in fish hold with long trip duration, use of contaminated ice and water to clean fish and boats and incomplete cleaning procedures in washing the boats" (Peter, 2004).

With respect to the year 2004, today preservation practices have been improved a lot. Awareness of fishermen, quality of ice, availability of ice, Access to national power to

produce ice, less interruption of power are the main courses for improvement of preservation practices.

Most of the fishery harbours managed by CFHC consists with ice plant. In Sri Lanka 70 privet ice plants are operated with the capacity of 2,012 tons/day. In addition to that 10 government ice plants are operated with the total capacity of 140 tons per day. It is reported price of ice block (50 kg) is cost around Rs 170 in the year 2010. But the price of ice in Jaffna peninsula is Rs,420 in the same year (Statistic: MFARD, 2010) . Only 8 private ice plants are operates in Jaffna with the capacity of 17 tons per day. As of MFARD 2010 data only 6 IMUL operates from Jaffna peninsula (Statistic; MFARD, 2010). Therefore it appears Ice demand of Jaffna peninsula is significant for the transport their harvest to the central fish market in Colombo rather than use in off show fishing vessels.

2.10.10 Post Harvest Fish Losses (PHFL) In Longline Fishing

Fish that is either discarded or sold at a relatively low price because of quality deterioration or owing to market dynamics are called PHFL. This includes fish operators (fishers, processors, traders, and other stakeholders involved in ancillary operations) lose potential income.

Post-harvest fish losses are a major concern and occur in most fish distribution chains in the Sri Lanka. Loss of income to fishers, processors and traders, enhancing food insecurity are some of the adverse effect of PHFL. However longline have significant advantage of handing fish against these losses from fishing to landing operation.

Post-harvest fish losses are often caused by biochemical and microbiological spoilage changes that occur in fish after death. A live fish has natural defense mechanisms that help to prevent spoilage. However, once the fish dies its defense mechanisms stop and microbiological spoilage begins to cause quality deterioration.

Factors influence the rate of spoilage of fresh fish can be described as follow,

- **Time** between death and final use or consumption. Even if fish are chilled using ice, they will gradually spoil over time
- **Temperature abuse**: High ambient temperatures, such as 20 °C, create favorable conditions for fish spoilage. Low temperatures, such as 5.0 °C and below, slow the action of bacteria and the rate of spoilage, helping to reduce losses.
- **Handling practices**: Poor handling practices lead to sustained and increased microbial contamination, hastening the spoilage rate of fish.

There are three types of losses

- Physical loss;
- Quality loss;
- Market force loss

Physical loss

Physical fish loss refers to fish that, after capture or landing, is not used. It is either thrown away accidentally, voluntary or as authorized. This is very common in longline fishing. Because fishing for high-value species such as Tuna, shrimp is often associated with high levels of bycatch. In some fisheries, most bycatch is discarded at sea as it consists of low-value, small fish that are not worth landing.

Quality loss

Quality loss refers to fish that has undergone changes owing to spoilage or physical damage and has suffered quality deterioration. Such fish is sold for a lower price than that which would have been achieved if the fish were of "best quality". This is the most common PHFL in many areas. In longline fishing this can be occurred due to poor insulation system and low quality ice.

Market forces loss

Market force loss is a loss caused by unexpected market demand and supply situations. These cause operators to sell their product at a price below expectations. The loss is the difference between the expected price and the actual price. Specially in export oriented fishing find the good vendor within reasonable time period for decent price may not be

happened. Inadequate market information and trade barriers can prevent the producer from gaining access to the right market with the right product at the right time. Sometimes, marketing malpractices can lead to improper pricing or cheating can occur due to export agents.

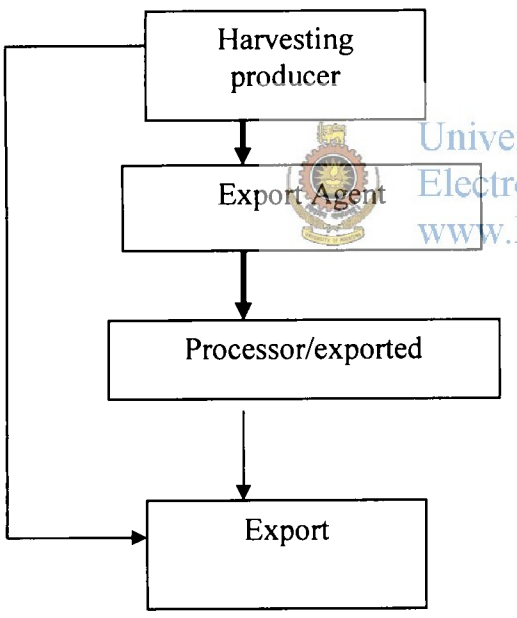
Reducing spoilage can be done by introduce appropriate technologies. Yvette & Yahya, (2011) in there report on " Post-harvest fish loss assessment in small-scale fisheries" state that Using insulated fish containers and training people on their design and construction has enabled many countries to increase fishing trip duration, while keeping fish iced for a longer period of time. The above fact of the report is more applicable to mass scale deep sea fisheries dispute of their topic of small scale fisheries. In fact not only preservation capacities of the vessels, but also fuel, water and food bunkering facilities of vessels need to be improved with fishing trip duration

2.10.11 Value Chain of the Longline Fishing in Sri Lanka

Study the value chain of longline fishing is very important to identify the problems and areas needs to be improved in deep sea fishing in Sri Lanka. The benefits of implementing traceability of fish supply chain is highlighted by Mai, Bogason, Arason, Arnason, & Geir, (2010) as market benefits, recall cost reduction, reduction of liability claims and lawsuits and process improvement. Specially dealing with international trade in longline fishing, it is very important to consider legislation aspect to improve the competiveness through supply chain. Longline fishing value chain can be categorized as Domestic and International market orient value chain

Export value chain (As shown in Figure 2.12) of longline fishing consists with Assembler, Processor/Exporter. Some time producer exports fish directly. Then the efficiency of supply chain increases and harvester can earn the mark up of export agent and processor. Hence the process will be economically more viable. Export agent play vital role in this supply chain. Because important market information are with him.

The domestic market value chain of the longline sea fisheries has three links connecting the harvester and consumer, namely assembler, commission agent and retailer as of Figure 2.13. The assembler is the first middleman. He buys fish directly from vessels when they come ashore and sends it to the wholesale market in Colombo or major city centers where the commission agents, the second middleman in the structure, take over. The commission agents sell the fish on behalf of assemblers for a commission. Commission agents do not take any risk associated with supply chain. Retailers, is the final middleman buy fish from the commission agents and sell it to consumer with some profit. Basic problem of local supply chain is seasonal price fluctuation and lack of buyers due to unaffordable retail prices.



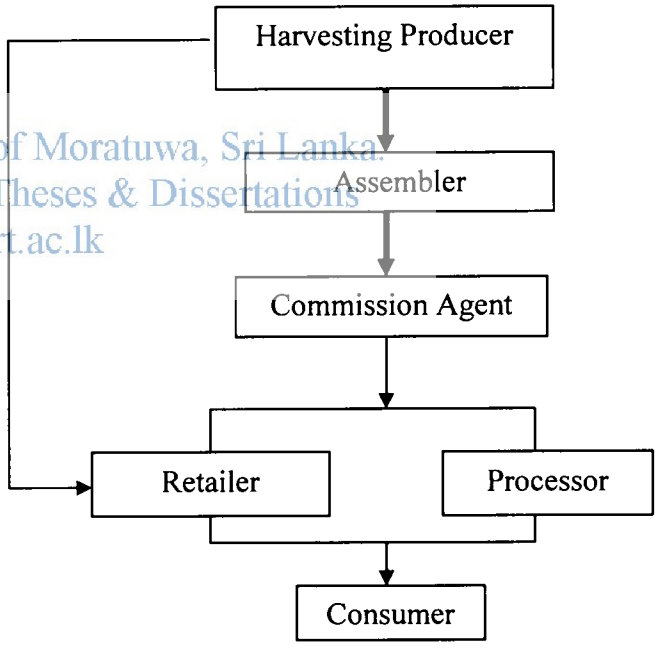


Figure 2.12 : Export Value Chain of Longline Fishing

Figure 2.13: Local Value Chain of Longline Fishing

2.11 Fisheries Management and Longline Fishing

Fishery management is an important aspect of deep sea fishing. Specially these activities are taken place mostly in international sea and there is an easy access to the Exclusive Economic Zone (EEZ) or extra sea bed of other countries. Fisheries management draws to the fishery sector in order to find ways to protect fishery resources. Modern fisheries management is often referred to as a governmental system of management rules based on defined objectives and a mix of management means to implement the rules, which are put in place by a system of monitoring control and surveillance.

According to Sainsbury, (1996) the biggest change in management and administration of world fisheries resulted in 1983, from the international low of the sea agreement which establish a 200 mile EEZ within which each coastal country has exclusion right to the exploration of marine life. As well as introducing this agreement it is important to respect and honor this agreement. Specially by developed countries by avoiding poaching in EEZ of developing countries.

Cox, (2006) pointed out that deep sea fisheries began to increase in importance in the 1970s, coinciding with declines in shallow water fisheries and the extension of the Exclusive Economic Zone to 200 nautical miles under the UN Convention on the Law of the Sea. Improvements of technology in terms of larger vessels and more powerful fishing gear helped expand the ability of fleets to exploit the deep-sea resources. Therefore according to Cox, policy implementation on EEZ enhances the deep sea fisheries. This is true for country like Sri Lanka. But it may negatively affect mass scale fish producing countries by limiting their harvesting zones.

In addition to place of borders, marine pollution, marine conservation, ecology balance need to address in fisheries management. Similar to other environmental issues, there can be conflict between the fishermen who depend on fishing for their livelihoods and fishery scientists. Fishing Scientist want to limit or cease operations to protect some fish stock for future. The slow growth of deep-sea species is largely explained by the low levels of energy and nutrients in the ocean depths which they inhabit. Issues involved in the long

term sustainability of fishing include overfishing, by-catch, marine pollution, environmental effects of fishing, climate change and fish farming.

New Fisheries and aquatic resources act (No 02, 1996) covers all the aspects of legislation related to the Sri Lanka fisheries which includes, Operation of licensing fishing, Registration of local fishing boats, Protection of fish and other aquatic resources (Ministry of Fisheries and Aquatic Resources Development, 2011). Under this act trawling has been band due to its adverse impact of natural resources. It indirectly promotes longline fishing which is environment friendly and enhances sustainable fishery industry.

2.11.1 Indian Ocean Tuna Commission (IOTC)

IOTC plays wide role in fishing management. It is an intergovernmental organization established under Article X IV of the FAO constitution. It is mandate to manage tuna and tuna-like species in the Indian Ocean and adjacent seas. The objective of the Commission is to promote cooperation among its members, with a view to ensuring, through appropriate management, the Conservation and optimum utilization of stocks covered by this Agreement and encouraging sustainable development of fisheries based on such stocks. In order to achieve these objectives, the Commission has following functions and responsibilities,

a) To keep under view the conditions and trends of the stocks and to gather, analyze and disseminate scientific information, catch and effort statistics and other data relevant to the conservation and management of the stocks and to fisheries based on the stocks covered by this agreement.

b) To encourage, recommend, and coordinate research and development activities in respect of the stocks and fisheries covered by this agreement, and such other activities as the commission may decide appropriate, including activities connected with transfer of technology, training and enhancement, having due regard to the need to ensure the equitable participation of members of the commission in the fisheries and the special interests and needs of members in the region that are developing countries.

c) To adapt, on the basis of scientific evidence, conservation and management measures to ensure the conservation of the stocks covered by this Agreement and to promote the objective of their optimum utilization throughout in the Area.
d) To keep under review the economic and social aspect of the fisheries based on the stocks covered by this agreement bearing in mind, in particular, the interests of developing coastal states. (About IOTC: Indian Ocean Tuna Commission, 2009)

In the view of above objectives and responsibilities of IOTC, it provides better protection for developing coastal states like Sri Lanka. Therefore role of IOTC is vital to enhance the longline fishery industry in the Sri Lanka as well as sustainable fishery industry in Indian Ocean and nearby sea. Specialy Sri Lanka is receiving assistance from IOTC to improve their statistical systems, improve the management practices and Conducts researches related to fishery industry.

2.11.2 Environmental impact

Longline vessels kill sea birds, sea turtles and sharks, as well as non target fish, which are attracted by the bait. Sea birds, Seasonal migration birds get hooked when the lines are near the surface. The birds are then dragged under water and drowned. Bird bycatch can be reduced by measures such as bird-scaring devices and weighting the lines to make them sink more quickly. Large numbers of bycatch fish are reportedly caught and thrown back dead. Because, sometime these fish are not economical to onboard to them.

Another issuer with longline fishing is overharvesting by using modern technology. It is not good for sustainability of marine environment. Cox, (2006) in his research paper on "Subsidies and Deep Sea Fisheries management: Policy Issues and Challenges " give some vital information on overharvesting issue. "In releasing its latest report on deep-sea fisheries, the International Council for the Exploration of the Sea (ICES) warned that "several deep-sea stocks are now heavily exploited and in some cases severely depleted" and "suggested that there should band immediate reduction of fishing pressure on fully exploited or overexploited deep-sea stocks" (ICES2003b). Non-governmental organizations, such as the World Wide Fund (WWF) for Nature, have also highlighted

the need to protect deep-sea stocks and there have been calls for the increased use of marine protected areas to protect deep-sea fish resources and the associated marine environment" (Cox, 2006). In fact developed countries are accountable for over exploring of deep sea stocks. As well as ICES and WWF findings, it is important to address this issue with developed countries. But the fact is these organizations are heavily funded from these countries. However organization likes IOTC where more power with developing countries pressing bigger countries to reduce their fishing action which is harmful for suitability of deep sea fish stocks.

In addition to above impact of environment on Fisheries also major challenging on longline. FAO (2010) pointed out that Many aquaculture operations located in deep sea and coastal systems will be vulnerable to climate change effects, such as sea-level rise, increased incidence of storm surges, as well as extreme weather events resulting in flooding, drought and rise in sea temperature etc. In the tropics, warmer air and water temperatures and rising water levels may drive species from their tropical habitats to subtropical regions (State of World Fisheries and Aquaculture, 2010). Actually coastal fishermen in Sri Lanka are worried about less fishing catch in these days. According to them less sea species are present in coastal zone. This can be due to over exploring or disturbing of their natural habitat as pointed out by FAO.

2.11.3 Marketing and Grading

As well as catching and fisheries Management of longline fishing, marketing also is an important element in longline fishing. Major part of high quality catch is sold to international market such as Shasimi market in Japan and European market. For Japanese market, it is require minimum processing and some time packing is require to the europium market. Un-processed and low grade catch is release to the local market.

Useful deep sea fish marketing strategies are found with research paper on Deep Sea Fisheries in Sri Lanka research by Amaralal, Helgi, & Ögmundur, (2010). According to them, in Sri Lanka there are mainly two different operational strategies used in deep see fisheries. One strategy is individual deep sea fishing where captains are independently

landing their trips' catch at the market. Second one is collection of export quality catch, where bigger export companies send boats to collect the quality catch at sea for export purposes. For the collective fishing to work a number of boats have to work together and after few days or a week a boat collects the total catch and brings it to land for processing and export. This way , the quality is better guarantied than the first strategy (Amaralal, Helgi, & Ögmundur, 2010). Their second strategy is applicable for mass scale fishing or feet fishing. Further for longline fishing most appropriate method is second one which sustains the quality of the catch. But all the vessels covered in this research follow the first strategy. Vessels operators sell to the export agent or commissioner at the shore.

Deep sea fisheries are increasingly using new technological equipment and technology for their operational activities. Mobile phones allow them communicate with assemblers and using the internet for communication with foreign buyers. This has resulted in a cost reduction and an increase of the profitability of the companies. Producers for export markets use safety standards in processing of fish for cater international market demand.

Processing is a very important aspect of export oriented longline fishing. Makoto, Patrice, Chin-Hwa, & Gakushi, (2010) in their report "Recent developments in the tuna industry " produced for FAO gives following facts on export marketing.

Onshore handling of tuna for export sashimi markets is just as important as on-board handling. In longline, Sashimi market is very important. The sashimi market was almost exclusively centred in Japan, but it has recently expanded worldwide. The Japanese domestic supply is slightly above 200 000 tonnes (all tuna combined but excluding skipjack, in round weight), while about 400 000 tonnes of tuna are imported (Makoto, Patrice, Chin-Hwa, & Gakushi, 2010). It shows huge potential of quality fish with Sasmi market specially in Japan. Actually Sri Lanka can earn extra income by improving the processing technology. Because processed fish can demand more rate in exporting.

Export marketing of fresh tuna is a very complex business. Freshness is the most important factor but fishermen and processors also have to consider grades of fish, market specifications, market trends and cost of exporting. All export fish should be firm

and fresh. Mushy flesh is unacceptable. In Japan the ranking or grading is A, (top quality) B, C, or D (reject). In Sri Lanka it uses simple grading their tunas as 'YES' or 'NO'. The yes fish are exported, and the no fish are sold at local market.

Sri Lanka has been exporting fish from a long time. But a substantial increase is noted only in recent years. Also exports have been directed only few destinations. Sri Lanka imports a large quantity of fish for consumption. In 2010, Sri Lanka has exported Rs 17,537 million while imported Rs12,567 millions value of fisheries. Fisheries contribution to the total value of exporting is 2.11% (Statistic: MFARD, 2010). As well as exporting fish it is important to reduce importing of fish for the betterment of the Sri Lankan economy.

2.12 Running Longline Vessels as a Business

Improvements in fisheries sector in Sri Lanka can be made possible by the provision of the various technical supports. The rate of improvement will depend largely on how quickly these changes can be incorporated in day-to-day operations. Government activity in promoting investment in fisher sector is important. The most effective bodies to work for change are the private commercial enterprises. Their survival depends on conducting an efficient business that meets the needs of the industry. They are most likely to respond to any changes that can work to their benefit.

After civil war in Eastern and Northern provinces, many developing projects are being implemented. Ministries, privet institutes, privet investors are moving these district to accelerate the development activates to get the maximum benefits from the freedom after war. Hence due to North -East natural existence and committed workforce, longline fishing can be a good option for the investment.

Basically, there are two elements in the business of a commercial fishing operation, the boat and the crew. These two elements work together for one goal, to catch fish and make money. In order to do this they must keep expenditures low while trying to keep revenues high. One way to do this is to distribute the revenue on a crew-share basis. Specially this is happen in small and medium scale fishing. All the vessels encounter in the research are

fallen in this category. That is, everybody shares in the risk and in the net proceeds and everybody has an incentive to perform well. However, in mass scale fishing, big companies employees staff in monthly salary basic.

Chapter 03:-

3.0. Methodology

3.1. Study Area

Nigombo is a popular base for longline fishing operation. Because export quality catch from longline vessels has easy access to the international market through the Katunayaka international air port. Further Negombo is a popular venue for dry fish industry. Most of the fish uses for dry fish production are inferior quality harvest from deep sea vessels and excess from fish supplies to the market demand. Gillnet vessels pass considerable amount of fish to the dry fish production. Therefore Negombo fishery harbour operates considerable amount of longline and gillnet fishing boats and it is an ideal place for a research on longline and gillnet fishing. First objective of the research will be worked out from the field data collection from Negombo fishery harbour.

To evaluate the trend of longline fishing, statistical data are used from MFARD and FAO.

3.2. Sample Procedure

Samples of vessels were selected using purposive sampling technique. Purposive sampling mean that Samples are selected based on the judgment of appropriate for the study. For economic efficiency (ARR), data were collected during February 2011 to October 2011, from 100 longline vessels. However 7 samples were given contradictory data related to a cost and revenue. Therefore researcher had to eliminate these exceptions by not considering those data for the study. Therefore the total longline vessels concede in this study is 93. Similarly out of 50 data collected vessels only 48 numbers were considered for gillnet fishing. For Evaluate the quality stranded (PHFL), it is considered 50 number of samples for each fishing method.

Total number of registered fishing vessels in Negombo Fishery Harbour for deep sea fishing is 220 (Ceylon Fishery Harbour Coperation, 2011). But the numbers of actively operate figure is not known. Total number of registered multiday vessels in Sri Lanka is

3,346 (Statistic: MFARD, 2010). Then the sample frame work for research is as of Table 3.1 below

Type of the vessel -A	Total number of vessels in deep sea fisheries-Negombo Harbour-B	Percentage to the Negombo deep sea vessels B/220	Number of samples -D	Percentage of the sample D/B	Total number of vessels in the country E	Percentage of total vessels of Country D/E
For Economic Efficiency (ARR)						
Longline	150	68.2%	93	62.0%	2,500*	3.7%
Gillnet Fishing	70	31.8%	48	68.6%	846*	5.6 %
Total	220	100.0%	141		3,346	4.2 %
For Quality Standard (PHFL)						
Long Line	150	68.2%	50	33.00%	2,500*	2.00%
Gillnet Fishing	70	31.8%	50	71.00%	846*	5.90%
Total	220	100.0%	100	0	3,346	3.00%

Legend : * :- approximate figures

Table 2.4: Sample Frame of the Study

No official figure for the longline, and gillnet fishing vessels operate in the country separately. The total number of the both type of vessels is 3,346. However rough estimation based on the information from the major fishery harbours, indicates it as around 2,500 numbers. This figure has been used to calculate the percentage of total vessels of the country. The questions asked were for one trip. The answers were then used for calculating the annual results of this study by multiplying the net figure from the number of trips per year. This may have had an effect on the results of the study. All study results were based on data that was given by the vessel captains. Some time they are reluctant to unveil their exact income figures. Moreover it is unknown samples equally represent the population of the vessels operating in the longline and gillnet fishing in the Sri Lanka. The above facts may have had some effect on the results of the study.

3.3. Sources of Information and Collaboration Institutions

Relevant information were collected from Ministry of Fisheries and Aquatic Resources Development (MFARD), Food and Agriculture Organization (FAO, www.fao.org) and National Aquatic Resources Research and Development Agency (NARA). Specially NARA resource library provide lot of information related to the research.

3.4. Data Collection

In order to achieve the objectives of this study, the relevant data and information were collected through primary and secondary sources. For the primary data collection from 150 Fishing vessels Field observations and informal discussion were mainly focused on individuals such as Fishery harbour managers, fishermen, CFHC Jetty supervisors, Ice Plant operators, and Fishing bites suppliers.

Secondary data were collected from internet, research reports, and publication and data base from Statistical division of Ministry of Fisheries and aquatic Recourse development. Relevant web sites of FAO, NARA were helpful to get additional information related to research.

3.5. Data Analysis

After completing the field survey, numerical data were tabulated in the excel sheets. Then data were analyzed using excel to get ARR and PHFL. These techniques helped to take the general idea about the ARR of each fishing methods. All the data use for analysis are quantitative data.

CHAPTER 04

4.0. Results and Discussion

4.1. Result Frame work

Figure 4.1: Results Frame Work of the Study

This chapter explains about the result and discussion of the research. The analysis is carried out using Microsoft Excel The research result frame work is as of figure 4.1.

4.2 Accounting Rate of Return

Accounting rate of return, also known as ARR calculates the return, generated from proposed capital investment. When comparing investments, the higher the ARR, the more attractive the investment.

ARR= Profit/Investment

It is general fact that revenue and expenses are depend on the vessels size. Hence these vessels are categories several length group. ARR was calculated for both gillnet fishing and Longline fishing method. Total Capital (Hull, Engine, Fishing equipment, Electronic, Fishing gear), Life Time, Depreciation, Insurance, fishing gear are used to calculate the fix cost.

Total trip Operating Cost (Fuel, Bait, Ice, Food, Other/Salt), Crew Share, Repairs and Maintenance (repair of hull and equipment, engine, fishing gear) are used to calculate variable cost.

Numbers of trips per year, Revenue per trip are used to calculate the Revenue. Numbers of trips per years, Life time of the vessels depend on several parameters. Sometime fishing cycle time of each vessel can be slightly varied during the heavy maintenance requirements and logistic problems of goods and manpower.

Further right judgment of the life time of a vessel is little bit tedious. Fishermen never leave the vessels unless their vessels find a major accident, or beyond the serviceable or repair condition. They can upgrade the engine, electronics, facilities or hull to compatible with new vessels. Such major upgrade occurs 5 to 10 year's times. Further information of relevant stake holders such as vessels operators, owners, harbour managers were taken to decide the life time.

During the data examination it was found that Capital investment for longline vessels is comparatively higher than gillnet vessels. Major component of capital cost is hull follow by engine, fishing gears and equipment. Longline vessels are designed with storage compartment and other technological advance arrangement than gillnet vessels. Therefore cost of hull is higher.

Further highest Variable cost for both type of fishing is labour. Fuel cost for longline vessels are most of the time lower than the net fishing. Travel distances and trip durations for gillnet vessels are significantly higher than the longline vessels. Big gillnet vessels some time sail up to Andaman and Nicobar Islands.

Fishermen do not have insurance policy for their fishing gears. Insurance companies are reluctant to issue insurance policies for fishing gears. Because fishing gears are difficult to trace in case of lost or accident. In such circumstance, insurance companies face difficulties to verify claims of fishermen.

All most all the longline fishing vessels of Negombo fishery harbour use ice cubes to preserve the fish. In latest modern longline Vessels use chilled bath to preserve to fish which is powered by an inboard engine. Chilled bath provide better export quality fish than ice cubes.

There are two types of vessels engaging in the deep sea fishing industry. One type is mother vessels which are actually catching fish. Other one is transporting vessels which are collecting fish from mother vessels. Some time international transporting vessels prefer to buy fish on sea rather than in land to avoid taxes. During the data collection stuff, Fishermen stated that fish catch was not sold to the transportation vessels. But there is a possibility to such selling.

Revenue of fishermen can be significantly higher than the declared amount. Some time fishermen reluctant to declared higher figures.

The analyses of these data are in Appendix 01 and Appendix 02. The ARR value can be categories according to boat length groups. The summery of ARR of longline and gillnet fishing is as of table no 4.1.

Boat Length	Gillnet Fishing	Longline	As %
30 ≤ L < 35	35.55		
35 ≤ L < 40	27.99	45.06	61.00%
40 ≤ L < 45	29.48	41.94	42.28%
45 ≤ L < 50	28.88	31.46	8.95%
50 ≤ L < 60	25.04		

Table 4.1: Accounting Rate of Return (ARR) of Longline and Gillnet Fishing

The above result can be graphed as follow.

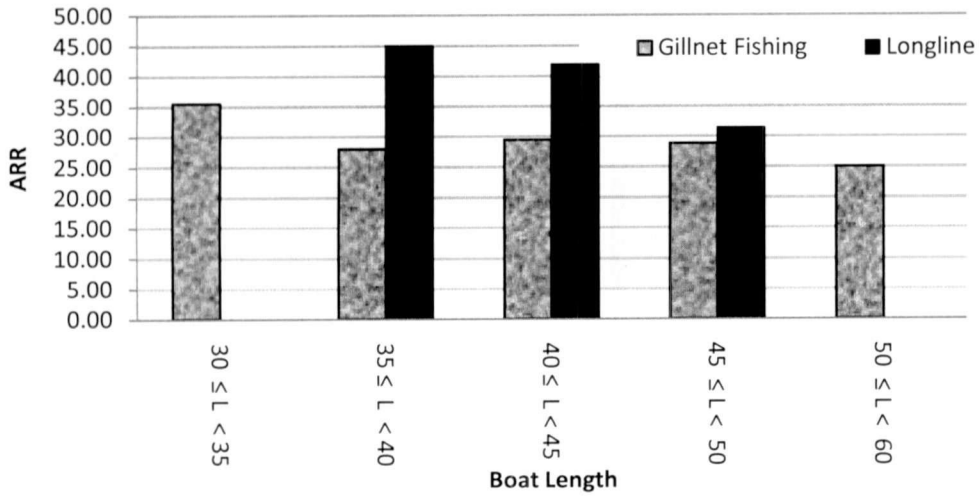


Figure 4.2: Accounting Rate Of Return for Longline and Gillnet Fishing

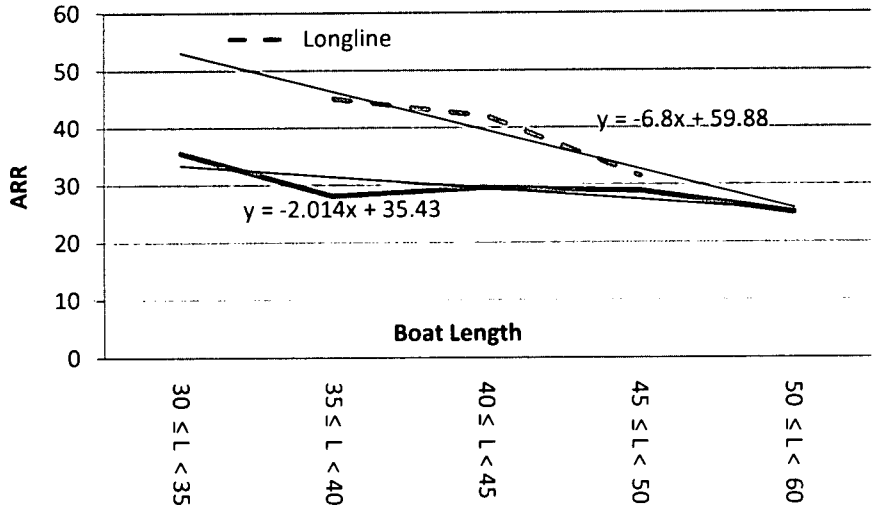


Figure 4.3: Increasing rate of ARR with boat sizes for Longline and Gillnet Fishing

It is found that vessels categories engage in longline and gillnet fishing earn more than 25% of net return for their investments. ARRs vary with vessel length groups. Longline fishing has higher return than Gillnet fishing for all the time in their respective categories. It indicates comparatively high profitability of longline operation.

Highest return for longline is reported by vessels length category between 35 and 40 fts This is the most profitable size of vessels to do longline fishing. However with the increase of length of the vessels net return for longline fishing gets reduce. High capital investment and less efficient fishing for bigger vessels are account for less ARR. Efficiency of fishing can be caused by lack of technological support and inadequate logistic and services for bigger longline operation.

Economic efficiency of gillnet fishing is highest for vessels length category between 30 to 35fts ($30 \leq L < 35$). ARR continually decrease with the length of gillnet vessels similar to longline fishing. As the above high investments and less efficient fishing are the reasons for less ARR from bigger gillnet vessels. However rate of reduction of ARR

with the length for gillnet fishing is less than the longline fishing. Rate of reduction of ARR for gillnet fishing is nearly one third from longline fishing. This may due to requirements of high technological, services support for longline fishing than gillnet fishing.

4. 3 Quality of Fish

Quality of fish is an important factor for deciding its price. To evaluate the quality, it is assessed the data of 50 number of longline and gillnet fishing vessels. The PHFL data and their calculations are in Appendix 03. The Summery of these results is as of table 4.2

Fishing Method	PHFL (As %)
Long lining	3.7 %
Net Fishing	24.5 %

Table 4.2: Post Harvest lost of Fish from Catching to Landing

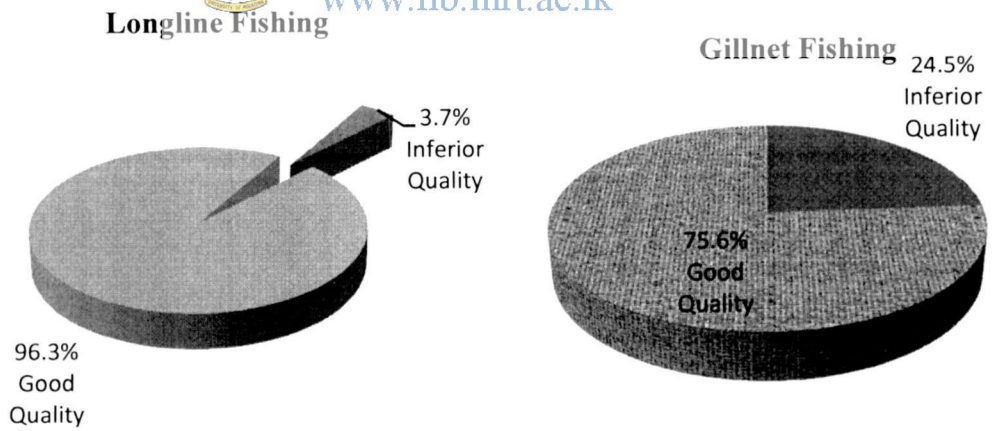


Fig4.4: Post harvesting Losses of Longline and Gillnet Fishing

Findings indicate that gillnet fishing enhance significance post harvest losses than longline fishing. As indicated in Table 4.2, around 24.5% of fish deterioration occurs from gillnet fishing. The above figures represent only the influence of fishing method on

PHFL which is catching to landing. When from catching to the consumer, this figure can be significantly high.

Jinadasa (1997) stated that post harvest losses of marine stocks as high as 40% are not uncommon in Sri Lanka fishery sector (Little & Murray, 2000). However, today fishermen have access to better technology and market chain than 1997. In fact today there is a better transport facilities and storage facilities in market places. Therefore highest contribution for the PHFL can be account from catching to landing. When consider the one day fishing and limited day fishing, PHFL from catching to landing is not a significant.

One of the basic problems in qualitative analyses is non availability of exact measurement or threshold for superior and inferior quality. It is judged by physical and visual examination. Based on that, fishermen offer low price for inferior quality.

It is found that gillnet fishing undergo 24.5% of post harvest lost which is very significant figure. Damages course by the fishing gear of Gillnet vessels is one of the significant factor for quality deterioration. During gillnet fishing different sizes of fish are caught and these spices drag, pressed each other. Further fish harvest of gillnet vessels spent many hours in the fishing gear. The fish have been dead in the water and have begun to spoil. By the time the fishing gear is hauled into the boat, the fish is not in fresh quality. In longline fishing, fish are alive in gears until it hauled in to the boat. Even longline can hull the harvest(Fish) without pressing each other to the vessels.

Net fishing vessels are normally undergoes bigger trip duration. These preservation practices are not capable of facilitate of such tips. Sometime vessels started preservation of harvest by using salt during the sea when inadequate ice or storage space.

As discuss in section 2-9 (Multiday Gillnet fishing) most gillnet vessels are converted from trawling Vessels, which is not properly designed. Their cold storage system, inadequate packaging and storage practices lead to damage and quality deterioration of fish harvest.

4.4 Evaluate the Trend of Deep Sea Fishing in Sri Lanka

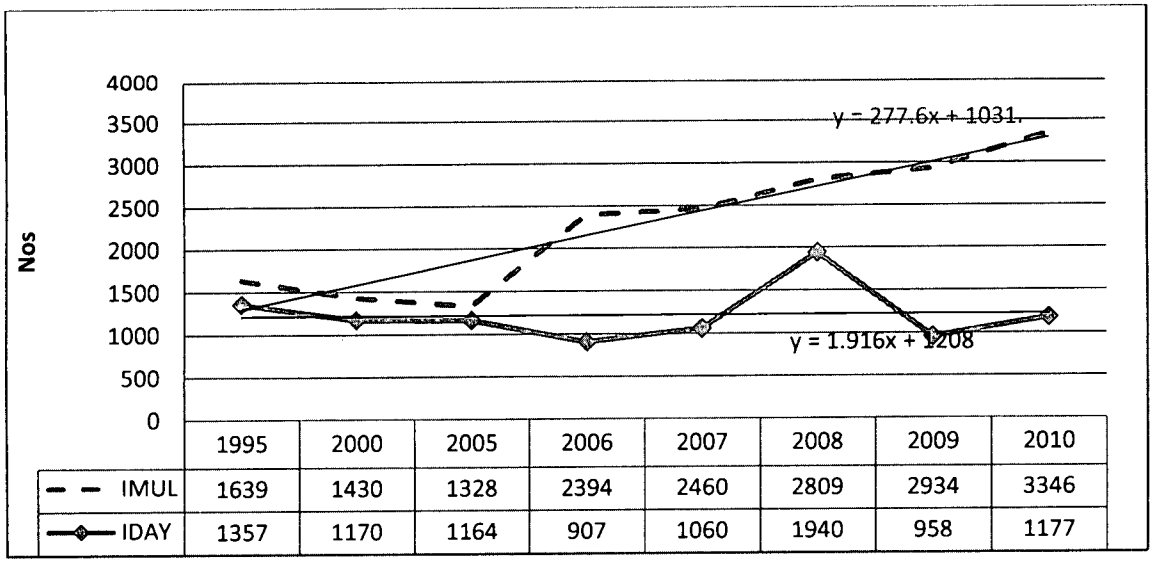
The above analysis demonstrate the economic efficiency and quality standard of longline fishing compare to gillnet fishing methods. However, it also important to analyze the way of longline fishing penetrate to the Sri Lanka fishing sector and forecast the future performance of the sector based on that. Accordingly to analyze the trend of deep sea fishing in Sri Lanka, following four sectors are considered

1. IMUL – (Inboard Multi-day Boats) and IDAY – (Inboard Single-day Boats) fishing Vessels trend
2. Production trend of Coastal and Deep Sea fishing sectors
3. Export Trend
    i, By weight
    ii, By value
4. World Trend

4.4.1 IMUL – (Inboard Multi-day Boats) and IDAY – (Inboard Single-day Boats)

Fishing vessels operates in Sri Lanka can be mainly categorized as, IMUL – (Inboard Multi-day Boats), IDAY –(Inboard Single-day Boats), OFRP –(Out-board engine Fiberglass Reinforced Plastic Boats), MTRB –(Motorized Traditional Boats), NTRB – (Non-motorized Traditional Boats), NBSB –(Beach Seine Crafts).

The figure 4.5, indicates registered number of operating vessels of IMUL and IDAY (Statistic: MFARD, 2010). It is mandatory to get resisted with MFARD all the vessels in every years for tracing and acquire services from fishery harbours. From the above categories IMLUs are the widely use for longline (Deep Sea) fishing while IDAYs use for coastal fishing.



	1995	2000	2005	2006	2007	2008	2009	2010
IMUL	1639	1430	1328	2394	2460	2809	2934	3346
IDAY	1357	1170	1164	907	1060	1940	958	1177

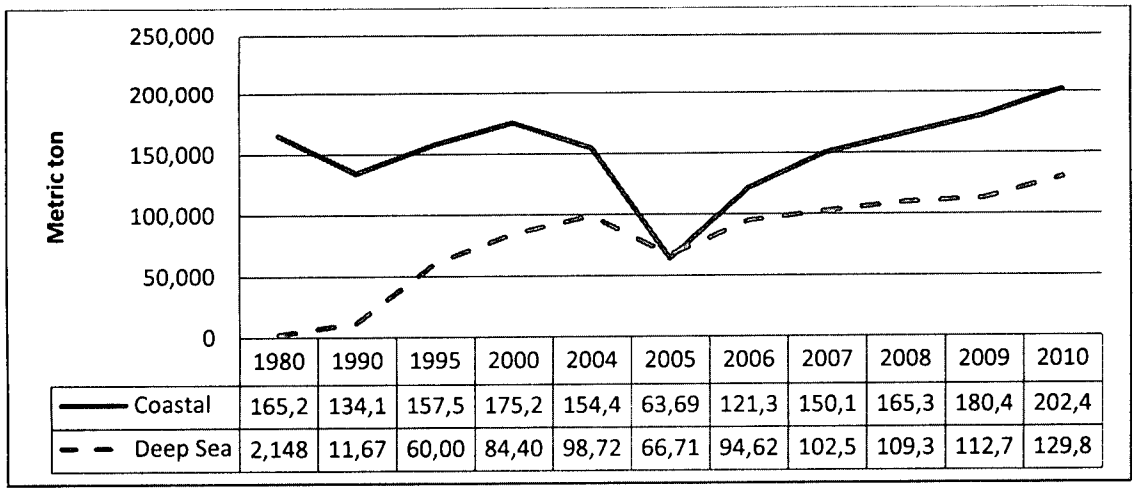
Figure 4.5: Operating Fishing Vessels of IMUL and IDAY

The above figures (Statistic: MFARD, 2010) gives the comparison of IMUL and IDAY vessels operate in the Sri Lanka. Decrees of total number of operating vessels for some years indicates for both types. This may due to non service condition, due to accidents, natural disaster like tsunami or converting vessels to other types.

There is a dramatically improvement of fishing vessels use in longline (IMUL) in last few years compare to fishing vessels use for coastal fishing (IDAY). It indicates that poor immediate recovery of 2004 December Tsunami effects for IDAY. But there was a sudden improvement of deep sea fishing vessels (IMUL). This mean, instead of their destroyed coastal vessels fishermen preferred to deploy deep sea vessels. It indicates positive trend for longline fishing in Sri Lanka when analyzing the relevant registered vessels in last few years.

4.4.2 Production trend of Coastal and Deep Sea fishing Sectors

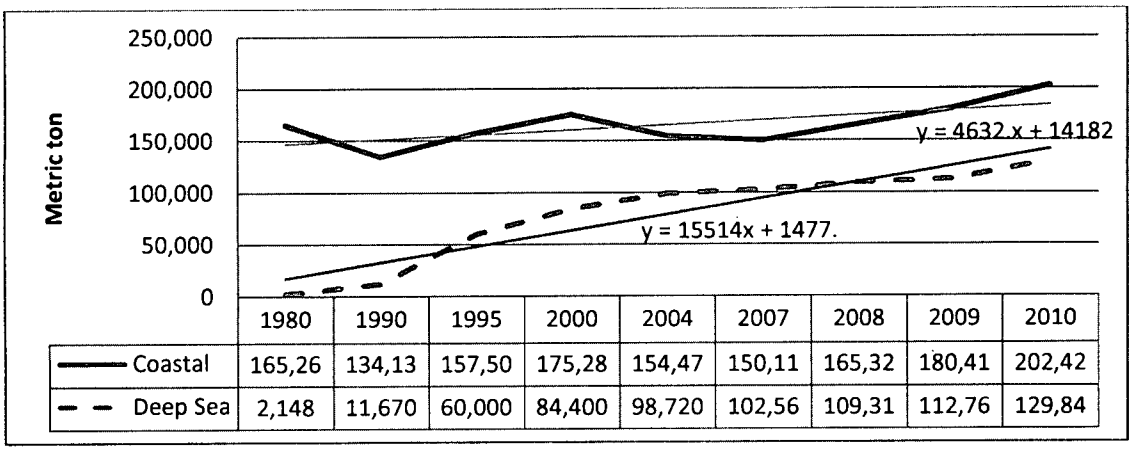
Fish production of deep sea and coastal fishing during the last few years also provide useful information of the performance of fishery sectors. This is demonstrate in figure 4.6



	1980	1990	1995	2000	2004	2005	2006	2007	2008	2009	2010
Coastal	165,2	134,1	157,5	175,2	154,4	63,69	121,3	150,1	165,3	180,4	202,4
Deep Sea	2,148	11,67	60,00	84,40	98,72	66,71	94,62	102,5	109,3	112,7	129,8

Figure 4.6: Fish Production by Coastal and Deep Sea Fishing Sub-sectors

The above data (Statistic; MFARD, 2010) indicate that coastal fishing is accountable for more production than deep sea fishing (Except 2005, due to Tsunami effect). The effect of tsunami has significantly influenced coastal fish production than deep sea fishing in year 2005 and 2006. It also indicates that the effect of Tsunami and cyclones are less for the deep sea fishing. Deep sea vessels equip with latest technological equipments to overcome negative effects of adverse costal weather. In Size they are big and can resist effect of wind and wave better than smaller vessels. Since data of year 2005 and 2006 influence by Tsunami, after elimination these two years (Deformed data) Figure No 4.7 can be achieved.



	1980	1990	1995	2000	2004	2007	2008	2009	2010
Coastal	165,26	134,13	157,50	175,28	154,47	150,11	165,32	180,41	202,42
Deep Sea	2,148	11,670	60,000	84,400	98,720	102,56	109,31	112,76	129,84

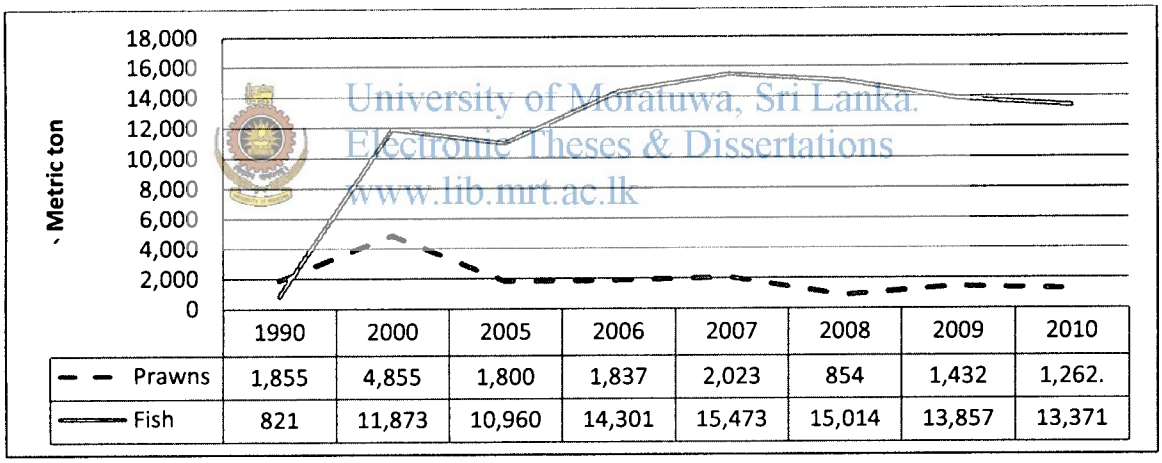
Figure 4.7:Fish Production of Coastal and Deep Sea Fishing Sub-Sectors

(Excluding 2005)

It shows that even though the coastal sea fish production is higher than the deep sea fishing production, increasing rate of deep sea fishery sector is around three times when compare with coastal fishing production. That mean significant improvement of deep sea section can be seen during the last few years.

4.4.3 Export Trend

In the above two deep sea fish production data indicates the fish production of deep sea sector by longline (which represent major parts) and as well as the other methods. There is no statistical data to separate longline fishing production from deep sea fishing production. However export amount of fish sole represents the production of longline fishing. Because only the longline produce fish are in achieve export quality. However Comparison was done with the export amount of prawn to find how these two sectors perform in last few years.

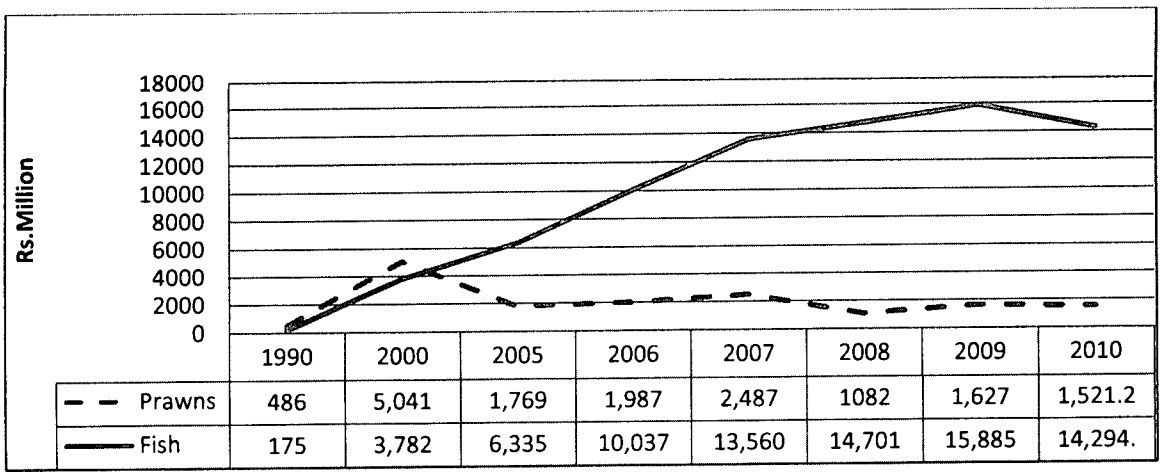


	1990	2000	2005	2006	2007	2008	2009	2010
Prawns	1,855	4,855	1,800	1,837	2,023	854	1,432	1,262.
Fish	821	11,873	10,960	14,301	15,473	15,014	13,857	13,371

Figure 4.8: Fish and Prawns Export of Sri Lanka (By Weight)

Data Source: (Statistic: MFARD, 2010)

The figure 4.8 shows that after 1990 exporting of fish is significantly higher than the prawn export amount. There is a significant influence on 2005 tsunami on fish exporting amount. However it has recovered soon. But after 2007 there is slightly decrease of fish exporting quantity. To get the better understanding of export behavior, export earning analysis is illustrated in figure 4.9.



	1990	2000	2005	2006	2007	2008	2009	2010
Prawns	486	5,041	1,769	1,987	2,487	1082	1,627	1,521.2
Fish	175	3,782	6,335	10,037	13,560	14,701	15,885	14,294.

Figure 4.9: Export Earning of Fish and Prawn **Data Source:** (Statistic: MFARD, 2010)

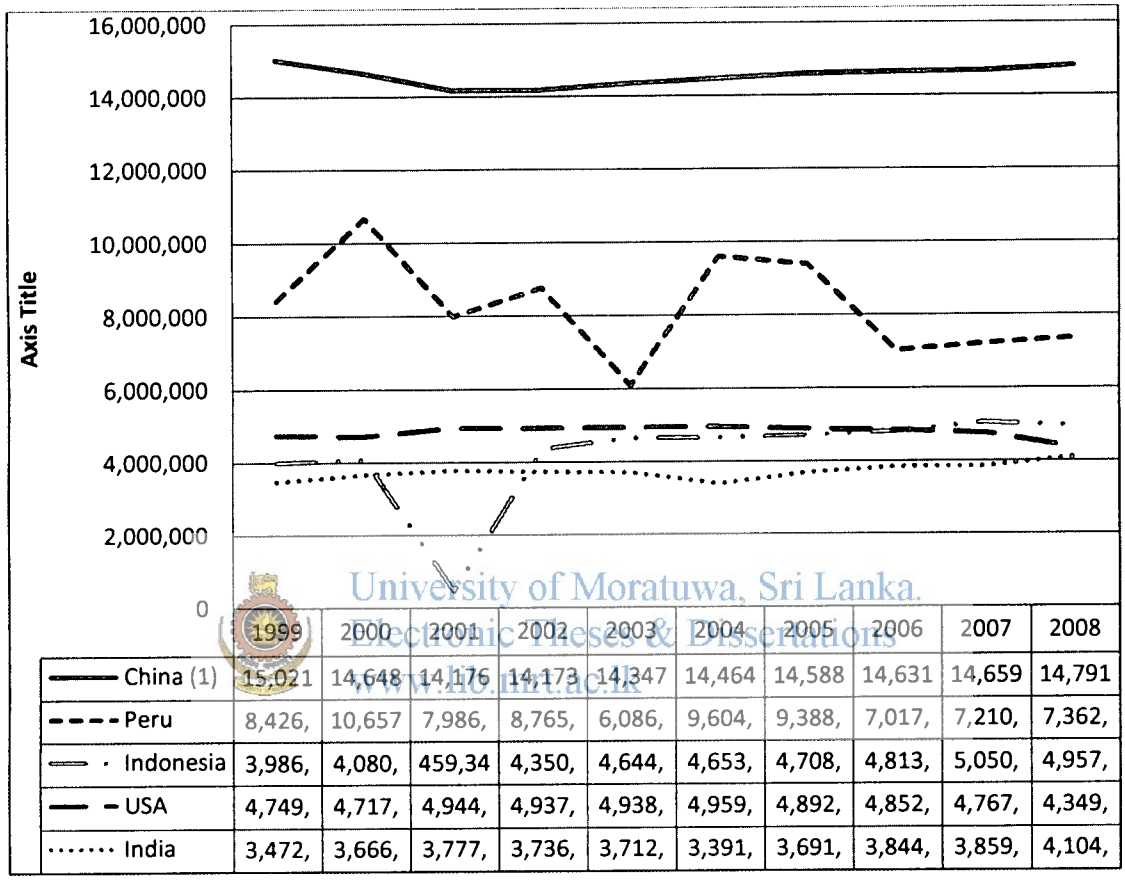
Figure 4.9 indicates that, even though there is a significant change of fish export volume after year 2007, there is continue improvement of export value of fish up to 2009. This may due to less supply create more demand and hence increase of unite price earning of fish. However there is a drop of export quantity and value in the year 2010. In these days fishermen worry about less fishing harvest due to over-harvesting of fishing by developed countries using their technology. On the other hand global environment impacts of sea species also very significant. Therefore it is better to study how global fish production behaves during last few years to compare with the Sri Lanka fishery sector.

4.4.4 World Trend

It is important to exam the world fish production during last few years to see the position of Sri Lanka Fishery trend with other countries. It is identified that world leading fish producer, China and other 4 major fish producers for this analysis. This is shown in figure 4.10. There is a limitation of above data after 2008. Latest figures of world fishery sector yet to be released by FAO. The above data (State of World Fisheries and Aquaculture, 2010) demonstrate world leading fish production countries maintain their production quantity without significant improvement trough out the last 10 years except Peru.

Due to less sensitivity in figure 4.10 for latest performance, Figure 4.11 has been developed to analyze the performance of last years. However the year 2005 discards due

to the effect of tsunami in South Asian region. From them three countries show slightly improvement of fish production and two countries show slightly decrease of fish production.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
China (1)	15,021	14,648	14,176	14,173	14,347	14,464	14,588	14,631	14,659	14,791
Peru	8,426,	10,657	7,986,	8,765,	6,086,	9,604,	9,388,	7,017,	7,210,	7,362,
Indonesia	3,986,	4,080,	459,34	4,350,	4,644,	4,653,	4,708,	4,813,	5,050,	4,957,
USA	4,749,	4,717,	4,944,	4,937,	4,938,	4,959,	4,892,	4,852,	4,767,	4,349,
India	3,472,	3,666,	3,777,	3,736,	3,712,	3,391,	3,691,	3,844,	3,859,	4,104,

Fig 4.10: Fish Production of Leading Fish Produce Countries (State of World Fisheries and Aquaculture, 2010)

But the important fact is that India has improved their fish production constantly even during the tsunami effect and there is a significant improvement of fish production from 2007 to 2008. Indian fishery sector is more relevant to Sri Lanka. Because they are positioning in same oceanographic area and use almost same technologies with relevant to Sri Lanka. However due to non availability of data of 2009, 2010 and absent of clear pattern in all countries not provide clear conclusion for the research from the world fish production.

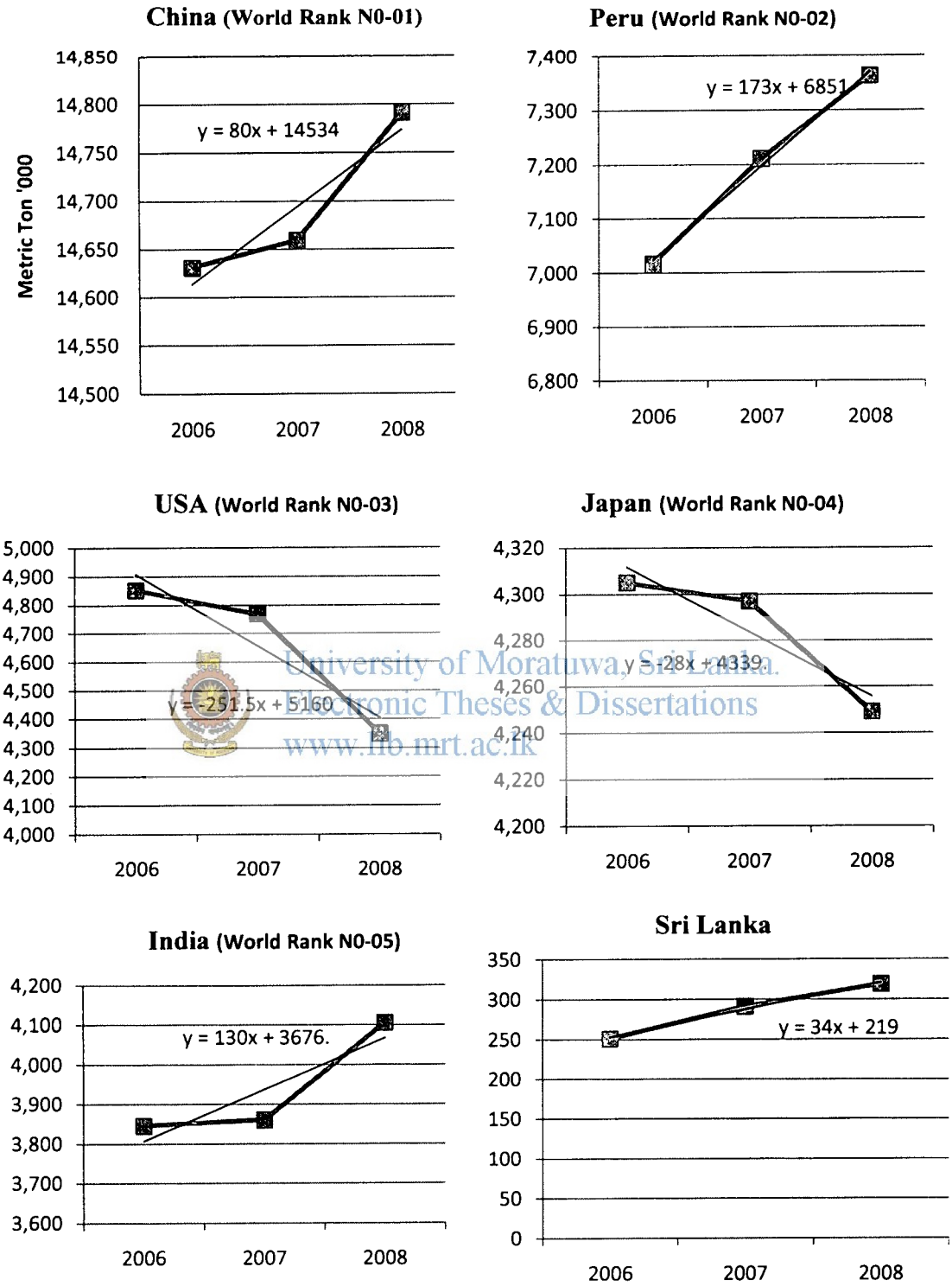


Figure 4.11: **Trend of Fish Production of Leading Fish Produce Countries** (State of World Fisheries and Aquaculture, 2010)

CHAPTER 05

5.0 CONCLUTION AND RECOMMENDATIONS

5.1. Conclusion

All vessels groups operating in the longline fishing and gillnet fishing have earned net profits. The return for investment of longline and gillnet fishing vary with the length. Longline fishing can maintain more than 30% net return for its investment and all the time longline fishing gets more return than gillnet fishing for their respective categories. Because longliners can earn higher price for per unite catch. Longline fishing mostly targeting the tuna and tuna like species which have demand in export markets, while gillnet fishing target catch for local market. For both longline fishing and gillnet fishing, the highest proportion of total operational cost goes to labour followed by fuel and foods.

Longline vessels length category between 35fts to 40fts ($35 \leq L < 40$) records the highest return for investment. The value of the highest ARR for longline fishing is 45.6%. However ARRs of longline vessels decrease with length when the vessels length is more than 40fts. Finding shows economically more viable and acceptable group for longline fishing is medium sizes rather than the bigger sizes. This may due to available technology and fishing grounds with the Sri Lanka. Mass scale longline operations with bigger vessels need high investment and latest technology to locate fishing ground more efficiently. For Gillnet fishing highest ARR is found with length group between 40fts and 45fts ($40 \leq L < 45$).

The lowest ARR correspond to longline fishing is vessels length group between 45to 50fts ($45 \leq L < 50$) and gillnet fishing between 50 to 60fts ($50 \leq L < 60$). The reason for the lowest profit of these groups are the lower corresponding catches and high initial investment of these bigger categories.

The number of fishing trips of a year decrees with the size of vessels. The number of trips per year is a dominant factor for ARR. By increasing the number of fishing trip can

increase the ARR. That means efficiency of departure, effective locate of fishing sites and rate of harvesting need to be improved with latest technology.

In real scenario, ARR for longline and gillnet fishing can be relatively higher than these figures. Normally fishermen prefer to declare bottom line of their income. Because they reluctant to give high figure since they may treat profit as sensitive business information.

From Catching to Landing, Longline vessels account only 3.7% of PHFL. This figure is around 15% of PHFL of Gillnet fishing. Therefore PHFL of longline fishing is significantly lower than the Gillnet fishing. Fishing gear of longline gives less impact on PHFL. On the other hand fishing gear of gillnet enhances the PHFL. Also preservation practices with Gillnet vessels are not at satisfactory level. What is the salient fact in low quality harvest of both methods is Fishermen do not discard them. Low Quality fish are sold at low price or use for dry fishing. Actually loss is happen to selling price of fish. They cannot demand attractive price for low quality fish. But in case of longline fishing they can demand attractive price for export quality tuna and tuna like fish which enhance the economic efficiency of investment.

Longline fishing implies attractive performance and positive development during last ten years. It is healthy situation for Sri Lankan fishing industry. Number of IMULs – (Inboard Multi-day Boats) which is used for longline fishing, have dramatically improved. The improvement of IMUL is significantly higher than IDAY – (Inboard Single-day Boats) fishing vessels which is used for coastal fishing.

Although Annual Fish Production of deep-sea sector is less than coastal fishing sector, deep-sea fishing continually increasing. With the present production trends of subsectors , deep sea fish production can exceed coastal fish production within two or three years. Fisheries sub-sectors production data which is also positive sign of improvement of deep sea fishery sector.

Export amount of fish by weight, show impressive performance after 2000. Last ten years it has improved almost 4 times. However there is a slightly decrees of fish production

after 2008. But the export earnings continually increase last 10 years except some short of decrees in 2010. It implies that earning for unite of export has increase. This may be due to high demand of export market or higher earning from high quality.

Analysis of World production trend show mix performance. Some countries demonstrate improvement while some demonstrate decreases. Indian fishery industry which is more relevant to Sri Lanka, indicates some short of improvement from the year 2006-2008 However, clear conclusion does not emerge from world fish production with the available data.

Therefore the results conclude that high return and high quality standard of longline fishing. This will make longline fishing more popular and attractive in deep sea fishery sector. Further Deep sea fishing will dominate Sri Lanka fishery sector as implied in trend analysis. Hence longline fishing will be very significant in Sri Lanka fishery sector.

By summarizing all, longline fishing is a leading tuna and other exported fish catching method is an attractive investment that holds potential for the Sri Lanka fishery sector. The costs for local operators to set up a longline fishing operation are high, but the potential returns are also great. The method targets the larger, deeper swimming tunas and other tuna like species that command high prices in export markets if they are handled carefully and quality is maintained throughout the catching.

Hence by actively promoting longline fishing as a means of enhancing fishery industry in Sri Lanka draw greater benefits from under utilize deep-sea resources by exploring these resources with longline vessels, improve the quality of food available to the population by providing good quality fish from longline fishing, Sustainability of industry due to profitability and positive trend of longline fishing, where possible, divert fishing pressure away from coastal area that are often overfished.

5.2 .Recommendation

By increasing the number of fishing trips per year can enhance the economic efficiency of longline fishing. Therefore, it needs to reduce of fishing trip duration by efficient fishing and efficient harbor operation.

Accessibility to modern technology and present of efficient service infrastructure is vital for efficient fishing. Modern technologies can play a vital role by demarcation rich fishing grounds, efficient sailing to these fishing ground and improve the efficiency of fishing gear. At present NARA fish site forecasting system is the most cost-effective and advance direction for Sri Lankan deep-sea fishermen. It is updated once a week. This should be increased up to 3 times a week. NARA needs financial assistance to improve the forecasting system. With the present of such system idle traveling for fishing can be significantly reduce.

Secondly efficient service infrastructures for deep-sea fishing vessels must be presented at fishery harbours. Most of the harbours have limited anchoring or mooring capacity in their jetties and Quay walls. This is not good for unloading operations and logistic supply for launching vessels. Efficient bunkering of fresh water, ice and fuel, appropriate continue source of bits are the major parameters for delaying the launching of deep sea vessels. Moreover proper landing of fish harvest will sustain the quality of longline catch.

Present of effective vessels monitoring system is essential to avoid crossing of Sri Lankan fishermen with their legitimate borders and avoid getting detention in other countries. Further such system needs to restrict foreign vessels poaching in the Sri Lankan Sea area with modern technology. Some time local multiday vessel do fishing in coastal zone which is harmful for small scale fishermen. Vessels monitoring system can use to avoid these practices too.

There must be good information network to up to date and sharing information with longline operators about export market information in order to enhance the economic efficiency of their operation. It appears in present scenario, middlemen/exporter enjoy

higher benefits. These benefits need to fairly transfer fishermen, Specialy small scale longline vessels operators also.

Attractiveness for deep-sea Sector was found after destroying coastal vessels in the year 2004 tsunami during the trend analysis. It was happen due to financial assistance given by government and other NGOs to re-establishment of their livelihood. After that there is an impressive production improvement in deep-sea fishery sector. Therefore one of the main barriers to develop Sri Lanka deep-sea fisheries is lack of capital investment. Government and privet financial institution are reluctant to provide credit facilities to fishery sector. Because pass negative records of repayment and mortgage issues with fishing industry. Fishermen don't have capacity to mass scale investment for long line vessels. Therefore it is good idea to establish mechanism for funding longline fishing industry. Legislation framework for vessels ownership, registration with harbours, and presence of vessels monitoring systems are the areas need to be improved to get credit facilities.

Data collection stuff of Sri Lankan major fishery harbours need to be strengthened. Almost all fishery harbours doesn't have proper statistical system or effective weight bridges operation to measure and record the day today catch. In such circumstance depends on fishermen's data/their log sheet may not be accurate. In future research related to fishers should be based on observation rather than collect information directly from fishermen. Because some time fishermen are reluctant to unveil some information specially income and catch related data.

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APPENDIX

Appendix 01 : Summery of ARR calculation For Gillnet Fishing

	Length		30 ≤ L < 35	35 ≤ L < 40	40 ≤ L < 45	45 ≤ L < 50	50 ≤ L < 60
	Hull		2,700,000	3,687,500	4,666,667	5,214,286	6,406,250
	Engine		596,250	815,000	1,000,000	1,121,429	1,353,125
	Fishing equipment		138,750	187,500	237,500	253,571	325,000
	Electronic		212,500	208,125	212,500	223,214	226,563
	Total vessel cost		3,647,500	4,898,125	6,116,667	6,812,500	8,310,938
	Fishing gear		475,000	640,000	825,000	914,286	1,140,625
X	***Total Capital***		***4,122,500***	***5,538,125***	***6,941,667***	***7,726,786***	***9,451,563***
	Life Time		12	14	13	13	14
	Depreciation		343,542	406,958	536,944	584,881	684,453
	Insurance, vessel		85,000	82,500	85,000	83,571	88,125
A	***Total fixed cost***		***428,542***	***489,458***	***621,944***	***668,452***	***772,578***
	Fuel		109,500	146,000	255,500	281,571	365,000
	Ice		17,000	25,000	42,000	45,857	48,000
	Food		250,000	275,000	291,667	300,000	300,000
	Other/Salt		12,000	19,500	31,667	40,000	56,250
B	Total Trip Operating Cost		388,500	465,500	620,833	667,429	769,250
	Trips / year		12	10	8	8	8
C	Total Trip Variable Cost		4,662,000	4,655,000	4,966,667	5,339,429	6,154,000
	Revenue per Trip		775,000	968,750	1,491,667	1,628,571	1,834,375
D	***Revenue per Year***	***x***	***9,300,000***	***9,687,500***	***11,933,333***	***13,028,571***	***14,675,000***
E	Crew Share	(X-C) /2	2,319,000	2,516,250	3,483,333	3,844,571	4,260,500
	Hull and equipment		187,500	212,500	333,333	385,714	437,500
	Engine		150,000	137,500	266,667	278,571	293,750
	Fishing gear		100,000	150,000	216,667	300,000	400,000
	Total Repairs and Maintenance		437,500	500,000	816,667	942,857	1,131,250
G	***Total Variable Cost***	***C+E+F***	***7,418,500***	***7,671,250***	***9,266,667***	***10,126,857***	***11,545,750***
Y	Total Yearly Cost	A+G	7,847,042	8,160,708	9,888,611	10,795,310	12,318,328
H	***Profit***	***D-Y***	***1,452,958***	***1,526,792***	***2,044,722***	***2,233,262***	***2,356,672***
I	***Account Rate of Return***	***H/X***	***35.55***	***27.99***	***29.48***	***28.88***	***25.04***

Appendix 02: Summery of ARR For Longline Fishing

Length			35 ≤ L < 40	40 ≤ L < 45	45 ≤ L < 50
	Hull		4,085,455	4,697,297	7,000,000
	Engine		901,364	993,243	1,500,000
	Fishing equipment		375,345	375,514	560,000
	Electronic		204,273	242,568	350,000
	Total Vessel cost		***5,566,436***	***6,308,622***	***9,410,000***
	Fishing gear		736,091	815,811	1,200,000
X	***Total Capital***		***6,302,527***	***7,124,432***	***10,610,000***
	Depreciation		473,500	570,755	707,333
	Insurance, vessel		82,182	92,703	100,000
A	***Total fixed cost***		***555,682***	***663,457***	***807,333***
	Fuel		150,645	196,311	255,500
	Ice		39,191	42,500	42,500
	Bait		94,000	131,216	160,000
	Food		118,364	225,676	250,000
	Other		5,873	12,081	7,000
B	Total Trip Operating Cost		408,073	607,784	715,000
	Trips / year		18	18	14
C	Total Trip Year Variable Cost		7,342,726	10,903,541	10,010,000
D	Revenue Per Trip		841,364	1,083,784	1,400,000
X	***Revenue per Year***		***15,144,545***	***19,451,351***	***19,600,000***
E	Crew Share	(X-C)/2	3,900,910	4,273,905	4,795,000
	Hull and equipment		228,182	288,514	300,000
	Engine		131,818	208,108	200,000
	Fishing gear		120,000	148,649	150,000
F	Total Repairs and Maintenance		480,000	645,270	650,000
G	**Total Variable Cost**	C+E+F	**11,723,636**	**15,822,716**	**15,455,000**
Y	**Total Yearly Cost**	A+G	12,279,317	16,486,173	16,262,333
H	***Profit***	***X-Y***	***2,865,228***	***2,965,178***	***3,337,667***
I	***Account Rate of Return***	***H/X***	***45.06***	***41.94***	***31.46***

Appendix 03: PHFL of Longliners and Gillneters (Part 01)

SN	Gillnetters			Longliners		
	Total weight (Kg)	PHFL		Total weight (Kg)	PHFL	
		Imperia Quality (Kg)	As %		Imperia Quality (Kg)	As %
1	21,000	5000	23.8%	15,000	450	3.0%
2	18,000	4500	25.0%	25,000	800	3.2%
3	24,000	3600	15.0%	30,000	1,100	3.7%
4	15,000	3400	22.7%	40,000	750	1.9%
5	36,000	9600	26.7%	10,000	300	3.0%
6	18,000	2800	15.6%	50,000	500	1.0%
7	15,000	2200	14.7%	30,000	1,200	4.0%
8	24,000	4500	18.8%	35,000	550	1.6%
9	30,000	5000	16.7%	25,000	1,250	5.0%
10	36,000	6000	16.7%	12,000	480	4.0%
11	24,000	6500	27.1%	9,750	520	5.3%
12	30,000	5000	16.7%	11,000	450	4.1%
13	21,000	6500	31.0%	13,500	270	2.0%
14	12,000	3000	25.0%	15,000	550	3.7%
15	24,000	4500	18.8%	12,000	450	3.8%
16	24,000	9000	37.5%	14,000	750	5.4%
17	21,000	3500	16.7%	15,000	450	3.0%
18	36,000	9000	25.0%	18,000	1360	7.6%
19	30,000	5500	18.3%	24,000	1200	5.0%
20	14,500	3000	22.0%	32,000	960	3.0%
21	18,000	4500	25.0%	45,000	2500	5.6%
22	320,000	9000	28.0%	13,000	400	3.1%
23	12,500	3500	29.0%	46,000	1500	3.3%
24	37,500	9000	24.0%	32,000	640	2.0%
25	10,000	3400	34.0%	38,000	1200	3.2%

Appendix 03: PHFL of Longline Vessels and Gillnet Vessels (Part 02)

SN	Gillnet Vessels			Longline Vessels		
	Total weight (Kg)	PHFL		Total weight (Kg)	PHFL	
		Imperia Quality (Kg)	As %		Imperia Quality (Kg)	As %
26	30,000	9600	31.0%	30,000	900	3.0%
27	14,500	2800	19.0%	14,000	420	3.0%
28	13,250	4200	32.0%	12,000	240	2.0%
29	16,000	4500	28.0%	14,000	280	2.0%
30	12,500	3000	24.0%	15,000	900	6.0%
31	17,000	4500	26.0%	16,000	820	5.1%
32	37,500	9000	24.0%	14,000	1200	8.6%
33	11,500	3500	31.0%	15,000	750	5.0%
34	31,000	9000	29.0%	16,000	560	3.5%
35	30,500	5500	18.0%	14,000	750	5.4%
36	14,500	4500	32.0%	15,000	450	3.0%
37	15,000	3600	24.0%	18,000	1500	8.3%
38	11,500	3000	30.0%	24,000	1300	5.4%
39	34,250	9600	28.0%	32,000	1100	3.4%
40	11,550	2800	24.0%	45,000	2600	5.8%
41	16,500	4200	26.0%	18,000	800	4.4%
42	18,750	4500	24.0%	46,000	1500	3.3%
43	16,500	5000	31.0%	34,000	800	2.4%
44	31,250	6000	19.0%	38,000	1100	2.9%
45	23,500	5500	28.0%	30,000	1200	4.0%
46	12,000	2800	24.0%	17,000	600	3.5%
47	16,500	4200	26.0%	14,000	300	2.1%
48	18,500	4500	24.0%	18,000	280	1.6%
49	20,500	4700	22.9%	16,000	900	5.6%
50	22,500	4200	18.7%	16,300	850	5.2%

Appendix 4: Details of Fish Identification

Code	English Name	Scientific Name
YFT	Yellowfin tuna	Thunnus albacares
SKJ	Skipjack tuna	Katsuwonus pelamis
BET	Bigeye tuna	Thunnus obesus
ALB	Albacore	Thunnus maccoyii
SBT	Southern Bluefin tuna	Thunnus alalunga
LOT	Longtail tuna	Thunnus tonggol
FRI	Frigate tuna	Auxis thazard
BLT	Bullet tuna	Auxis rochei
FRZ	Frigate & Bullet tunas	Auxis spp.
KAW	Kawakawa	Euthynnus affinis
TUN	Tunas & Bonitos *NEI	Thunnini and Sardini *NEI
COM	Narrow barred Spanish Mackerel	Scomberomorus commerson
GUT	Indo-Pacific King Mackerel	Scomberomorus guttatus
STS	Streaked Seerfish	Scomberomorus lineolatus
WAH	Wahoo	Acanthocybium solandri
KGX	Wahoo and Seerfishes *NEI	Scomberomorini *NEI
SWO	Swordfish	Xiphias gladius
BLM	Black Marlin	Makaira indica
BUM	Blue Marlin	Makaira nigricans
MLS	Striped Marlin	Terapturus audax
SFA	Indo-Pacific Sailfish	Istiophorus platypterus
SSP	Short-billed spearfish	Tetrapturus augustirostris
BILL	Billfish*NEI	Xophioidei *NEI
TUX	Tuna-like fishes *NEI	Scombroidei *NEI
SKH	Sharks *NEI	

*NEI: Not elsewhere included

Source: (Alejandro, Chris, Miguel, Francois, Koichi, & Shunji, 2007)