THE UNIVERSITY OF HULL

IMPACTS OF COASTAL LAND RECLAMATION ON THE FISHERIES OF MUKIM LEKIR, MALAYSIA.

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By

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Abstract

In 1997, land reclamation works began in the coastal area of Mukim Lekir. Ultimately, an area of 8,094 ha was planned to be reclaimed along Lekir's coastline, but to date; only Phase 1 of the project has been completed. The Phase 1 project of 405 ha, created a man-made island for the location of a 2,100MW, coal-fired power plant; a first of its kind in Malaysia. Although the reclaimed land was only 5 % of the total intended area, its impacts on the livelihoods of the coastal communities, especially fishers, were serious and nearby mangroves were degraded. The effect of this intervention was observed to be long-term, contrary to the claims made by the project proponents. Fishers and other coastal inhabitants incurred monetary losses, which were neglected by the project proponents, who also failed over the issue of compensation.

This study attempts to establish evidence that the project caused hardship to coastal population, especially fishers who depended on fishery resources that were found to decline after the commencement of the project. It began by assessing the status of fish stock, analysing its catch-rates trend and comparing them with resource status before the project. A socio-economic survey by face-to-face questionnaires interview was carried out on the population to obtain information on how the project had affected their livelihoods in terms of incomes, job opportunity, fishing activities, pollution, etc. The research design intended to prove that environmental degradation was caused by the project by comparing the status of resources before and after the intervention. On the issue of compensation, losses were valued in monetary terms, so that it was easily understood and appreciated. The purpose of valuing damages was to allow affected persons to claim compensation in monetary terms. This study emphasized losses through mangrove degradation and losses as result of fishery resources declining. In addition, losses incurred by cockle farmers and the government were also gauged. For mangrove degradation, a survey using the Contingent Valuation Method was carried out to estimate people's willingness to pay (WTP) on a hypothetical project aiming to protect the mangroves. The amount they were WTP was the benefit loss of not being able to use the mangroves. Other losses valuation was straightforward since it involved marketable or tangible goods. The standing of fishers and other affected communities claiming compensation in the court of laws was discussed

Fish stock assessment done in 2002 and 2003 in the Lekir waters indicated that the resource showed a declining trend since 1996. Commercial fish declined at a greater rate in sub-area A, which was closer to the impacted area, than in sub-area B; located further away. Sub-area A was also found to loose its potential as breeding and nursery grounds, since fewer juveniles and fingerlings were caught compared with the 1996 survey. The decline in the fisheries indicative from the surveys was verified by fishers who complained of reduced catches and incomes. In the socio-economic survey, fishers were found not to benefit from the development since the project did not provide them with employment opportunity or generate other kinds of income-induced opportunity. The degradation of the mangroves and the fishery were proven to be caused by the present of the project since the control areas, in the absence of perturbation did not show similar characteristic as the impacted areas. The benefit loss of mangrove use was estimated at RM 81,959/year whereas other society losses were RM 118,333,321 in the six years since the perturbation. If fishers were to claim compensation, they have to prove that their losses were above and over the general public and preferably under the rule of *Rylands V Fletcher*. Other segments of the society may need government intervention since they were claiming pure economic loss, which is unrecoverable in the Common Laws.

This study does not advocate monetary compensation to each affected individual but prefers long-term aid to regenerate rural livelihoods. Economic projects are proposed involving active participation of the community. Further researches are also suggested to improve data collection, developing comprehensive stock assessment and improving EIA procedures.

I would like to dedicate this work
to *Hj. Ramli bin Hj. Abdul Rani*,
my late father who loved me so much,
and to my mother.

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Abbreviations

AC	Appeal Cases
All ER	All England Law Reports
ALR	Administrative Law Reports
Anor.	Another
AFS	Annual Fisheries Statistics
ANOVA	Analysis of Variance
APM	Automatic Price Mechanism
ARIMA	Autoregressive Integrated Moving Average
ASEAN	Association of South-East-Asia Nations
BACI	Before-After Control-Impact
BACIP	'Paired' BACI
BOD	biological oxygen demand
CBA	Cost-benefit analysis
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CLJ	Cambridge Law Journal
CPI	Consumer Price Index
CPI-FF	CPI for food and fuel
CPUE	Catch-per-unit-effort
CR	Criminal Reports
CV	Contingent Valuation
CVM	Contingent Valuation Method
DBD	Double-bounded dichotomous
DBR	double-bounded referendum
DC	dichotomous choice
DKSB	Desa Kilat Sdn. Bhd.
DMS	Department of Meteorological Services
DOE	Department of Environment Malaysia
DOF	Department of Fisheries Malaysia
DOFP	Department of Fisheries Perak

EC	European Community
EEZ Act	Exclusive Economic Zone Act 1984
EG	Estate Gazette
EGD	Estate Gazette Digest
EIA	Environmental Impact Assessment
EQA	Environmental Quality Act 1974 (Act !974) Malaysia
EWCA	Court of Appeal (England and Wales)
EXCH	Exchequer Reports
FASM	Fisher's Association of South Manjung
FDA	Fisheries development Authority Malaysia
FDOM	Fisheries District Office of Manjung
GDP	Gross Domestic Product
HL	House of Lords
HSC	Higher School Certificate
IB	iterative bidding
IRS	Impact verses Reference Site
JP	Justice of the Peace/Justice of the Peace Reports
JT	Judgment Text
JVC	Joint Venture Concession Group
LCDP	Lekir Coastal Development Project
LCE	Lower Certificate of Education
LGR	Local Government Reports
Llyod's Rep.	Llyod's Reports
LMF	Lekir's Mangroves Fund
LOMD	Land Office of Manjung District
LQR	Law Quaterly Review
MAS	Marine Aquaculture System
MCE	Malaysian Certificate of Education
MDO	Manjung District Office
MSA	Merchant Shipping (Oil Pollution) Act 1994
MSY	Maximum Sustainable Yield
NGO	Non-governmental Organization
NIDBMS	National Integrated Data Base Management System

NSB/C	Net Social Benefit/Cost
NUV	Non-Use Values
NZLR	New Zealand Law Reports
OE	open-ended
OECD	Organization for Economic Cooperation and Development
Ors	others
PPP	Polluter Pays Principle
QB	Law Reports: Queen's Bench Division
SBD	single-bounded dichotomous
SBR	single-bounded referendum
SC	Session Cases
SCC	Supreme Court Cases
SEPD	Settlement of Environmental Pollution Dispute
SPSS	Statistical Package for the Social Sciences
TEV	Total Economic Value
TJSB	TNB Janamanjung Sdn. Bhd.
TNB	Tenaga Nasional Berhad
TOL	Temporary Occupational License
TVC	Total Variable Costs
UV	Use Values
V	Versus
VOA	Van Oord ACZ (M) Sdn. Bhd.
WLR	Weekly Law Reports
WTP	Willingness to pay

CHAPTER 1: INTRODUCTION

1.1 South Manjung coastal development

In 1997, Desa Kilat Sdn. Bhd. (DKSB) made a proposal to the State Government of Perak, Malaysia, to develop an area of 8,094 ha over a period of 20 years involving creation of a series 'islands' interlinked to each other and the mainland by bridges (Perunding Utama, 1997). The project site was located southeast of Pangkor Island, off-shore of Lekir, in Manjung District, State of Perak some 290 km north of Kuala Lumpur (Figure 1.1). This land reclamation project was named the Lekir Coastal Development Project (LCDP) and was implemented in two phases. Phase 1 was the reclamation of 405 ha of land to construct a power plant while Phase 2 was the remainder of the project.

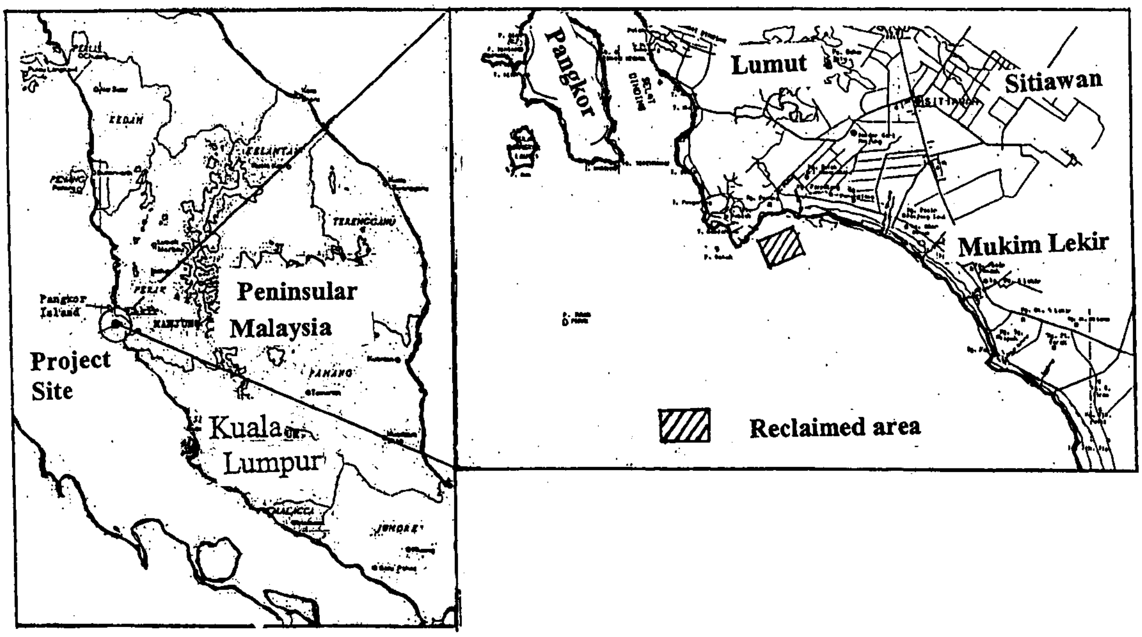

Figure 1.1: The location of the project site

The Phase 1 reclamation works began in early September 1997 and were completed in late 2000 by DKSB, a private limited company owned by Joint Venture Concession Company (JVC) comprising three shareholders namely; Malakoff Limited Co., Gantang Sakti Private Limited Co., and a joint - shareholder of Halim Rasip Holding and Perak State Economic Development Corporation. The latter is a corporation owned by the State Government of Perak holding 13.26% of the total stake in the JVC, while the others are privately owned companies. Phase 1 began at Tg Katak forming an island separated from the coastal shoreline by a 150-200 m wide tidal waterway. The area reclaimed was to locate a coal-fired power plant belonging to Tenaga Nasional Berhad (TNB; a major power producer in Malaysia), which in turn appointed its subsidiary company, TNB Janamanjung Sdn. Bhd. (TJSB), to develop the power plant under independent principles. The three top shareholders of TNB - Khazanah Nasional Berhad, Minister of Finance and Bank Negara Malaysia (National Bank of Malaysia) - are all government-related and owned corporations holding a 64.02% stake of the total (TNB, 2002).

Phase 1 of the development consisted of two sub-phases namely, sub-phase 1 (the reclamation works) and sub-phase 2 (the construction of deep water jetty). During sub-phase 1, about 15 million m^3 of sand was dredged at the burrow site located at Dinding Channel. However, the dredging work at this site was cut short because there were complaints by fishers of excessive sedimentation which forced the trailer suction hopper dredger to move to another site. The initial plan as laid by Perunding Utama (1997) was to allocate 202 ha for the power plant, 115 ha for other industries and ancillary facilities, 65 ha for a coal center and 23 ha for a marine terminal and jetty (Figure 1.2), but, as announced by TNBJ (2003), only 325 ha was reclaimed, of which 291 hectares were acquired by them while the remaining 34 ha were put aside by DKSB for future development.

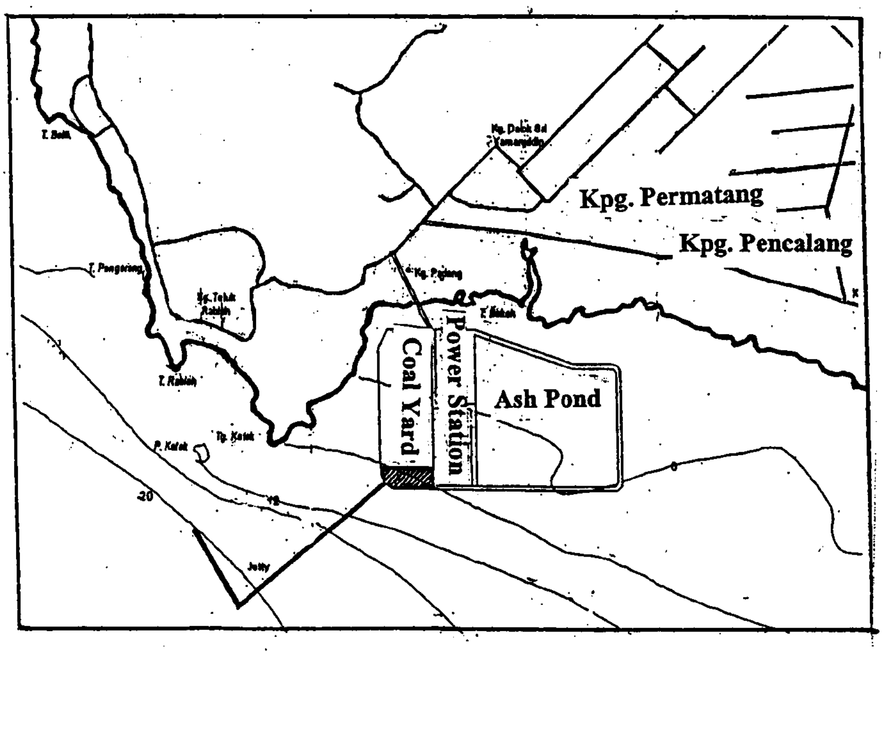

Figure 1.2: Lay-out plan of the power plant and jetty.

Sub-phase 2 involved firstly, the construction of deep water jetty with the Jetty Head in an "L" configuration to the Approach Jetty, aligned to the northwest. Later, if there was need for expansion caused by greater demand for jetty services, the Jetty Head would be extended to the southeast forming a complete "T" shape.

The Malaysian Government made an exclusive offer to the TNB to develop the coal-fired power station at Manjung, Perak with a total capacity of 2100MW, in order to meet the nation's electrical energy demand in the next millennium. It involved the erection of three 700MW steam turbine generators, which were the largest to be built in Malaysia (Sime Darby Group News, February 2001). In line with the government's policy of liberalizing the energy supply industry, TNB formed a wholly-owned subsidiary, TNBJ specifically to undertake the development of the power station.

The power station use pulverized coal combustion power station technologies firing mainly sub-bituminous grade coal, to meet existing environmental regulations. Power Technology (2003) claimed that the power plant has higher emission standards than the 50 mg/Nm^3 typical for the Association of South-East Asia Nations (ASEAN) countries, which operate to particulate levels of 400 mg/Nm^3.

1.2 Environmental impact assessment (EIA)

Under Section 34A of the Environmental Quality (Amendment) Act 1985 (this 1985 Act amended the Environmental Quality Act 1974) which officially came into force on 9 January 1986, there is need to carry out an EIA on any prescribed development activity before being granted approval. Land reclamation and the construction of a power plant are the prescribed activities as stipulated by the Environmental Quality (Prescribe Activities) (Environmental Impact Assessment) (Amendment) Order 2000 (Order 2000); the subsidiary legislation of the 1985 Act.

According to Gilpin (1995) and Ahmad (1985), there are usually three parts to an EIA. First, an Environmental Impact Statement is written to describe the proposed project and the predicted environmental effects of the project in the near and long term future. Second, the EIA lays out the alternatives for decision-makers that might decrease environmental damage, and calculates the costs and benefits of each alternative. Third, the public and relevant interest groups are informed about the contents of the EIA and allowed to negotiate over the details of the plan. The final decision on the development project is usually made by a government agency. The preparation of the EIA in Malaysia must adhere to the guidelines as stipulated by DOE in their published handbook titled, "A Handbook of Environmental Assessment Guidelines". These guidelines describe in details the requirements and procedures of preparing the EIA report.

Two EIA reports were presented by DKSB and TJSB to the Detailed EIA ad hoc Review Panel (Panel) to meet the requirement of Section 34A of the 1985 Act and its subsidiary legislation, the Order 2000, for the reclamation of 8,094 ha of coastal areas and to build a coal-fired power-plant on 405 ha (Phase 1) of the reclaimed land, respectively. These reports were prepared by consulting companies (Perunding Utama Sdn. Bhd. for DKSB and Tenaga Nasional Research and Development Sdn. Bhd. for TJPL). Both consultancy company reports are referred to as Perunding Utama (1997) and Tenaga Nasional (1997), respectively, throughout this study. The Department of Environment Malaysia (DOE), which is under the authority of the Ministry of Science, Technology and the Environment, is the responsible agency for the approval of the EIA report of any project that falls within the stipulated activities as listed under the Order 2000. The final decision whether or not a project should proceed lies with the Approving Authority, which consists of the National Development planning Committee for Federal Government sponsored projects, the State Executive Council for State Government sponsored projects, various Local authorities or Regional Development Authorities with respect to planning approval within their respective area and the Ministry of Trade and Industry for industrial projects. The EIA approval, however, does not necessarily obligate the Approving Authority into permitting the project it merely indicates that the project has fulfilled the compulsory requirement under the law leaving the next decision to the relevant authority. Nevertheless, the EIA approval is prerequisite of private or public projects that come under the jurisdiction of the law.

The EIA reports produced by DKSB and TJSB failed to address the environmental costs and benefits of the project to society. Although a cost benefit analysis (CBA) was required by DOE, the policy makers were more interested in knowing if the project would bring harm to society or would reject it only if the social costs exceeded social benefits. Unfortunately, the question of benefits to the society were poorly addressed and dealt with by the Panel during several appraisal meetings pertaining to the reclamation and building of power plant projects. Whereas the EIA report was detailed in several issues, it seemed to distract the Panel from *bona fide* problems of holistic issues, i.e. was there any benefit generated from the project and by how much in monetary terms. During a discussion session with researchers from Joint EIA Research Program on EIA and Roads (Staerdahl,2002), Prof. Dr. Mohd Fauzi Mohd Jani , in his own words said;

"Social impact assessment should be addressed better, example, when resettlement is necessary it is not enough just to assess the loss of income for the villagers. It is also necessary to assess how the lives and culture of the people living in the village will get affected. It might impact the villagers for the rest of their lives. And it should not be just a chapter in the EIA report. It should be a supplementary report in its own right"

This can be elaborated further that social impact assessment is crucial, that it addresses not only the project impacts on society's culture, but also costs and benefits generated in term of monetary and non-monetary values. Nonetheless, the projects were given the go ahead permit on 14 May 1997 by DOE (reference AS 50/013/100/030 Jld. 3[22]) with issues particularly on costs and benefits to society being left unresolved.

In the EIA reports, the impacts on the livelihood of fishers were not given appropriate priority by Perunding Utama (1997) and Tenaga Nasional (1997). While the former adopted qualitative inferences about the costs and benefits of the projects without offering firm evidence about their findings, the latter was obscure as far as CBA is concerned. Both consultants did not raise the benefit issues satisfactorily in accordance with proper CBA disciplines. It performed qualitative analysis of the expected benefits and costs rather than giving actual and quantified figures of predicted benefits and costs. While it is not the intention of this study to demerit the works of both consultants, it recognizes the need to fulfil a proper CBA study of the projects. Equally imprudent in this respect were the policy makers, professionals, government officials and the Panel who despite representing a wide range of disciplines, failed to alert the developers about the deficiency of the reports and insist on further study. Because the CBA study requirement by law was ambiguous in depth and dimension, the reports succeeded by providing meager information about social benefits. Although the reports were considered adequate and fulfilled the requirement underlined, they failed to address the most important issue; that is, what are the benefits to society?

1.3 The importance of this study

There is a growing trend in Malaysia to turn to coastal areas for development as an easy access to land acquirement. Perunding Utama (1997) said that it is cheaper to reclaim the coastal area than having to buy land from the respective owners. This is in contrast to the basic purpose of land reclamation, which according to Ualberta (2005), is to improve disturbed land (soil, vegetation, water) to achieve land capability equivalent to the pre-disturbed condition or as put by the ICID Dictionary (1996) to make land capable of more intensive use by changing its general character. The anomaly is also brought up by Salleh Buang who reminds that Malaysia has not reached a stage of critical land shortage for housing and urban development (Malaysian Nature Society, 6 October 1999) therefore, any development based on the premise of land shortages is unjustified. What is more alarming is the contention brought by Perunding Utama (1997) that declared that land reclamation is the solution to overcome the problem of coastal development in Manjung, since it is being restrained by mangroves and other natural occurring habitats and, moreover, the muddy nature of the areas does not make it suitable for tourism development. It is alarming because, from the developer's perspective, mangroves are being regarded as disturbed or futile areas to justify reclamation for development. This was approved by various government authorities through an EIA prepared by Perunding Utama (1997) making the future of mangroves at risk.

This phenomenon is considered an unhealthy development of environmental usage and warrants the need to pursue studies on environmental damages and valuation. Furthermore, since project proponents of LCDP and the government alike, ignored society losses in their actions or decisions, there is a need to define losses in monetary terms, particularly intangible goods such as mangrove usage. The only other study of this nature in Malaysia was on the environmental damage of Singapore's land reclamation by the Malaysian Government but it again lacked any valuation component (ITLOS, 2003).

A further need for this research is because predictions made by the project proponents in the EIA documents were later proved to be inaccurate. The actual outcome of the project diverged extensively from the predicted outcome (Table 1.1). The loss to fisheries and the

Table 1.1: Predictions and actual outcome of the project

Predictions by Perunding Utama (1997)	Observation by the researcher in 2002
1. Potential for coastal erosion at Teluk Bekah and the southern edge of the proposed island. Existing conditions for the other coastal areas in Lekir are expected to be unchanged.	1. Instead of erosion, accretion was evidence at Teluk Bekah and the southern edge of the 'island'. There seemed to be coastal accretion in more areas situated south of the reclaimed land.
2. Accretion of the leeward side of the island with potential to recreate conditions conducive for the re-establishment of mangroves in currently eroded areas between Teluk Bekah and Pasir Panjang Laut.	2. Accretion was observed between Teluk Bekah and Pasir Panjang Laut, but it greater amount so much so the waterway channel the 'island' and the mainland was congested. This obviously had breached the assurance by the developer to maintain about 150 m channel at all time to allow existing shoreline activities (e.g. fishers passage to fishing ground) and natural tidal flushing of the coastline (Perunding Utama, 1997).
3. Accretion of the seaward side of the island with potential for formation of shallow areas over time and the establishment of mangroves vegetation, hence new habitat that may attract fish and other marine related life.	3. This has not occurred yet.
4. Sediment dispersion during reclamation that may affect seawater supply to existing hatcheries and pond culture at Teluk Bekah on the mainland, with potential to affect prawn and fish culture during high tide. Sediment dispersion contributed by dumping at the reclamation site has potential to affect Pulau Katak and Teluk Rubiah only under certain tidal conditions.	4. No complaint recorded by the Department of Fisheries, Perak.
5. Loss of mudflats to aquatic birds and related marine fauna, as well as feeding and nursery grounds for fish and other aquatic life.	5. Some mangroves were seen to be degraded. Areas badly damaged were Kg Permatang and Kg. Pasir Panjang Laut, and Kg Tg. Kepah.
6. Loss of fishing areas for artisanal fishers in the reclaimed area but with possible options for fishing in other areas nearby. There may be temporary loss of fisheries during construction in the area due to migration of fish elsewhere.	6. Fisheries losses are not temporary. Between 1998 and 2002, the decline is evident. Fishers complain of bad catches and blamed the 'island'.

environment appears to be more than envisaged by the developers. The observation by the researcher did not detect accretion caused by land-based sources and mangroves degradation was obviously related to accretion. On fisheries losses, complains were heard from fishers during face-to-face confrontation with them. Thus there is a need to redress this situation so compensation mechanisms can be proposed.

The overall aims of this study are, to evaluate the impacts on fisheries resources and socio-economics of the fishers emanating from the land reclamation and the building of the coal-fired power plant. While the electricity will be benefit people living distant from the coastal area, the livelihoods of the fishers that depend on the fisheries resources has been hampered by low fish catches and other environmental hazards. There is no doubt that the benefits of a 2,100 MW of electricity to the nation will surpass the value of fisheries resources of the district. For example, at full impact, the 2,100 MW coal-fired power plant will bring a net profit of RM 1 billion (The Star, 30 July 2005) whereas the value of fish landings of Mukim Lekir in 2003 was only RM 3.3 millions (Annual Fisheries Statistics of Perak, 2003). The concern here is the Net Social Benefit (the NSB or if it is loss, is known as Net Social Costs - NSC) that are borne mainly by the fishers and the other coastal communities. There is a need to determine the NSC so that appropriate compensation can be paid to those affected and mechanisms for addressing environmental damage can be identified and costed.

In Malaysia, there is a precedent for such work whereby in connection with Singapore's land reclamation, 114 fishers of Sungai Tebrau were each compensated between RM 200 to RM 500 after negotiating their losses with the developer known as Tebrau Bay that carry out the sand dredging works (Berita Harian, 21 July 2003). Nonetheless, at the International Tribunal for the Law of the sea in Hamburg (ITLOS, 2003), the counsels and advocates of Singapore put the following questions (with some modification by this study); to rebut Malaysia's contention of environmental damage, *inter alia*:

(a) Is there a real risk of harm to the environment?

(b) Is the reclamation works alone affecting the environment?

(c) What is the exact problems, where it is taking place and how the reclamation has caused these problems?

(d) What is the prove that the reclamation projects are already causing and threaten to cause harm to the marine environment?

(e) How the changes in physical, chemical and biological parameters affect the aquatic life?

(f) How close the mathematical predictions are corresponding to reality?

(g) Is the socio-economic study reliable?

(h) Where is the erosion taken place?

(i) Is there a decline in fisheries?

The questions put by Singapore form the basis of the aims of this study since they are interesting for three reasons: (1) they coincide with this study in pursuit of examining and valuing the impact costs incurred by fishers and other coastal dwellers; (2) they are questions posed by lawyers for the defendant and thus it is expected the same kind of question would be brought up by defendants in any land reclamation trial; and (3) it is the first and only case as yet in Malaysia, involving a dispute concerning land reclamation whereby one party is claiming against another. As such, although the judgment is not binding in courts, it could serve as guidelines in any claim for compensation.

1.4 The objectives of the study

Fishers are the societal group most affected by the reclamation works. From the very beginning of the works (the dredging of sand, the pumping of sand into the coastal area and the construction and operation of the power plant) fishers are always vulnerable to such deviant activities so complaints are made but little effort to remedy the situation has been taken by the authorities. A comprehensive study of the impacts on their livelihoods and socio-economic status is much sought to explain the inherent problems in a more rigorous manner and adhering to accepted and well-known methodologies. The livelihoods of any person must not been taken lightly disregarding of how minor they are. Xavier (2001) reminded that in the law of tort, any person who causes injury to another person or another's property is liable for the act or omission that caused the damage. Although the statutes of Malaysia do not provide a conducive platform for them to obtain justice, they could turn to the common law courts as an alternative to claim compensation. Thus, the overall objectives of this study are to determine losses in monetary terms so that compensation can be claimed.

To meet the objectives of this study the following actions are needed and developed:

(1) To assess the present status of fish stocks in terms of catch-rate, total biomass and Maximum Sustainable Yield (MSY) and to compare these parameters with previous data prior to the intervention.

(2) To analyze impacts of land reclamation on the livelihoods of fishers and other coastal inhabitants.

(3) To identify the damage and cause-effect relationship between the intervention and the perpetrator.

(4) To value, in monetary terms, the economic losses to fishers and the environment, particularly of mangrove uses.

(5) To explore, in legal terms, fishers' standing with regard to damage claim.

(6) To suggest appropriate remedies in building up the economy of fishing communities through compensation mechanisms.

The hypotheses of this study are thus given as follows:

(1) There is the depletion of fish stocks after the intervention compared with the before data.

(2) Fishers and other coastal inhabitants do not benefit from the coastal development.

(3) Mangroves and fisheries degradation is caused by the intervention.

(4) Mangrove uses and producer/consumer surpluses are calculated in monetary terms to show losses incurred by the society.

(5) Fishers and other aggrieved parties could claim compensation in the court of laws.

1.5 Organization of the thesis

This thesis is distinguished by four components: the preliminary studies, damage and cause-effect relationships, damage valuation and claiming compensation. The justification to expand the studies will be dependant on the outcome of the preliminary studies which investigated whether the fisheries resources are affected and fishers are aggrieved by the consequences. The next move is to identify the perpetrator by building up the linkage between the damage and its cause. For compensation action, damages have to be valued, thus compensation prospects are discussed. In the conclusion chapter, compensation mechanisms will be proposed to provide alternatives economic remedies for fisher communities.

1.5.1 Preliminary studies

Fishers' losses in particular and society's losses in general, become the main concern of this study and to begin with, two surveys were carried out concurrently to explore and investigate if there really was resource degradation and its effect on the fishers. Two chapters are assigned to address this matter. Chapter 2 assesses fish stock characteristics before and after the intervention. The swept-area method is used to determine catch-rate, total biomass and an estimation of MSY. The effect of the project is illustrated by comparing three surveys before-land-reclamation on fisheries resources carried out by Perunding Utama (1997), Tenaga Nasional (1997) and MFRDM (2000) with a recent survey. Chapter 3 describes a socio-economic survey to review the livelihoods of fishers and other related coastal inhabitants in connection with the reclamation project.

1.5.2 Damage and cause-effect relationship

Proving the seriousness of the damage is fundamental since minor and temporary damage may not attract the attention of the public. Damages can be in the form of economic and environmental degradation. Incomes reduction is a form of economic damage resulting from decline in fish catches, whilst the reduction in stocks is an environmental damage. The 'Before-After Control-Impact' (BACI) approach is used to prove the cause-effect relationship between the damage and its perpetrator when before and after data are available. Such an approach is described for the fisheries characteristics in Chapter 4 since before and after data were available but no such information was available for assessing physical habitat degradation, such as degradation of the mangroves. In this case, the Impact versus Reference Sites (IRS) method suggested by Stewart-Oaten and Bence (2001) was used.

1.5.3 Damage valuation

Two chapters are devoted into valuation of the losses involving tangible and intangible goods. Chapter 5 deals with the valuation of the benefit loss incurred by the people of

Mukim Lekir resulting from degradation of the mangroves. Mangroves uses other than harvestable products for personal use or sale in local and international markets are intangible goods that require specific techniques of valuation. In this chapter, the Contingent Valuation Method (CVM) is adopted, and the results discussed.

Tangibles goods such as fish, cockle culture and government expenditure are gauged in Chapter 6. In this Chapter, the focus is on the societal losses as result of change in fish prices, loss of cockle farming income and failure of government expenditure to achieve its objectives.

1.5.4 Claiming compensation

Chapter 7 discusses the possibilities of aggrieved persons claiming compensation in the court of laws. It suggests the basis of fishers and non-fishers claims for compensation. Since the statutes of the country do not provide a comfortable space for claimants of environmental damage, the civil courts are considered the most appropriate venues. However, there are obstacles to be solved; whether fishers or any other person have the *locus standi* (Ansari, 2004; Edwin,2003; Singh,2003; Thye, 2002 and Ansari, 1998); whether the economic claims are recoverable (Chin,2003; Matta,2003; Ansari, 2000; Xavier, 1998 and Leng, 1992); or whether the claim is on private or public property (Cole, 2002).

1.5.5 Conclusion

Chapter 8 highlights the key findings of this thesis and provides recommendations to revitalize the fishing community by way of creating local economic activities funded by the developers, and suggests further research.

CHAPTER 2: FISH STOCK ASSESSMENT BY SWEPT AREA METHOD

2.1 Introduction

Enumeration of fish stocks in the sea has been the subject of interest for many years. It is based on the need to know the amount of fish that can be harvested to forecast how much money to invest or whether it is worth going out fishing to earn a living. More recently, fisheries managers use knowledge of fish stock size as indicators of overexploitation (Caddy and Mahon, 1995). It is also used when fisheries are proven exhausted and facing extinction (e.g. the study on Gulf of Thailand - IOC Workshop Report No.141, 1997). In this context, Gulland (1983) pointed out that the concept of Maximum Sustainable Yield (MSY) serves as a useful first approximation, as it provides three distinct functions – a description of the status of the fish stocks in relation to exploitation, a definable objective of management, and a measure of the success with which a stock is being managed. The need to manage the fisheries is over whelming, and MSY is a useful reference tool to guide decision making (Caddy and Mahon, 1995). It guides recommendations about how to adjust levels of fishing effort, a component of the fishery system that managers can sometimes control, unlike the stock itself (Ault, *et al.* 1996). It can also be useful to assess impacts of an environmental intervention on fish

The land reclamation project, for example, is suspected of causing environmental degradation resulting in fish mortality. The 1998 fish landings by the traditional fishers of South Manjung were the lowest recorded by the Department of Fisheries of Perak (DOFP) at 5,481.19 t compared with 7,109.07 t in 1997, the year the reclamation project began. The 1998 sudden drop marked the beginning of an era of difficult years for fishers. What was predicted as temporary or short-term effects by the project proponents turned out to be protracted since there was no indication of recovery. This may verify the 'myth' that the EIA reports prepared by the industry consultants are biased towards the needs of the industry (Idris, 2000 and Parkinson, 2004). Coastal land reclamation, the building of power plant, offshore gas and oil exploration are among other man-made interventions that affect the marine life, direct or indirectly.

In this study, the swept-area method based on trawling was used to assess fish stocks on two occasions, and to compare the assessments with a survey before the intervention. The objective was to show the changes in the fish stock characteristics over time and to validate fishers' claim on fish depletion as the result of land reclamation works. The swept-area method is based on research trawl survey catches per unit of area. From the densities of fish observed (the weight of the fish caught in the area swept by the trawl), an estimate of the biomass in the sea is obtained, from which an estimate of MSY is calculated. This method assumes that the mean catch in weight per unit area is an index of stock abundance (Gulland, 1969, Pauly, 1984). This method is rather imprecise and it predicts only the order of magnitude of MSY (Sparre and Venema 1992). Nevertheless, it is sufficient at this moment as to give an idea of the status of the fisheries within the coastal limit coupled with some knowledge of fish landings obtained from the fishers and fish traders. With limited past surveys done in the area, this is probably the most reliable source of fisheries assessment data to hand that can be used to draw out fundamental inferences about the fisheries before the land reclamation and serves as a benchmark for a comparative study after the completion of the project.

2.2 Materials and methods

If assessment of the stock status is to be used as a tool to detect damage to fisheries after the intervention, there is a need for data before the intervention. This is the be the biggest obstacle since previous resource surveys by the authority in the vicinity of the areas were minimal. The alternative was to refer to two surveys, one was carried out by Perunding Utama (1997) and Tenaga Nasional (1997) and the other was by the Department of Fisheries Malaysia (DOF).

2.2.1 Description of the survey areas

For the purpose of this survey, two boundary lines were drawn perpendicular to the Mukim Lekir boundaries along the shoreline at latitude $4^{0}10.5^{'}N$ at the northern end and latitude $4^{0}0.0^{'}N$ at the southern end to delimit Lekir waters. The coastal waters of Lekir were further delimited by boundary line at longitude $100^{0}35.0^{'}E$ estimated at 1.9 nm from the shoreline at the north and 8 nm at the southern shoreline. The coastal waters of Lekir were then split into two sub-areas (A and B) by latitude $4^{0}5.0^{'}N$ for the purpose of stratified random sampling. No depth stratification was made in the survey but nevertheless recorded during trawling. The total area covered during the survey was estimated at 50 nm^2 (excluding the non-trawlable area between 1.5nm to 6 nm from the shoreline with a depth less than 5.5 m) (Figure 2.1).

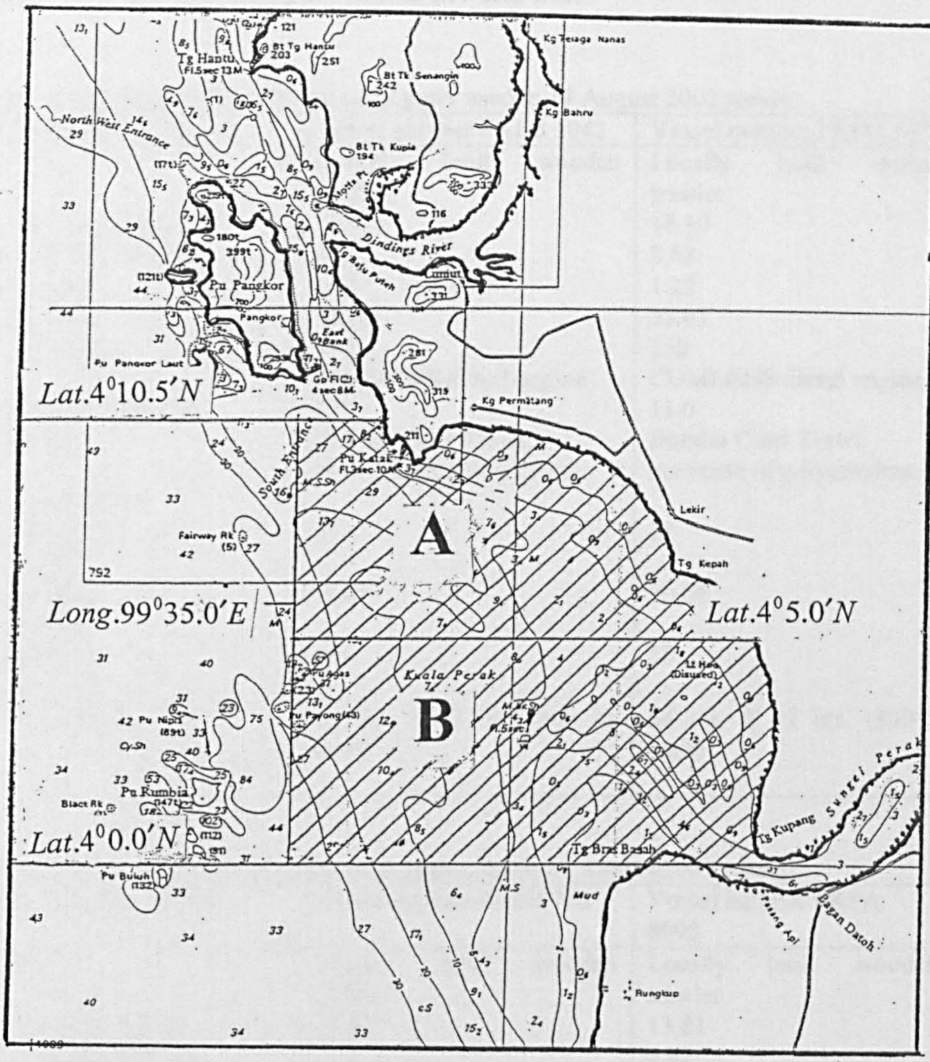

Figure 2.1: Trawl areas of Mukim Lekir water.

2.2.2 Research vessel and fishing gear specifications

The trawlers used were registered commercial fishing vessels stationed at Pulau Pangkor and Kampung Acheh and were selected to hold similar characteristics in terms of size (measured in tonnage), engine capacity (measured in horse power) and the trawl net size. However, the effort to locate such perfect similarities was unsuccessful because the participation of the trawlers was on a voluntarily basis due to financial constraints thus limiting choice of the vessels. Fortunately, all the volunteered trawlers used similar net sizes which permitted the survey to be conducted with approximately constant effort, if each trawled at the same speed. This was not always possible as trawling speeds were between 3.25 and 4.2 knots (average of 3.65 knots). Their principal characteristics and gears used are illustrated in Tables 2.1 and 2.2.

Table 2.1: Principle characteristics and gears used in 17 August 2002 survey

Characteristics and gear	Vessel number PKFB 1042	Vessel number PKFB 1075
Type	Locally built wooden trawler	Locally built wooden trawler
Overall Length (m)	12.93	16.10
Breadth (Width)(m)	4.57	5.65
Depth (m)	1.17	1.22
Load (GRT)	19.56	28.07
Engine (bhp)	190 CUMMINS diesel engine	250 CUMMINS diesel engine
Sailing speed (knots)	9.5	11.0
Gear type	Bottom Otter Trawl, net made of polyethylene	Bottom Otter Trawl, net made of polyethylene
Cod-end mesh Size (mm)	25	25
Headrope Length (m)	30.05	30.05
Overall net Length (m)	50	50
Otter board size and length	64 ins. X 47 ins. (300 kg each).	64 ins. X 47 ins. (300 kg each)

Table 2.2: Principle characteristics and gears used in 21 August 2003 survey

Characteristics and gear	Vessel number PKFB 716	Vessel number PKFA 8098
Type	Locally built wooden trawler	Locally built wooden trawler
Overall Length (m)	12.74	13.81
Breadth (Width) (m)	5.13	4.42
Depth (m)	1.54	1.44
Load (GRT)	38.54	24.87
Engine bhp)	335 CUMMINS diesel engine	275 CUMMINS diesel engine
Sailing speed (knots)	12.5	11.5
Gear type	Bottom Otter Trawl, net made of polyethylene	Bottom Otter Trawl, net made of polyethylene
Cod-end mesh Size (mm)	25	25
Headrope Length (m)	30.05	30.05
Overall net Length (m)	50	50
Otter board size and length	64 ins. X 47 ins. (300 kg each)	64 ins. X 47 ins. (300 kg each)

The design and technical specifications of the bottom otter trawl net is provided in Appendix 1 (Figure 2A). According to Munprasit, *et al.* (1995), there are four major trawl fishing methods used in Malaysia, namely bottom beam trawling, bottom otter trawling, bottom double rigging trawling and bottom pair trawling. In the west coast of Peninsular Malaysia, otter bottom trawling is generally used and divided into three kinds, namely fish trawling, shrimp trawling and brine shrimp trawling. The trawl net used for this survey was the fish trawl having a larger mesh size at the wing net compared with the other types of otter bottom trawl nets. The length of warp rope was readjusted during trawling to suit a water depth ratio of 4: 1, to ensure the bobbins on the ground line touched the sea-beds.

2.2.3 Survey design and sampling stations

Two surveys were performed in 17 August 2002 and 21 August 2003, about a year apart. The average depths in Sub-area A and Sub-area B were 17.75 m and 33.08 m respectively. Areas less than 5.5 m deep and closer to the shore were untrawlable by vessels commissioned for this survey. Thus, the boundary of this survey was exclusively confined to areas having water depths ranging from 5.5 m to 33.08 m. The selection of the trawling stations for the 2002 survey was through by random sampling where each trawling area was defined as an area of 6 nm^2 or a rectangular grid 4.0 nm by 1.5 nm. At each station, the survey vessel trawled in a straight line but was free to choose the direction. The 2003 survey repeated the trawling routes assigned in 2002.

2.2.4 Sampling procedure

Since this survey was only intended to ascertain the index of stock abundance, i.e. the mean catch per unit area and then to convert it into an absolute measure of biomass using the "swept area method", only species identification, weight of the species and their number was attempted and enumerated. The sampling and catch recording procedures as outlined by Pauly (1980) were adopted as a point of reference. All individuals of each species of commercial value were accounted for, except in trash fish where a 10% sampling method was employed. Trash fish is defined as fish with little or no commercial value (FAO, 2003A) due to its unfavorable market demand or below marketable size. Commercial species that were caught below marketable size were categorized as trash fish in this study and fish having individual weight of more than 10 kg were considered outliers, and separated from the samples. The following procedures were carried out during the survey:

Step 1: The unwanted catch such as jelly fishes were thrown overboard. No poisonous snake or animal was caught.

Step 2: Debris of all kinds were also thrown overboard.

Step 3: Big fish of more than 10 kg were separated and kept aside since they will not be included in the total catch.

Step 4: Fishes of commercial value were sorted according to species and put in respective baskets. Trash fishes of all species were put together in baskets.

Step 5: Each species of commercial value was weighed and enumerated.

Step 6: The trash fishes were weighed together and then about 10% were removed randomly, sorted out according to species, weighed and enumerated.

Step 7: All fishes were handed over to the vessel owner after the survey.

2.2.5 The trawl surveys

Eight stations numbered 1A, 2A, 3A and 4A in Sub-area A and 1B, 2B, 3B and 4B in Sub-area B surveyed on the 17 August 2002 (Figure 2.2). Fishing information and the trawling logs of these surveys were recorded and shown in Appendix 1 -Table 2A, -Table 2B, -Table 2C and -Table 2D. Figure 2.3 shows the trawling stations 1A2, 2A2, 3A2 and 4A2 in Sub-area A and stations 1B2, 2B2, 3B2 and 4B2 in Sub-area B surveyed on the 21 August 2003. Fishing information and the trawling logs of this survey were recorded and

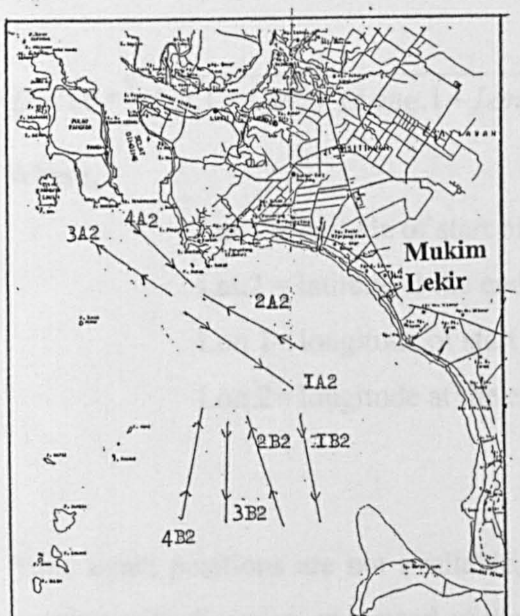

Figure 2.2: Surveyed areas on 17 August 2002

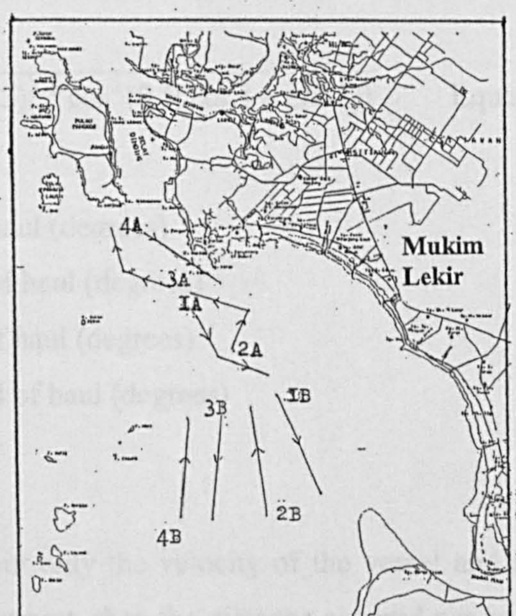

Figure 2.3: Surveyed areas on 21 August 2003

shown in Appendix 1-Table 2E, -Table 2F, -Table 2G and -Table 2.H.

The positions and directions of the vessel were plotted using a hand-held Global Positioning Satellite (GPS) (Advanced AE 688) and the water depths were recorded using an echo sounder (KODEN CVS-108).

2.2.6 The swept-area

The sweep area or the effective path swept, a, was estimated as:

$$a = D * h * X2 \qquad \text{,and} \qquad D = V * t \text{.....Equation 1}$$

where V is the velocity of the trawl over the ground when trawling, h is the length of the head- rope and t is the time spent trawling. $X2$ is that fraction of the head-rope length, h, which is equal to the width of the path swept by the trawl, i.e. the wingspread, $h*X2$, D is the distant covered during the trawling (Appendix 1-figure 2B). For the purpose of this study, $X2$ was set at 0.5, as suggested by Pauly (1980) and advocated by Ahmad, *et al.* (2003) for Malaysian waters.

When the exact position of the start and the end of the haul were available, the distance covered can be estimated in units of nm by:

$$D = 60 * \sqrt{(Lat.1 - Lat.2)^2 (Long.1 - Long.2)^2 * \cos^2(0.5[Lat.1 + Lat.2])} \qquad \text{Equation 2}$$

Where,

Lat.1 = latitude of start of haul (degrees)

Lat.2 = latitude at the end of haul (degrees)

Lon.1= longitude of start of haul (degrees)

Lon.2= longitude at the end of haul (degrees)

If the exact positions are not available, but only the velocity of the vessel and its course together with direction and speed of the current, then the distance covered per hour can be calculated from:

$$D = \sqrt{VS^2 + CS^2 + 2 * CS * \cos(dirV - dirC)} \qquad \text{(nm)} \qquad \text{Equation 3}$$

Where,

VS = velocity of vessel (knots=nm/hr)

CS = velocity of current (knots)

dirV = course of vessel (degrees)

dirC = direction of current (degrees)

2.2.7 Biomass estimation by the sweep area method

To estimate biomass, catch in weight per unit area (kg/nm^2), the following equation is used,

$$\frac{Cw/t}{a/t} = \frac{Cw}{a} \qquad \text{Equation 4}$$

where if *Cw* is the catch in weight (kg) of a haul, then Cw/t is the catch in weight per hour, when t is the time spent hauling (in hours). *a* is the area swept and *a/t* is the area swept per hour.

The estimate of the average biomass per unit area (kg/nm^2), Δb, is,

$$\Delta b = \frac{\Delta Cw/a}{X1} \qquad \text{Equation 5}$$

where *X1* is the fraction of the biomass in the effective path swept by the trawl which is actually retained in the gear (also known as the catchability coefficient), and let *Cw/a* be the mean catch per unit area of all hauls. The value of *X*1 was chosen to be 0.5, which is commonly adopted for trawl surveys in Southeast Asia (Isarankura, 1971; Saeger, Martosubroto and Pauly, 1976; MFRDM, 2000 and Ahmad *et al,* 2003). However, Alias (2003) suggested the catchability coefficient of 0.25 when dealing with pelagic species.

The total biomass, *B*, in this area, *A*, is obtained from,

$$\mathrm{B} = \frac{(\Delta Cw/a) * A}{X1} \qquad \text{Equation 6}$$

where *A* nm^2 be the total size of the area under investigation.

2.2.8 Cadima's formula for estimating MSY

Cadima's formula (in Sparre and Venema, 1992) is used to derive MSY where no previous data series on catch and effort are available. It is simple approximation and should be used with caution. Cadima's estimator has the form:

$$MSY \quad = 0.5 * Z * \Delta B \qquad \text{Equation 7}$$

where B is the average (annual) biomass and Z the total mortality. Since $Z = F + M$ and $Y = F * \Delta B$, Cadima suggested that in the absence of data on Z, Equation 7 could be rewritten:

$$MSY \quad = 0.5 * (Y + M * \Delta B) \qquad \text{Equation 8}$$

where Y is the total catch in a year and ΔB is the average biomass in the same year. F and M are fishing mortality and natural mortality, respectively.

2.3 Results

2.3.1 Trawl survey on 17 August 2002

Catch rates (kilogram per hour, kg/hr)

The average catch rate of the whole survey area was 237.8 kg/hr, of which 71.8 % consisted of trash fish (Table 2.3). The average catch rate for commercial fish was 67.4 kg/hr. There was no significant difference in catch-rates between sub-area A and Sub-area B, being 230.8 kg/hr and 246.4 kg/hr respectively (t=-0.363, df=6, *P*=0.729 ns), but trash fish of sub-area B made up 78.1 % of the total catch which was higher than in sub-area A (65.0 %), suggesting commercial fish were more abundant in sub-area-A. Pelagic fish dominated in both sub-areas. On the average, 70.40 % of the catch was pelagic fish (168.0 kg/hr compared with only 70.7 kg/hr for demersal fish).

Table 2.3: Catch rates of demersal and pelagic fish in areas (kg/hr)

Area	Demersal (commercial)	Pelagic (commercial)	Demersal (trash)	Pelagic (trash)	Catch-rate (kg/hr)
Sub-area A	38.4	42.4	51.4	98.6	230.8
Sub-area B	16.9	37.2	40.4	152.2	246.7

More demersal fish were caught in sub-area A (89.8 kg/hr) than in sub-area B (57.3 kg/hr), but the reverse was seen for pelagic species. However, unlike demersal fish, which also attained higher commercial fish species composition in sub-area A, the commercial fish composition in pelagic species was lower in sub-area B. In both sub-areas, more pelagic fish of commercial value were caught (16.7 % of the total catch rate as compared to 11.6 % of the demersal species).

Catch rates, in terms of number of individuals, provided a slightly different composition. The average catch rate in both sub-areas was 13,740 individuals/hr, but trash fish contributed 95.5 % of the catch (Table 2.4). The catch rate in sub-area A was higher (14,818 individuals/hr) than that in sub-area B (12,661 individuals/hr). The contribution of commercial fish in sub-area A was 6.3 %, which is slightly higher than that in sub-area B at 2.6 %. More pelagic trash fish individuals were caught in sub-area A (82.2 %) than in sub-area B (73.3 %). In sub-area A, demersal fish made up of 13.1 % of the catch which was lower than that in sub-area B (20.7 %), but the proportion of pelagic fish was higher in sub-area A than in sub-area B, at 86.9 % and 75.2 % respectively.

Table 2.4: Catch rates of demersal and pelagic species in areas (individuals/hr) (17 August 2002).

Area	Demersal (Commercial)	Pelagic (Commercial)	Demersal (Trash)	Pelagic (Trash)	Average Catch rate
Sub-area A	254	686	1,694	12,184	14,818
Sub-area B	88	246	2,795	9,532	12,661

Although the weight of commercial fish is higher in sub-area A, so was the number, thus the weight : number ratio was lower than in sub-area B. In sub-area A, the mean weight of each fish is only 86 g compared with 162 g in sub-area B. This suggests that it is more effective to fish in sub-area B than in sub-area A.

Catch composition

In terms of weight, 19 demersal species and 11 pelagic species of commercial importance were caught in sub-area A. The most abundant species was *Rastrelliger kanagurta* (Cuvier, 1816), which made up 23.1 % of the total catches. In accordance to species grouping, *Sphyraena jello* (Cuvier, 1829) contributed 18.9 % of demersal catch, whilst *R. kanagurta* represented 44.0 % of the pelagic catch (Table 2.5). In sub-area B, only 15 demersal species were caught, but slightly more pelagic species (13 species) compared with sub-area

A (Table 2.6). Pelagic species, *Pampus argentus* (Euphrasen, 1788) contributed 33.5 % of the total catches. In accordance to species grouping, *P.* argentus contributed 48.8 % of the pelagic catch, whilst *Loligo duvauceli* (Orbigny, 1848) contributed 60.0 % of the demersal catch. Examining the first six most abundant demersal species, with the exception of *D.zugei* and *T. Lepturus*, which were no longer abundant in sub-area B, the rest of the abundant species in sub-area A were the same as sub-area B. Two species which were not abundant in sub-area A but became abundant in sub-area B were *Sepia aculeate* (Van Hasselt, 1835) and *L. sp.* (Lamark, 1798). The ray fish, *D. zugei* was not caught in sub-area B. For pelagic species, only three species, *P. argentus*, *P. chinensis* and *S. tol* were abundant in both sub-areas and *D. haselti* was not caught in sub-area B.

Table 2.5: Commercial species caught in sub-area A on 17 August 2002 (kg/hr)

Demersal Species	kg/hr	Pelagic species	kg/hr
Alu-alu(*Sphyraena jello)* Cuvier, 1829	29	Mambong/kembong (*Rastrelliger kanagurta*) Cuvier, 1816	74.6
Daun baru (*Drepane punctata*) Linnaeus, 1758	22.4	Tamban (*Dussumieria haselti.*) Bleeker, 1851	20
Sotong (*Loligo duvaucell)* Orbigny, 1848	12.6	Bawal putih (*Pampus argentus*) Euphrasen, 1788	18.4
Pari Ketuka (*Dasyatis zugei*) Muller and Henle, 1841	13.8	Bawal tambak (*Pampus chinensis*) Euphrasen, 1788	10.4
Duri (*Arius thalassinus)* Ruppell, 1837	11.5	Talang (*Scombroides tol*) Cuvier, 1832	9.9
Timah (*Trichiurus lepturus*) Linnaeus, 1758	11.2	Tenggiri batang (*Scomberomorus commerson*) Lacepede, 1800	8.3
Gerut-gerut (*Pomadasys hasta*) Bloch, 1790	10.06	Kapas laut(*Gerres abbreviatus*) Bleeker, 1850	8.1
ketam nipah(*Sylla serrata*) Forsskal, 1775	7	Tamban sisek (*Sardinella fimbriata*) Valenciennes, 1847	8
Ketam renjong (*Portunus pelagicus*) Linnaeus, 1758	6	Peláta(*Alepes djedaa*) Forsskal, 1775	5.82
Gelama pisang (*Pennahia macrophthalmus*) Bleeker,1850	6	Senangin(*Eleutheronema tetradactylum)* Shaw, 1804	4.2
Ketam merah (*Charybdis cruciata*) Herbst, 1794	5.2	Bawal hitam (*Formio niger*) Block, 1795	2
Udang putih besar (Penaeus marguiensis) de Man, 1888	4.5		
Pari tembikar (*Gymnura poecilura*) Shaw, 1804	3		
Jenahak (*Lutjanus johni*) Bloch, 1792	2.7		
Sebelah (*Pseudorhombus malayanus*) Bleeker, 1865	2.7		
Kerisi (*Nemipterus japonicus*) Bloch, 1791	2.1		
Kerapu (*Epinephalus tauvina.)* Forsskal, 1775	2		
Sotong katak (*Sepia aculeata)* Van Hasselt, 1835	1.1		
Gelama papan (*Nibea soldadu)* Lacepede, 1802	0.8		
TOTAL	153.66	TOTAL	169.72

Table 2.6: Commercial species caught in sub-area B on 17 August 2002 (kg/hr)

Demersal species	kg/hr	Pelagic species	
Sotong(*Loligo duvaucelli)*	40.5	Bawal putih (*Pampus argentus*)	72.6
Alu-alu(*Sphyraena jello)*	11.24	Talàng (*Scombroides tol*)	22.6
Daun baru (*Drepane punctata*) Linnaeus, 1758	3.2	Bawal hitam (*Formio niger*)	11.3
Sotong daun (*Loligo sp.*) Lamarck, 1798	3.2	Bawal tambak (*Pampus chinensis*)	10.5
Duri (*Arius thalassinus*)	2.7	Pelaling (*Rastrelliger brachysoma*) Bleeker, 1	8.8
Sotong katak (*Sepia aculeata)*	2.5	Tenggiri batang (*Scomberomorus commerson*)	7.3
Rambai (*Atropus atropus*) Bloch and Scneider, 1801	1.3	Kapas laut(*Gerres abbreviatus*)	4.4
Ketam merah (*Charybdis cruciata*) Herbst, 1794	1	Senangin(*Eleutheronema tetradactylum)*	4.1
Gelama(*Johnieops sina)* Cuvier, 1830	0.65	Pelata(*Atule mate*) Cuvier, 1833	3.9
Jenahak merah (*Lutjanus johni.*) Bloch, 1792	0.3	Parang (*Chirocentrus dorab*) Forsskal, 1775	1.65
Udang putih besar (*Penaeus marguiensis)*	0.3	Selar kuning (*Selaroides leptolepis*) Cuvier, 1833	1
Timah (*Trichiurus lepturus*)	0.3	Cincaru (*Megalaspis cordyla*) Linnaeus, 1758	0.6
Udang lipan (*Parapenaeopsis gracillima)* Nobili, 1903	0.26	Mambong/kembong (*Rastrelliger kanagurta*)	0.05
Ketam renjong (*Portunus pelagicus*)	0.1		
Gerut-gerut (*Pomadasys hasta*) Bloch, 1790	0.05		
TOTAL	67.6	TOTAL	148.8

In terms of individuals number, *R. kanagurta* retained its dominance by being the most abundant species in sub-area A (31.6 % of the total catches) (Table 2.7). The most abundant pelagic species was *R. kanagurta* being represented by 43.4 % of the catches and *L. duvaucelli* which contributed 32.6 % of the demersal catches. In sub-area B, *L. duvaucelli* was also the most abundant demersal species being represented by 63.5 % of the catches but for pelagic species, *P. argentus* was the most dominant (45.9 % of the total catches) (Table 2.8). Only one individual *R. kanagurta* was caught in sub-area B.

Examining the six most abundant species, only L. duvaucelli and *Arius thalassinus* (Ruppell, 1837) of the demersal species, and the pelagic species *P. argentus* and *Gerres abbreviatus* (Bleeker, 1850) were abundant in both sub-areas.

Table 2.7: Commercial species caught in sub-area A on 17 August 2002 (Individual/hr)

Demersal species	ind./hr	Pelagic species	ind./hr
Sotong (*Loligo duvaucelli*)	331	Mambong/kembong (*Rastrelligar kanagurta*)	1190
Timah (*Trichiurus lepturus*)	89	Tamban (*Dussumieria haselli*.)	800
Pari Ketuka (*Dasyatis zugei*)	86	Tamban sisek (*Sardinella fimbriata*)	320
Duri (*Arius thalassinus*)	82	Bawal putih (*Pampus argentus*)	120
Gelama pisang (*Pennahia macrophthalmus*)	80	Kapas laut(*Gerres abbreniata*)	109
Ketam renjong (*Portunuspelagicus*)	74	Pelata(*Alepes djedaa*)	97
Udang putih besar (Penaeus marguinensis)	52	Talang (*Scombroides tol*)	43
Daun baru (*Drepane punctata*) Linnaeus, 1758	51	Bawal tambak (*Pampus chinensis*)	26
Ketam merah (*Charybdis cruciata*)	41	Tenggiri batang (*Scomberomorus commerson*)	17
ketam nipah(*Sylla serrata*) Forsskal, 1775	30	Bawal hitam (*Formio niger*)	14
Sebelah (*Pseudorhombus malayanus*)	25	Senangin(*Eleutheronema tetradactylum*)	8
Alu-alu(*Sphyraena jello*)	18		
Kerisi (*Nemipterus japonicus*)	17		
Gerut-gerut (*Pomadasys hasta*)	13		
Jenahak (*Lutjanus johni*)	9		
Kerapu (*Epinephalus tauvina*.)	8		
Sotong katak (*Sepia aculeata*)	5		
Gelama papan (*Nibea soldadu*)	3		
Pari tembikar (*Gymnura poecilura*)	2		
TOTAL	1016	TOTAL	2744

Table 2.8: Commercial species caught in sub-area B on 17 August 2002 (Individual/hr)

Demersal species	ind./hr	Pelagic species	ind./hr
Sotong(*Loligo duvaucelli*)	224	Bawal putih (*Pampus argentus*)	451
Sotong katak (*Sepia aculeata*)	27	Pelaling (*Rastrelliger brachysoma*)	173
Rambai (*Atropus atropus*)	24	Talang (*Scombroides tol*)	75
Udang putih besar (*Penaeus marguiensis*)	21	Bawal hitam (*Formio niger*)	64
Gelama(*Johnieops sina*)	12	Bawal tambak (*Pampus chinensis*)	49
Duri (*Arius thalassinus*)	10	Kapas laut(Gerres abbreniata)	46
Ketam merah (*Charybdis cruciata*)	10	Pelata(*Atule mate*)	36
Udang lipan (*Parapenaeopsis gracillima*)	8	Tenggiri batang (*Scomberomorus commerson*)	28
Sotong daun (*Loligo sp.*)	7	Senangin(*Eleutheronema tetradactylum*)	23
Daun baru (*Drepane punctata*)Linnaeus, 1758	3	Parang (*Chirocentrus dorab*)	16
Alu-alu(*Sphyraena jello*)	2	Selar kuning (*Selaroides leptolepis*)	11
Timah (*Trichiurus lepturus*)	2	Cincaru (*Megalaspis cordyla*)	10
Jenahak merah (*Lutjanus sp.*)	1	Mambong/kembong (*Rastrelliger kanagurta*)	1
Ketam renjong (*Portunus pelagicus*)	1		
Gerut-gerut (*Pomadasys hasta*)	1		
TOTAL	353	TOTAL	983

2.3.2 Trawl survey on 21 August 2003

Catch rates (kilogram per hour, kg/hr)

The average catch rate for the whole survey area was 175.5 kg/hr, of which 80.7 % consisted of trash fish (Table 2.9). The average catch rate for commercial fish was thus 33.1 kg/hr. There was a significant difference in catch-rates between sub-area A and Sub-area B, being 214.7 kg/hr and 136.3 kg/hr, respectively (t= 2.7, df= 6, P= 0.036), and trash fish of sub-area A made up 82.8 % of the total catch which was higher than in sub-area B (78.6 %) suggesting commercial fish were more abundant in sub-area-B. More demersal and pelagic fish were caught in sub-area A (60.1 kg/hr and 154.5 kg/hr) than in sub-area B (30.0 kg/hr and 106.3 kg/hr), respectively. Pelagic fish dominated in both sub-areas. On average, 74.3 % of the catch was pelagic fish, or 130.4 kg/hr, compared with only 45.1 kg/hr of demersal fish.

Table 2.9: Catch rates of demersal and pelagic fish in areas (kg/hr)
21 August 2003

Area	Demersal (commercial)	Pelagic (commercial)	Demersal (trash)	Pelagic (trash)	Catch-rate (kg/hr)
Sub-area A	14.65	22.30	45.40	132.36	214.71
Sub-area B	8.20	21.03	21.8	85.25	136.28

In terms of individual numbers, the average catch rate for both sub-areas combined was 10,208 individuals/hr, but trash fish contributed 96.2 % of the catch (Table 2.10). The catch rate in sub-area A was higher (11,300 individuals/hr) than that in sub-area B (9,115 individuals/hr). The contribution of commercial fish in sub-area A was 4.8 %, which is slightly higher than that in sub-area B at 2.8 %. In sub-area A, demersal fish made up of 11.7 % of the catch which was lower than that in sub-area B (22.0 %), but the proportion of pelagic fish was higher in sub-area A than in sub-area B, at 88.3 % and 78.1 % respectively.

Table 2.10: Catch rates of demersal and pelagic fish in areas (individuals/hr)

Area	Demersal (Commercial)	Pelagic (Commercial)	Demersal (Trash)	Pelagic (Trash)	Average Catch Rate
Sub-area A	181	341	1,140	9,638	11,300
Sub-area B	106	142	1,893	6,974	9,115

Similar to the 2002 survey, sub-area B was more effective to fish than sub-area A, based on respective weight : number ratios of commercial fish between the areas. In sub-area A, the weight : number ratio was lower than in sub-area B and moreover, in sub-area A, the mean weight of each fish was only 70.8 g compared with 117.9 g in sub-area B.

Catch composition

In terms of weight, 29 demersal species and 14 pelagic species of commercial importance were caught in sub-area A. The most abundant species was P. argentus (11.7 % of the total catches). In accordance to species grouping, *Gazza minuta* (Bloch, 1795) contributed 13.6 % of demersal catch, whilst *P. argentus* represented 19.5 % of the pelagic catch. (Table 2.11). At sub-area B, only 18 demersal species and less pelagic species (13 species) were caught compared with sub-area A (Table 2.12). Pelagic species, *P. argentus* made up of 23.7 % of the total catches. In accordance to species grouping, *P. argentus* contributed 34.4 % of pelagic catch, whilst *S. jello* contributed 24.6 % of demersal catches. Examining the first six most abundant species, only *S. jello* and *L. duvaucelli* remained abundant in both sub-areas, and *G. minuta,* which was the most abundant in sub-area A, was not caught in sub-area B. All together, 11 demersal species present in sub-area A were not caught in sub-area B. The pelagic species on the other hand, exhibited slightly different composition between sub-areas with five species dominating both areas, with the exception of *Alepes djedaba* (Forsskal, 1775) which was not caught in sub-area B.

Table 2.11: Commercial species caught in sub-area A on 21 August 2003 (kg/hr)

Demersal species	kg/hr	Pelagic species	kg/hr
Kikek labu (*Gazza minuta*) Bloch, 1795	8	Bawal putih (*Pampus argentus*)	17.25
Daun baharu (*Drapane punctata*)	7.5	Pelata(*Alepes djedaba*)	15.65
Ketam merah (*Charybdis feriatus*)	6.35	Selar kuning (*Selaroides leptolepis*)	15.3
Sotong (*Loligo duvauceli*)	5.45	Bawal tambak (*Pampus chinensis*)	13.9
Alu-alu(*Sphyraena jello*)	4.25	Mambong/kembong (*Rastrelliger kanagurta*)	11.4
Gerut-gerut (*Pomadasys hasta*)	4.25	Talang (*Scombroides tol*)	7.7
Cermin(*Carangoides malabricus*) Bloch and Schneider, 18C	3.85	Parang (*Chirocentrus dorab*)	3.15
Udang putih besar (*Panaeus marguiensis*)	3.5	Tenggiri batang (*Scomberomorus commerson*)	1.15
Kapas laut (*Gerres filamentosus*) Cuvier, 1829	3.1	Pelata(Atule mate)	1
Sotong katak (*Sepia aculeata*)	2.2	Senangin(*Eleutheronema tetradactylum*)	0.75
Banang (*Albula vulpes*) Linnaeus, 1758	2.1	Bawal hitam (*Formio niger*)	0.45
Rambai landeh (*Alectis indica*) Ruppell, 1830	1.75	Pelaling (*Rastrelliger brachysoma*)	0.45
Sotong arus (*Sepioteuthis lessoniana*) Lesson, 1830	1.65	Kapas laut(Gerres abbreniata)	0.16
Ketam renjong (*Portunus pelagicus*)	0.65	Senangin buis (*Polynemus sextarius*)	0.1
Tengkerong(*Otolithes ruber*) Bloch and Schneider, 1801	0.5		
Duri (*Arius thalassinus*)	0.45		
Kerisi (*Nemipterus japonicus*) Bloch, 1791	0.4		
Biji nangka(*Upeneus sulphureus*) Cuvier, 1829	0.35		
Gelama pisang (*Pennahia macropthalmus*) Bleeker, 1850	0.35		
Puntung damar(*Sillago sihama*) Forsskal, 1775	0.27		
Baji (*Platycephalus indicus.*) Linnaeus, 1758	0.25		
Jenahak (*Lutjanus johni*)	0.25		
Togok (*Psettodes erumei*)	0.25		
ketam nipah(*Sylla serrata*)	0.22		
Gelama papan (*Nibea soldadu*)	0.2		
Kapas laut(*Gerres abbreviatus*)	0.16		
Udang kulit keras (*Parapenaeopsis sculptilis.*) Heller, 1862	0.16		
Udang lipan (*Parapenaeopsis gracilima*):Nobili, 1903	0.1		
Udang putih (*Penaeus indicus.*) H. Milne Edwards, 1837	0.1		
TOTAL	58.61	TOTAL	88.41

Table 2.12: Commercial species caught in sub-area B on 21 August 2003 (kg/hr)

Demersal species	kg/hr	Pelagic species	Kg/hr
Alu-alu(*Sphyraena jello*)	9.3	Bawal putih (*Pampus argentus*)	28.9
Duri (*Arius thalassinus*)	6.8	Talang (*Scombroides tol*)	13.3
Kikek (*Leiognathus equulus*) Forsskal, 1775	4.2	Bawal tambak(*Pampus chinensis*)	10.9
Sotong(*Loligo duraucelli*)	4	Selar kuning (;*Selaroides leptolepis*)	10.6
Ketam renjong (*Portunus pelagicus*)	2.3	Mambong/kembong (*Rastrelliger kanagurta*)	4.9
Cermin(*Carangoides malabaricus*)	2.2	Todak (*Tylosurus leiurus*)	4
Kapas laut(*Gerres filamentosus*)	1.7	Parang (*Chirocentrus dorab*)	3.8
Daun baharu (*Drapane punctata*)	1.3	Pelata(Atule mate)	2.3
Udang lipan (*Parapenaeopsis gracilima*)	1.3	Tenggiri batang (*Scomberomorus commerson*)	1.9
Biji nangka(*Upeneus sulphureus*)	1.2	Senangin(*Eleutheronema tetradactylum*)	1.6
Sotong cerut(*Loligo sp*)	0.6	Pisang/delah (*Caesio xanthonotus*)	1.2
Sotong daun (*Loligo sp.*)	0.6	Pelaling (*Rastrelliger brachysoma*)	0.4
Jenahak merah (*Lutjanus sp.*)	0.5	Bawal hitam (*Formio niger*)	0.3
Udang putih besar (*Penaeus marguiensis*)	0.5		
Gelama(*Johnieops sina*)	0.4		
Ketam merah (*Charybdis cruciata*)	0.4		
Sotong katak (*Sepia aculeata*)	0.3		
Gerut-gerut (*Pomadasys hasta*)	0.2		
TOTAL	37.8	TOTAL	84.1

In terms of individual numbers, *Selaroides leptolepis* (Cuvier, 1833) became the most abundant species in sub-area A (25.3 % of the total catches). Within respective groups, the most abundant pelagic species was *S. leptolepis* being represented by 38.8 % of the catches and *G. minuta* which contriibuted 18.8 % of the demersal catches (Table 2.13). In sub-area B, the most abundant species was *P. argentus,* which contributed 21.5 % of the total catches (Table 2.14). *G. minuta* was also the most abundant demersal species being represented by 26.1 % of the catches and for pelagic species, *P. argentus* was the most dominant (37.5 % of the catches). Examining the six most abundant species, the demersal species *G. minuta, L. duvaucelli* and *Carangoides malabaricus* (Bloch and Schneider, 1801) and five pelagic species were abundant in both sub-areas, with the exception of *A. djedaba,* which was abundant in sub-area A but not caught in sub-area B.

Table 2.13: Commercial species caught in sub-area A on 21 August 2003 (individual/hr)

Demersal species	ind./hr	Pelagic species	ind./hr
Kikek labu (*Gazza minuta*)	136	Selar kuning (*Selaroides laptolepis*)	528
Sotong (*Loligo duvaucelli*)	127	Pelata(Alepes djedaba)	498
udang putih besar (*Penaeus marguinensis*)	103	Mambong/kembong (*Rastrelliger kanagurta*)	115
Cermin(*Carangoides malabricus*	67	Bawal putih (*Pampus argentus*)	98
Udang kertas (*Parapenaeopsis sp*	50	Talang (*Scombroides tol*)	46
Ketam merah (*Charybdis feriatus*	44	Bawal tambak (*Pampus chinensis*)	29
Daun baharu (*Drepane punctata*	41	Pelata(Atule mate)	15
Rambai landeh (*Alectis indica*)	28	Pelaling (*Rastrelliger brachysoma*)	9
Kapas laut(Gerres filamentosus)	23	Parang (*Chirocentrus dorab*)	7
Gerut-gerut (*Pomadasys hasta*)	20	Tenggiri batang (*Scomberomorus commerson*)	5
Biji nangka(*Upeneus sulphureus*	12	Bawal hitam (*Formio nigar*)	4
sotong katak (*Sepia aculeata*)	11	Kapas laut(Gerres abbreniata)	4
Kapas laut(Gerres abbreniata)	10	Senangin(*Eleutherpnema tetradactylum*)	3
Alu-alu(*Sphyraena jel*	9	Senangin buis (*Polynemus sextarius*)	1
Kerisi (*Nemipterus japonicus*)	7		
Puntung damar(*Sillago sihama*)	6		
Gelama pisang (*Pamalia area*)	5		
Sotong arus (*Sepiotenthis lessonasa*)	5		
Tengkerong(*Otolithes ruber*)	5		
Udang nipah (*Penaeus sp.*)	3		
Udang lipan (*Parapenaeopsis gracillima*)	3		
Ketam renjong (*Portunus pelagicus*)	2		
Baji (*Platycephalus sp*	1		
Banang (*Albula vulpes*)	1		
Duri (*Arius thalassinu*	1		
Gelama papan (*Nibea soldadu*)	1		
Jenahak (*Lutjanus johni*)	1		
ketam nipah(*Sylla serrata*)	1		
Togok (*Psettodes erumei*)	1		
TOTAL	724	TOTAL	1362

Table 2.14: Commercial species caught in sub-area B on 21 August 2003 (individual/hr)

Demersal species	ind./hr	Pelagic species	ind./hr
Kikek labu (*Gazza minuta*)	110	Bawal putih (*Pampus argentus*)	212
Sotong(*Loligo durauceli*)	82	Selar kuning (*Selaroides laptolepis*)	141
Biji nangka(*Upeneus sulphureus*	50	Talang (*Scombroides tol*)	52
Cermin(*Caranx malabricus*)	44	Mambong/kembong (*Rastrelliger kanagurta*)	50
Duri (*Arius thalassinu*	30	Pelata(Atule mate)	45
Ketam renjong (*Portunus pelagicus*)	19	Bawal tambak (*Pampus chinensis*)	23
Sotong cerut(*Loligo sp*	16	Parang (*Chirocentrus dorab*)	14
udang putih besar (*Penaeus marguinensis*)	14	Pelaling (*Rastrelliger brachysoma*)	9
Kapas laut (*Gerres filamentous*)	13	Senangin(*Eleutheronema tetradactylum*)	7
Udang lipan (*Parapenaeopsis gracillima*)	8	Tenggiri batang (*Scomberomorus commerson*)	7
Alu-alu(*Sphyraena jel*	7	Bawal hitam (*Formio niger*)	3
Daun baharu (*Drepane punctata*	7	Todak (*Tylosurus leiurus*)	2
Sotong katak (*Sepia aculeata*)	7	Pisang/delah (*Caesio xanthonotus*)	1
Gelama(*Johnieops si*	4		
Sotong (*Loligo durauceli*)	4		
Jenahak (*Lutjanus johni*)	3		
Gerut-gerut (*Pomadasys hasta*)	2		
Ketam merah (*Charybdis cruciata*	2		
TOTAL	422	TOTAL	588

2.3.4 The biomass estimation

Based on catch rates or catch weight per hour, *Cw/t* and the area covered, *a/t*, (Table 2.15), the mean catch per unit area, (Cw/a) of commercial demersal species, commercial pelagic species, demersal trash species and pelagic trash species respectively are given in Table 2.16). The mean catch per unit area from the 17 August 2002 survey was 8,228 kg/nm^2. giving an average biomass per unit area of 16,456 kg. The total biomass for the study area of 50 nm^2 was 822,810 kg. Since 71.8 % of the total catch comprises of the trash fish, the total biomass of commercial fish is 232,444 kg. This biomass estimation maybe imprecise if the catchability coefficient of demersal and pelagic species differs, i.e. between 0.5 for demersal species and 0.25 for pelagic species as suggested by Alias (2003). Hence, there is a need to estimate the biomass for each species group separately in accordance to their living habitats and the above parameters (Table 2.17). The total biomass of the commercial fish is then increased to 381,449 kg.

Table 2.15: Catch rates and area covered in each station.

Station	Area Covered, a/t (nm^2 / hour)	Catch Rate, Cw/t (kg / hour)				
		Demersal (commercial)	Pelagic (Commercial)	Demersal (trash)	Pelagic (trash)	All Species
1A	0.0280	53.7	19.3	52.0	48.0	173.0
2A	0.0276	19.8	48.8	42.83	107.17	218.60
3A	0.0284	43.9	45.7	57.46	142.54	289.60
4A	0.0276	36.1	55.9	53.25	96.75	242.0
1B	0.0284	6.96	24.7	38.66	71.35	141.06
2B	0.0308	10.15	31.75	59.17	180.8	281.90
3B	0.0324	39.35	49.50	32.65	146.94	268.85
4B	0.0284	11.1	42.65	30.95	209.52	293.75
1A2	0.0282	0.82	9.1	27.54	206.47	243.92
2A2	0.0275	13.16	17.4	24.26	137.73	192.56
3A2	0.0298	24.75	44.7	30.66	158.34	258.45
4A2	0.0263	19.88	17.95	99.15	26.88	163.83
1B2	0.0340	5.8	22.6	8.0	61.0	97.4
2B2	0.0312	10.7	14.0	4.8	117.0	135.8
3B2	0.0324	2.1	11.8	5.4	81.0	98.2
4B2	0.0318	14.2	40.7	69.0	82.0	191.7

Table 2.16: Catch per unit area in each station and species groups.

Station	Catch per unit area, Cw/a (kg / nm^2)				
	Demersal (commercial)	Pelagic (Commercial)	Demersal (trash)	Pelagic (trash)	All Species
1A	1,917.86	689.29	1857.14	1714.29	6,178.57
2A	717.39	1,768.12	1551.81	3882.97	7,920.29
3A	1,545.77	1,609.15	2023.24	5019.01	10,197.18
4A	1,307.97	2,025.36	1929.35	3505.43	8,768.12
1B	245.07	869.72	1361.27	2512.32	4,966.90
2B	329.55	1,030.84	1921.10	5870.13	9,152.60
3B	1,214.51	1,527.78	1007.72	4535.19	8,297.84
4B	390.85	1501.76	1089.79	7377.46	10,343.31
Average	858.27	1,478.11	1,592.68	4,302.10	8,228.10
1A2	29.08	322.70	976.60	7321.63	8,649.65
2A2	478.45	632.73	882.18	5008.36	7,002.18
3A2	830.54	1500.0	1028.86	5313.42	8,672.82
4A2	755.89	682.51	3769.96	1022.05	6,229.28
1B2	170.59	664.71	235.29	1794.12	2,864.71
2B2	342.95	448.72	153.85	3750	4,352.56
3B2	64.81	364.20	166.67	2500	3,030.86
4B2	446.54	1279.87	2169.81	2578.62	6,028.30
Average	389.86	736.93	1,172.90	5,202.27	5,853.80

Table 2.17: The Biomass estimates of all species in accordance to living habitats and species group of commercial and trash fish (swept-area survey on 17 August 2002).

Species Group	Habitats	
	Demersal (X1 = 0.5)	Pelagic (X1 = 0.25)
Commercial (kg)	85,827	295,622
Trash (kg)	159,268	860,420

The average biomass per unit area for the 21 August 2003 survey was 5,853.8 kg/nm^2 with X1 taken as 0.5 giving a total biomass for the study area of 585,380 kg. However, considering 80.85% of total catch in Lekir water comprised trash fish, the total biomass of commercial species was only 112,100 kg. Taking the catchability coefficient of 0.25 for pelagic species raised the total biomass of commercial fish to 186,372 kg (Table 2.18).

Table 2.18: The biomass estimates of all species in accordance to living habitats and species group of commercial and trash fish (swept-area survey on 21 August 2003).

Species Group	Habitats	
	Demersal (X1 = 0.5)	Pelagic (X1 = 0.25)
Commercial (kg)	38,986	147,386
Trash (kg)	117,290	1,040,454

2.3.5 The estimation of abundance

The average fish abundance in sub-Area A and sub-Area B for the 2002 survey was 1,544 individuals/ha and 1,229 individuals/ha, respectively, while the average in sub-Area A of 2003 survey was 1,176 individuals/ha and in sub-Area B, 831 individuals/ha (Table 2.19).

Table 2.19: Number of individuals per hectare.

Station	Number of Individuals/hr	Area Covered nm^2/hr	Number of Individuals/nm^2	Number of Individual/ha
1A	11401	0.0280	407179	1187
2A	10868	0.0276	393768	1148
3A	22972	0.0284	808873	2358
4A	14029	0.0276	508297	1482
1B	7621	0.0284	268345	782
2B	13545	0.0308	439773	1282
3B	13824	0.0324	426667	1244
4B	15654	0.0284	551197	1607
1A2	15657	0.0282	555,213	1619
2A2	9877	0.0275	359164	1047
3A2	10900	0.0298	365772	1066
4A2	8766	0.0263	333308	972
1B2	3695	0.0340	108677	317
2B2	12766	0.0312	409167	1193
3B2	11007	0.0324	339722	990
4B2	8990	0.0318	282704	824

2.3.6 The estimation of Maximum Sustainable Yield (MSY)

The crucial problem determining MSY (in solving Equation 8.0) is the estimation of the natural mortality (*M*). Usually, *M* can only be estimated for for unexploited stocks (where $M = Z$) (Sparre and Venema, 1992). Ahmad (1988) and Isa (1988) pointed out that the *M* values for demersal species are rather limited in the west coast waters of Peninsular Malaysia. Nonetheless, many surveys adopted Pauly's empirical formula to estimate *M* in Northern Borneo (Pauly, 1980), Philippines (Ingles and Pauly, 1984) and West Coast of Peninsular Malaysia (Isa, 1988 and Ahmad, 1988). MFRDM (2000) concluded that the *M* values obtained by those surveys were between 1 and 2. Natural mortality of 0.6 has also been used in the estimation of MSY in the Malaysian Economic Exclusive Zone waters (Anon., 1988), and MFRDM (2000) adopted three *M* values of 0.6, 1 and 2 in their MSY estimations. This study followed the procedure adopted by MFRDM (2000) to estimate MSY of Lekir waters. The total catch, (*Y*), was assumed to be the total fish landing (excluding trash fish) by traditional fishing gears of South Manjung operating in Lekir waters in 2002 and 2003, despite a small number of them also operating in other waters. The total biomass of all species excluding trash fish was 186,372 kg or 186.37 t for 2002 and 381,449 kg or 381.45 t for 2003. Based on data the MSY for commercial species was between 2,096 t and 2,227 t in 2002, but had increased to between 2,932 t and 3,200 t in 2003 (Table 2.20).

Table 2.20: The estimation of MSY of fish stock in Lekir water, year 2002 and 2003

Year	*M* Value	Total Catch (*Y*) t	Biomass (*B*) t	MSY ($0.5*[Y+MB]$) t
2002	0.6	4,081.0	186.37	2,096.41
	1.0	4,081.0	186.37	2,133.69
	2.0	4,081.0	186.37	2,226.87
2003	0.6	5,636.21	381.45	2,932.54
	1.0	5,636.21	381.45	3,008.83
	2.0	5,636.21	381.45	3,199.56

2.4 Previous Surveys in Lekir Waters

The fisheries resources in Mukim Lekir waters were considered poorly implemented and there has been no concerted effort to investigate the resource status of these waters. Apart from a coral inventory survey in 2001(Fauzi, 2001), previous fisheries-related surveys were carried out in 1996 (Tenaga Nasional (1997), Perunding Utama (1997)) for project developers, TJSB and DKSB respectively, and in 1997 by the DOF. The former surveys were intended to prepare EIA papers to be presented to the authority for approval of the reclamation project and the building of the power plant on the reclaimed land. The survey carried out by DOF in 1997 was highly relevant to this study but was based on fisheries beyond 12 nautical miles from the shoreline. Sub-area III of the 1997 survey was located between Pulau Pangkor and Sabak Bernam, and included the Lekir waters, but, the waters were divided into two strata: the stratum 1 with water depths from 18 m - to 55 m and stratum 2 from 56 m t- 91 m.(DOF, 2000).

Tenaga Nasional (1979) selected seven sampling points in the study area within a 3 km radius from the proposed power station site (Figure 2.4). At each point, three sets of gill nets were deployed for of two hours between high tide and low tide. Cast nets were also used to catch the juveniles or fish larvae. Fifteen fish species were recorded (Appendix 1-Table 2I), but 63 commercial fish species (Appendix 1- Table 2J) were commonly caught in the study areas based on observations at fish landing sites and interviews with fishers and fish traders. The most dominant fish species in the Tenaga Nasional (1997) survey were *Arius macalatus* (74 individuals), *Johnius dussumieri* (36 individuals) and *Leiognathus splendens* (24 individuals). Twelve species of *Penaeidae* shrimps were also recorded (Appendix 1-Table 2K). The cephalopods commonly caught by the fishers within the study areas were *Loligo edulis* and *Sepia* sp. (Appendix 1-Table 2L). Some

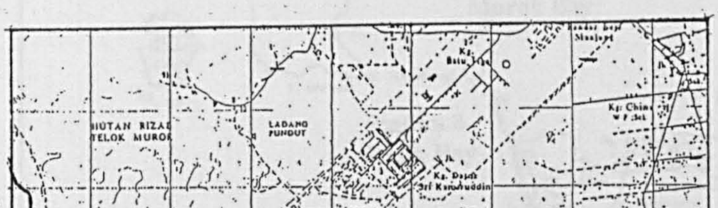

Figure 2.4: The location of fish sampling stations at Teluk Batu.Shaded area indicates pomfret fishing grounds as delineated by local fishers.
Source: Tenaga Nasional (1997).

mollusc species, *Anadara granosa, Donax faba* and *Phaxas attenuatus,* were also found.

Perunding Utama (1979) carried out a survey of fish diversity and abundance in a wider area that included neighbouring Mukim Lumut. Three sampling stations adjacent to Mukim Lumut in Dinding Channel were selected: Station 6 (Kepiah Bay), Station 7 (Murok Bay) and Station 8 (Batik Bay) (Figure 2.5). A beach seine of 280 m length, 4.5 m depth and with a coded mesh size of 1.9 cm was used to catch the fish at each station. A total of 71 fish species and other economically-important species were caught (Appendix 1 - Figure 2B). The mean fisheries stock size was estimated by the swep area method. Fish abundance declined towards the estuary, from 1,474 individuals/ ha at Batik Bay to 901 individuals/ ha at Murok Bay and 280 individuals/ ha at Kepiah Bay. The corresponding biomass decreased from 58.17 kg/ ha to 43.98 kg/ ha and 7.19 kg / ha, respectively.

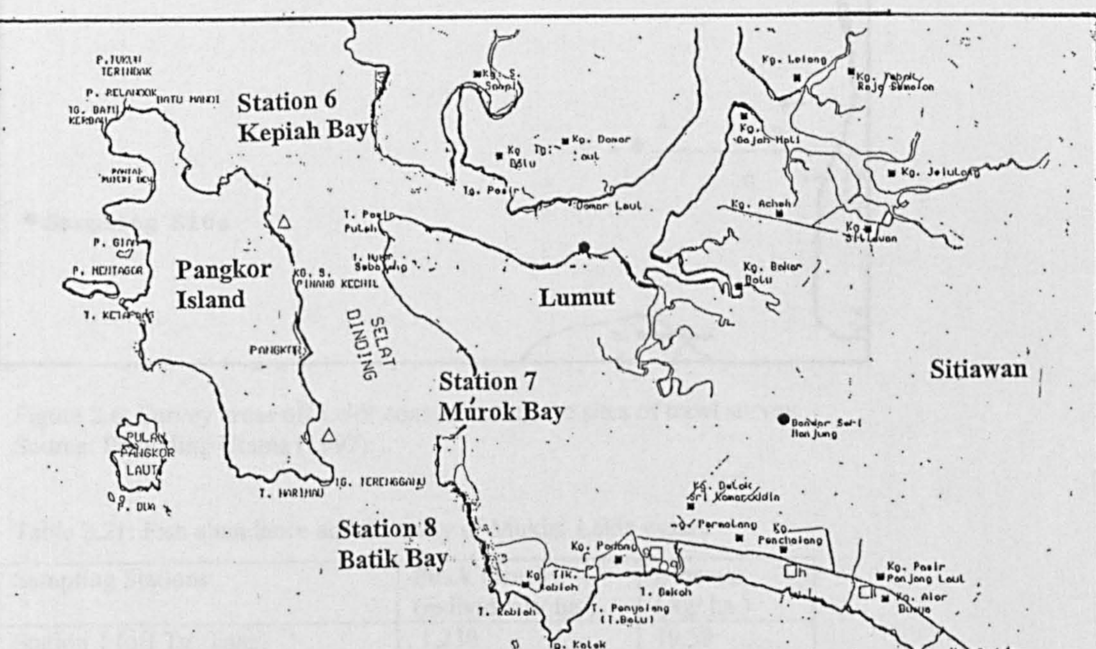

Figure 2.5: Sampling stations in Dinding Channel.
Source: Perunding Utama (1997).

A swept area method survey in Mukim Lekir waters was also carried out by Perunding Utama (1979) using an otter trawl net (see Figure 2.6 for trawl stations) (Table 2.21). The list of families of fishes and prawns recorded in Mukim Lekir's waters including their abundance is given in Appendix 1 (Figure 2D and Figure 2E).

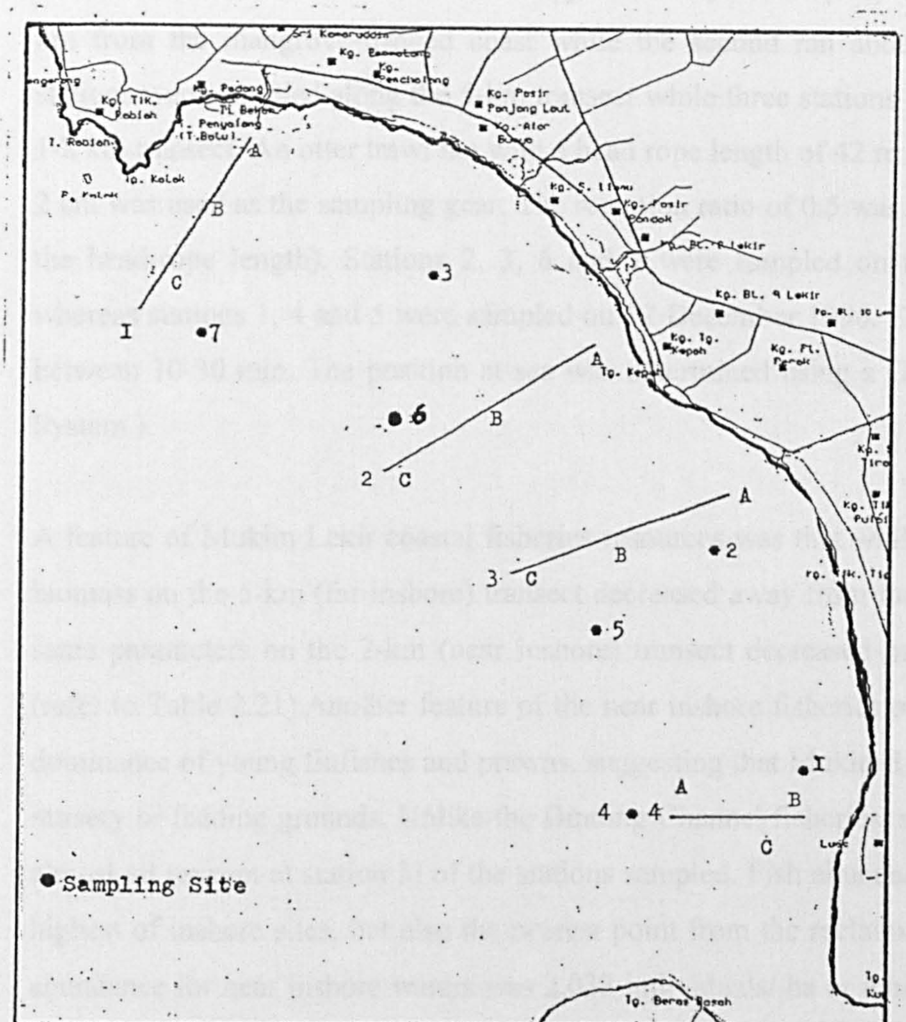

Figure 2.6: Survey areas off Lekir coast showing the sites of trawl survey.
Source: Perunding Utama (1997).

Table 2.21: Fish abundance and diversity of Mukim Lekir waters

Sampling Stations	Stock Density (individuals/ ha)	Biomass (kg/ ha)
Station 1 (off Tg. Tuas)	1,230	19.59
Station 2 (off Kg. Sg. Tiram)	1,904	14.49
Station 3 (off Kg. Sg. Limau)	2,967	72.87
Station 4 (Sg. Perak estuary)	4,948	69.29
Station 5 (off Kg. Sg. Tiram)	2,900	27.0
Station 6 (off Batu 8 Lekir)	900	14.0
Station 7 (off Tg. Katak)	250	3.20

The swept-area method was used by Perunding Utama (1997) to estimate the fish abundance and biomass in Mukim Lekir waters. Fish diversity and abundance were surveyed by sampling the fauna along two transects running parallel to the entire Mukim

Lekir coast. These two transects were approximately 3 km apart; the first ran between 1-2 km from the mangrove-fringed coast while the second ran about 5 km offshore. Four stations were sampled along the 5-km transect while three stations were sampled along the 1-2 km transect. An otter trawl net with a head rope length of 42 m and a code-end mesh of 2 cm was used as the sampling gear. The retention ratio of 0.5 was adopted (the fraction of the head-rope length). Stations 2, 3, 6 and 7 were sampled on the 11 December 1996 whereas stations 1, 4 and 5 were sampled on 12 December 1996. Each station was trawled between 10-30 min. The position at sea was determined using a GPS (Global Positioning System).

A feature of Mukim Lekir coastal fisheries resources was that while the stock density and biomass on the 5-km (far inshore) transect decreased away from the Sg. Perak estuary, the same parameters on the 2-km (near inshore) transect decreased in the opposite direction (refer to Table 2.21).Another feature of the near inshore fisheries of Mukim Lekir was the dominance of young finfishes and prawns, suggesting that Mukim Lekir shallow waters are nursery or feeding grounds. Unlike the Dinding Channel fisheries, shrimps were present in almost all (except at station 3) of the stations sampled. Fish abundance at station 3 was the highest of inshore sites, but also the nearest point from the reclaimed land. The mean fish abundance for near inshore waters was 2,033 individuals/ ha or a biomass of 35.65 kg/ ha. Finfish comprised 92% of the total abundance and 95 % of the biomass. Shrimp (all penaeids) catch represented 8 % of the abundance and 3 % of the biomass. At the far inshore, the mean fish abundance and biomass were 2,150 individuals/ ha and 27.21 kg/ ha respectively.

A total of 36 families, consisting of 60 species, were recorded in the near inshore waters while 36 families consisting of 77 species were recorded in the far inshore waters According to Perunding Utama (1997), most of the fishes captured were small size, mainly young juveniles, with an average weight of 18.2 g in the near inshore and 12.8 g in the far inshore waters.

In 1997 the catch rate of demersal species increased as the water became deeper but more trash fish were caught in shallower water than in deep water (Table 2.22). The proportion pelagic fish, which constituted about 2 % of the catch, decreased as the water became deeper. Fish caught were identified to various levels; genus, species family levels or fish group. In stratum 1, 12 levels of demersal fish of commercial value were caught and of the six most dominant were Synodontidae, *Upeneus* sp. (Cuvier, 1829) and *Parupeneus* sp. (Bleeker, 1863) (grouped together), *Loligo* sp., *Abalistes* sp. (Bloch and Schneider, 1801) and *Alutera monoceros* (Linnaeus, 1758) (grouped together), rays and Nemipteridae whereas the only pelagic fish found, in order of magnitude, were Carangidae, *Scomberomorus* sp. (Lacepede, 1801) and *Chirocentrus* sp. (Cuvier, 1816) (grouped together) and *Euthynus affinis* (Cantor, 1849) and *Rastrelliger* sp. (grouped together). More demersal and pelagic fish of commercial value were caught in stratum 2. The first three of the six most dominant demersal fish were similar to stratum 1, i.e. Synodontidae, *Upeneus* sp. and *Parupeneus* sp. (grouped together), *Loligo* sp. followed by Nemipteridae, *Playcephalus* sp. (Miranda Ribeiro, 1902) and *Elates* sp. (Jordan and Seale, 1907) (grouped together) and Serranidae. The only six pelagic fish caught in stratum 2 , in order of magnitude, were Carangidae, Stromatidae, *Sphyraena* sp. (Artedi in Rose, 1793), *Euthynus affinis* and *Rastrelliger* sp. (grouped together), *Arioma indica* (Day, 1871) and Clupeidae. Twenty-five levels of demersal fish and 6 levels of pelagic fish were identified in stratum 2.

Table 2.22: Average catch rates (kg/hr) by depth strata during the survey on the west coast of Peninsular Malaysia, 1997.

Depth Stratum	Number of Hauls	Group of Fish (kg/hr)			Total Catch (kg/hr)
		Commercial Demersal	Commercial Pelagic	Trash	
1(18-55m)	1	63.20	6.25	140.86	210.31
2(55-91m)	4	93.74	1.06	5.74	100.54
1 - 2	5	78.47	3.66	73.30	155.43

Source: Extracted from MFRDM (2002)

2.5 Discussion

The 1996 survey by Perunding Utama (1997) resembled the study area of sub-area A of this study for three reasons: (1) the surveys took place within the areas confined by grids latitude 4° 10.5'N, latitude 4° 0.0'N and longitude 100° 35.0'E, also known as Lekir waters: (2) the aquatic communities of the survey areas were mangroves-related since the depth of the waters was less than 40 m. Alias (2000) found that mangroves related demersal community assemblages are present in the coastal waters of west coast of Peninsular

Malaysia up to the depth of 40 m; and (3) both survey areas were close to each other; (the 1996 survey was carried between 1 km and 5 km from the shoreline and survey in sub-area A between 1.1 km and 8.2 km). Sub-area B, by contrast, was further away from the shoreline at about 8.33 km for the nearest trawl station, thus loosening its resemblance to the inshore characteristics. Hence, due to location, ecological and distant likeness of the two areas, sub-area A and the inshore areas surveyed by Perunding Utama (1997) were assumed to display the similar characteristics thus, comparing both areas is expected to provide before and after scenarios.

Comparing the 1996 survey with the present survey was limited by lack of data provided by the former. Perunding Utama (1997) did not attempt to discuss the biomass characteristics with reference to commercial and trash species, and species in relation to their living habitats. However, they did describe at each trawl station fish biomass and abundance, in terms of number of weight and individual per hectare at the family level. Therefore, for comparative purposes between the three swept-area surveys, this study is limited to examining the total biomass of the survey years, fish abundance or stock density in terms of number of individual caught and species diversity at the family level composition. Statistical testing was not possible since data provided by the before surveys were inadequate. Nonetheless, the primary aim is to describe how changes in fisheries resources have taken place between the three surveys.

The 1996 average total biomass and stock density was estimated at 31.43 kg/ha and 2,092 individuals/ha, respectively. In comparison, the average total biomass and stock density in 2002 was 24.09 kg/ha and 1,544 individuals/ha; and in 2003, 22.27 kg/ha and 1,176 individuals/ha. A substantial decline both in biomass and the number of individuals from 1996 through 2003 was observed.

Perunding Utama (1997) found 13 major families dominating the inshore waters and 23 families, considered insignificant due to their small representation by number. In their routine of arranging the families in accordance to their order of magnitude, Perunding Utama (1997) grouped families represented by less than seven individuals under the 'other' category. Following the same routine as Perunding Utama (1997), the family arrangement in order of magnitude is shown in Table 2.23. In 2002 survey, there were 10 families considered major while in the 2003 survey, it reduced to eight families, compared with 13 families in 1996 survey. Nearly half of the families in 1996 survey ceased to be dominant in 2002 and 2003.

Table 2.23: Major fish families in 1996, 2002 and 2003.
(Number of individuals / ha)

Survey Years					
1996		2002		2003	
Family	Number of Individuals	Family	Number of Individuals	Family	Number of Individuals
Sciaenidae	659	Cluepidae	506	Carangidae	368
Engraulidae	414	Leiognathidae	310	Cluepidae	313
Leiognathidae	320	Carangidae	214	Leiognathidae	199
Penaedae	155	Mullidae	213	Engraulidae	130
Ariidae	148	Sciaenidae	136	Scombridae	37
Cluepidae	146	Theraponidae	70	SQUIDS	32
Trygonidae	42	Scombridae	31	Mullidae	25
Theraponidae	36	Engraulidae	19	Balistidae	25
Ambassidae	30	Pomadasyidae	14	Others	47
Siganidae	19	SQUIDS	9		
Triacantidae	18	Others	22		
Carangidae	13				
Soleidae	7				
Others	85				

Penaedae and Ariidae were no longer dominant in 2002 and 2003, being represented by a very small number of individuals/ha whereas families Trygonidae, Ambassidae, Triacanthidae and Soleidae ceased to exist at all in the samples hauled. The rest of the families; Sciaenidae and Theraponidae continued to dominate in 2002 but became insignificant in 2003 while Engraulidae, Leiognathidae, and Carangidae remained dominant throughout the survey years. Only Cluepidae exhibited an increasing trend since 1996.

Generally, only four families continually dominate the waters based on their occurrence in all major families group in the three surveys *viz.* Leiognathidae, Carangidae, Engraulidae and Clupeidae. Nonetheless, between 2002 and 2003, Scombridae, Loligidae and Mullidae were also dominated the waters.

If sub-area A resembled the area surveyed in 1996, sub-area B most resembled stratum 1 in 1997 survey for the following reasons: (1) the water depth of stratum 1 was between 18 m to 55 m, which was about similar to the water depth of sub-area B, between 12.9 m to 56 m; and, (2) both the stratum 1 and sub-area B are areas adjacent to Mukim Lekir and mangrove- related. Therefore, in this study comparison is made between these two areas as the 1997 survey provided the before data.

The catch rate of demersal fish of commercial value declined from 63.20 kg/hr in 1997 to 16.90 kg/hr in 2002 and 8.20 kg/hr in 2003 (Table 2.24). However, the catch rate of pelagic fish increased since 1997. Similar to the demersal fish, the trash fish declined from 140.86 kg/hr in 1997 to 107.05 kg/hr in 2003 although it increased in 2002. In general, although catch rate increased in 2002, it decline markedly in 2003 as compared with both the 1997/2002 survey outputs.

Table 2.24: The comparison of catch rates between the 1997, 2002 and 2003 surveys

Area	Demersal (commercial)	Pelagic (commercial)	Trash	Catch-rate (kg/hr)
1997	63.20	6.25	140.86	210.31
Sub-area B(2002)	16.9	37.2	192.6	246.7
Sub-area B(2003)	8.20	21.03	107.05	136.28

The fish species composition in 1997 differed markedly from the sub-area B for both demersal and pelagic species as none of the six most dominant species caught in 1997 appeared in 2002 or 2003, except *Loligo* sp. which was caught in 2002. In terms of individual weight, the size of demersal fish reduced from 329.99 g in 1997 to 319.0 g in 2002 and 303.0 g in 2003, but the reverse is found for pelagic fish (Table 2. 25).

Table 2.25: Average individual fish weight of demersal and pelagic species.

Survey Year	Average Individual Fish Weight (g)	
	Demersal	Pelagic
1997	329.99	193.87
2002	319.0	275.0
2003	303.0	302.0

Due to limited resource data provided by the 1996 and 1997 surveys, the subsequent comparative study is confined to between the 2002 and 2003 surveys. In general, catch rates in terms of density and abundance as obtained by the 2002 survey at 238.7 kg/hr and 13,740 individuals/hr declined to 176 kg/hr and 10,208 individuals/hr in 2003 respectively.

A similar trend was observed in both sub-areas A and B, which had declined from 230.8 kg/hr and 246.5 kg/hr in 2002 to 214.5 kg/hr and 137.5 kg/hr in 2003 respectively. However, the decline in sub-area B was greater than in sub-area A, as indicated by a 44.21 % decline compared with only 7.07 % decline in sub-area A. In terms of abundance, similar declining trend is also observed. Sub-area B experienced 28.0 % decline from 12,661 individuals/hr in 2002 to 9,115 individuals/hr in 2003 compared to 23.7 % decline in sub-area A from 14,818 individuals/hr in 2002 to 11,300 individuals/hr in 2003. When the value of the catch is considered, both sub-areas recorded a decline in commercial fish, but the declining rate in sub-area A was higher (54.5 %) compared to sub-area B (43.7 %).

Two indicators were apparent: (1) commercial fish declined at a greater rate in sub-area A than in sub-area B; and (2) the trash fish decreased in both sub-areas but at lower rate in sub-area A. However, when the ratio of number of trash fish individuals : commercial fish individuals is considered, it shows that sub-area A was more exploited than in sub-area B (in sub-area A, the ratio increased from 15 in 2002 to 21 in 2003, whereas in sub-area B, the ratios remained virtually the same at 35.3 in 2002 and 35.8 in 2003). Thus, it indicates that in sub-area A the ratio increase was caused by the decrease of the commercial fish. Although the commercial fish decline in sub-area B was substantial, it seemed to be compensated by the decline of trash fish as well as the number of individuals. It was shown earlier with respect to weight to number ratio, sub-area B was more profitable to fish, in both survey years.

Based on the six most dominant species caught in each sub-area, the composition of demersal species was different between sub-area A and sub-area B, and between two survey years. Only two demersal species; *S jello* and *L. Duvauceli* were common in both sub-areas that were caught in 2002 and 2003 surveys, whereas the composition of pelagic species was more stable between sub-areas and survey years. In the 2002 survey, four pelagic species; *P. argentus, P. chinensis, S. tol* and *S. commerson* were common in both sub-areas and five pelagic species (*P. argentus, S. leptolepis, P. chinensis, R. kanagurta* and *S. tol*) caught in 2003 were also common in both sub-areas. Between the two surveys, five pelagic species appeared in both years (*R. kanagurta, P. argentus, P. chinensis, S. tol and S. commerson*). This implies that sub-area A and sub-area B hold similar characteristic as far as pelagic species are concerned whereas, with respect to demersal species, each sub-area showed major dissimilarities. Moreover, the composition of pelagic species did not vary much within one year as experienced by the demersal species.

Fish are considered trash when there is no demand in the fish markets and particularly finfish; size is the decisive factor during sorting procedures of landings by fishers. By measuring the samples of trash finfish as sorted by them, this study found that the sizes ranging from 10.31 gm to 40.7 gm were categorized as trash finfish that was later sold to feed mills or as aquaculture feeds. Unlike finfish; prawns, crabs and squids were always in markets demand no matter what their sizes were. Therefore, fishes mostly caught by Perunding Utama (1997) with the average individual weight of 18.2 gms in near inshore waters and 12.8 gms in far inshore waters were indeed trash fish. Moreover, they claimed that these sizes were fairly small and juvenile. It is not known however, if Perunding Utama (1997) had caught any marketable commercial species at all since they did not provide the numerical evidence to that effect. This limit further the comparative study between the 1996 survey and the results achieved by this study.

It can be inferred that based on six major species, in general, the size of fish caught in 2003 was smaller than in 2002. This was confirmed when the sizes in weight per individual of fish was calculated. Finfish, including the trash fish, weighed 182 gm per individual in 2003 compared with 190 gm per individual in 2002. With the exception of crabs, the size of prawns and squids were also smaller in 2003 than in 2002, at 15.8 g and 12.3 g compared with 48.0 g and 40.8 g respectively. Large-sized crabs were caught in 2003 than in 2002 (Table 2.26).

Table 2.26.: Comparison of fish sizes in 2002 and 2003

Survey Year	Fin-fish (g)	Crabs (g)	Prawns (g)	Squids (g)
2002	190.0	126.0	48.0	40.8
2003	182.0	154.0	15.8	12.3

However, since trash fish comprised 72 % to 81 % of the total catch, the sizes were greatly influenced by them and concealed the actual sizes of commercially larger fish, which is the main concern of the fishers. Therefore, to accommodate such a need, the 2002 and 2003 surveys attempted to describe fish composition with respect to sizes by sorting into fishes, crabs, prawns, squids and trash fish grouping (Table 2.27).

Table 2.27: The average weight of each individual in respective group.
(*Figure in parentheses indicating weight including anchovies)

Year Survey	Sub-Area A					Sub-Area B				
	Finfish (g)	Crabs (g)	Prawns (g)	Squids (g)	Trash* (g)	Finfish (g)	Crabs (g)	Prawns (g)	Squids (g)	Trash* (g)
2002	284	126	49	87.4	10.87 (10.31)	335	NIL	19.4	148	27.05 (25.31)
2003	209	260	28.7	120	24.7 (21.3)	363	131	83.9	62.3	40.7 (34.6)

Fish in sub-area A were lower in weight than in sub-area B in both years, which was concurrently observed in trash fish, whereas crabs, prawns and squids do not portray any marked characteristics between the two zones, which are differentiated by water depth and distant from the shoreline. Although the total biomass in 2003 decreased to 22.27 kg/ha from the previous year of 24.76 kg/ha, the trash fish size nearly doubled in both zones. Given that the total biomass in 2003 consisted mainly of trash fish (80.9%), severe over-exploitation appears to have occurred in the waters compared with 2002.

The levels of MSY estimated in 2002 and 2003 indicated that Lekir fisheries were heavily over-exploited since the total fish landed in each year surpassed the maximum levels. For example, in 2002, the MSY was estimated at 2,096 t (M=0.6) whereas fish landed was 4,081 t or almost double the sustainable level. Similarly, in 2003, fish landed almost double the MSY of 5,636 t. In theory, the over-exploited fish stock may collapse and face the danger of extinction (Sparre and Venema, 1992). To remedy the situation, fishing effort has to be reduced. In a study performed by FAO (2001) on small pelagic fisheries of the west coast of peninsular Malaysia, a 25 % cut in fishing effort would result a 10 % increase of total catch by year 15 and 20 % increase if the cut is 50 %. The number of fishers expected to be diverted to other job opportunities was between 10,000 to 20,000.

2.6 Conclusion

Penang's coastal land reclamation is a good example of how it had affected the traditional fisher catches. The project began sometime in 1990 in which year had a record of 29,620 t of fish landings. The following year, the landings had dropped to astounding 19,207 t and kept declining till 1994 (Penang People's Report, 1999). A study by Penang Inshore Fishermen's Welfare Association (PIFWA) between 1970 -1999, linked fish decline to, among other things, land reclamation that had caused loss of mangroves, soil erosion, sedimentation caused by dredging and obstruction to fisher access to sea.

Lekir waters might have experienced similar consequences of land reclamation. Comparing catch rates as provided by previous surveys (the 1996 1997 surveys) with surveys done by this study (the 2002 and 2003 surveys) indicated that it had reduced substantially. The sub-area A, which is closer to the shore, may also loose its potential as breeding and nursery ground since juveniles and fingerlings caught had reduced compared with the amount caught by the 1996 survey.

The future of fisheries in Lekir is bleak. With the emergence of the 'island' which has robbed a portion of valuable fishing ground and the destruction of some mangroves nearby, fishers are competing among themselves in a limited fishing area and thus imposing greater fishing pressure. Fish resources nearer to the shore are depleted, commercial fish stocks are declining and smaller in sizes and trash fish are dominant. Although fishers may fish in areas further away in search of commercial valuable fish, given their existing capacity, the operational costs may also increase. Without any action to reduce the excess fishing effort, the resources may never recover.

CHAPTER 3: SOCIO-ECONOMICS STUDY OF SOUTH MANJUNG

3.1 Introduction

The observation made by the researcher in 2002 indicated that mangroves in areas nearer to the reclaimed land were degraded and fishers blamed the 'island' for their bad catches (Chapter 1). In Chapter 2, the trawl surveys in Mukim lekir waters indicated that the total fish biomass in 2003 had reduced to 22.27 kg/ha from 24.76 kg/ha in 2002 and substantially below the 31.43 kg/ha determined by Perunding Utama (1997). This could be inferred to be related with the 'island', but further studies are needed to confirm it.

Following a lengthy face-to-face discussion with the Head of the Fisheries District Office of Manjung (FDOM) on 12 January 2003, who firmly reiterated that fishers had confronted the greatest hardship of their lives, much more than what the project proponents had anticipated, the need to study the impacts of land reclamation on the livelihood of fishers and possibly other inhabitants was prevalent. The main reason was because despite benefits to the country in general, the development should not cause undesired hardship to the local people, and furthermore, the good environment belongs to affected people who should be compensated accordingly. The decline in fish catches after the project completion is seen by many, and felt by most fishers, as the direct effect of the project.

Perunding Utama (1997) stated that the reduction in the amount of fish caught around the project site would be short-term and Tenaga Nasional (1997) claimed that the impact of the construction activities of the power plant on fisheries was small compared with that of the land reclamation. Apparently, both claims contradict reality considering the declining catches. This serves as an impetus to're-open' the case and study the impacts of the land reclamation on fishers' livelihood some six years after the commencement of the project. The aim of this study, was, to determine if the impacts still influence fishers everyday livelihood or alternatively, if the impacts have subsided over the years. If the latter is the case, then further study would be of little relevance.

The status of fish resources would potentially be inferred from published Annual Fisheries Statistics of Perak, but they are not representative being the only legitimate source because they are analyzed to meet district and state obligations and are inadequate for impact assessment. Thus there is need to reanalyze the raw data for the affected area but that alone maybe insufficient if endorsement from the community is not obtained because they disagree about the results reflecting the fishers real experience. Thus, a socio-economic survey was needed to gain endorsement from the affected community.

This study was constructed to determine if there was any change in the livelihoods of the fishers and non-fishers living near the project area since surveys of Perunding Utama (1997) and Tenaga Nasional (1997). This study also needs to determine how serious is the problem by seeking answers to these questions. Is there still a difference in levels of attitude and perception towards the development among the population after several years the completion of the projects?; Which working segment: the fishers, government servants or non-government servants is the most affected by the projects and how bad is it?; Income is the factor influencing a person's happiness, but is it the only factor?; Finally, does the project management demonstrated its social responsibilities towards the community? In other words, do the impacts remain a relevant issue that needs to be addressed urgently or is it no more an issue making subsequent studies unnecessary. This socio-economic study will serve as an impetus for future studies if the impacts are found to be persistent.

3.2 Materials and methods

3.2.1 The study site

The State of Perak is administratively divided into nine districts, of which Manjung was one. Manjung district was further sub-divided into five smaller administrative localities known as sub-districts or 'Mukim', of which three were of interest here: Mukim Lekir, Mukim Lumut and Mukim Sitiawan (Figure 3.1). Following classification of areas by the Department of Statistics Malaysia (2000), Mukim Lekir is rural by definition having a population less than 10,000 individuals, while the other Mukims are considered 'urban large' with populations between 10,000 to 74,999 individuals (Mukim Beruas, Mukim Pangkalan Baru and Mukim Lumut) or metropolitan with a population above 75,000 individuals (Mukim Sitiawan).

The DOFP, for its administrative purposes, had unilaterally sub-divided the Manjung district into two areas; the South Manjung fisheries administration that includes 16 fishing bases and the North Manjung that includes nine bases. South Manjung consists of Mukim Lekir, Mukim Sitiawan and Mukim Lumut but some bases in the latter Mukim, because of their proximity to North Manjung office, were assigned under the responsibility of that office. Fortunately, fishers from those bases do not fish in Lekir water making the task of data collection less complex. Thus fishers, in this study, were those that fish in Lekir water and live within Mukim Lekir, Mukim Sitiawan and Mukim Lumut . In term of size, the largest was Mukim Sitiawan, which covers 331.5 km^2, followed by Mukim Lumut 251.2 km^2 and Mukim Lekir being the smallest of all Mukims in Perak estimated at 137.3 km^2. The population of these three Mukims totaled 152,817 of which 51 % (77,543) were male.

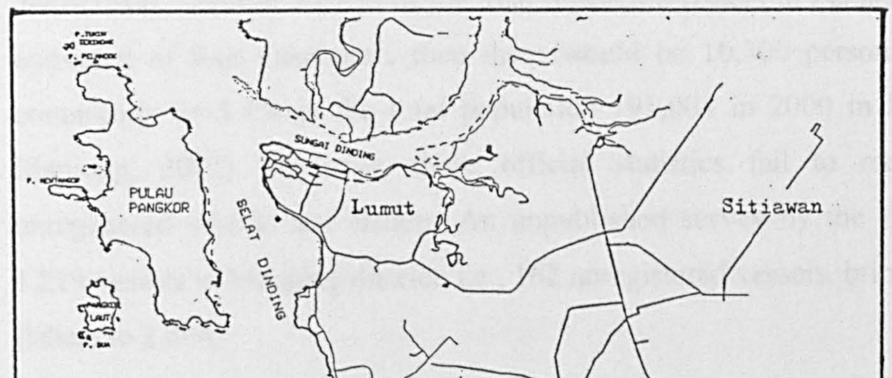

Figure 3.1: Sea-front Mukims of Manjung Districts

The 405 ha of reclaimed land was situated at Teluk Pencalang, adjacent to Mukim Sitiawan shoreline at Manjung district in Perak Darul-Ridzuan, Malaysia. The nearest towns are Sitiawan and Lumut. The island-shaped reclaimed land is approximately 10 km south of Lumut town . The reclaimed land was on the Lekir waters which was defined as waters adjacent to Mukim Lekir on the east and Mukim Sitiawan on the north.

3.2.2 *The populations under study*

There are four major fisheries districts in the state of Perak, namely Kerian, Larut & Matang, Hilir Perak and Manjung. The 2001 Fisheries Statistics of Perak indicated that there were 4,045 fishing vessels registered in those districts of which 1,057 vessels or 26.1%, were from the Manjung district . The total number of registered fishers of Manjung district was 2,060 or 27.7 % of the total registered fishers in Perak. If each fisher's family consisted of five members[1], then there would be 10,300 persons living in the fishing community or 5.4% of the total population 191,004 in 2000 in Manjung district (PDT Manjong, 2002). However, those official statistics fail to record the existence of unregistered vessels and fishers. An unpublished survey by the FDOM in 2000, record 1,219 vessels in Manjung district; i.e., 162 unregistered vessels, bringing to total number of fishers to 2,804.

Mukim Lekir had a population of approximately 9,150 living in 1,880 houses. The area was chosen for study primarily because it was the only Mukim that received direct impact from the reclamation project (Perunding Utama, 1979 and Tenaga Nasional, 1979). Only traditional fishers were studied since they fished in Lekir waters. Other households in those two Mukims were not being accounted for since they lived far away from the reclaimed land thus the physical and visual effects were irrelevant.

There were estimated 444 fishers living in Mukim Lekir, 766 fishers in Mukim Lumut and 954 fishers in Mukim Sitiawan making up a total of 2,164 fishers in South Manjung. As reference, the socio-economic surveys carried out by Tenaga Nasional (1979) and Perunding Utama (1979) chose Kg. Teluk Penchalang, a village situated about 3 km from the reclamation project and villages within 2 km radius of the coastal zone respectively as

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[1] An estimator adopted by PDT Manjong (2000) and Perunding Utama (1997).

their study sites. The latter survey had more coverage, but the former survey covered a much wider area to include all inhabitants within the boundary of Mukim Lekir and fishers living in other Mukims but fishing in Lekir waters. The wider scope of study was essential since it was assumed that the impacts were widespread beyond the 3 km radius previously surveyed. There were two fishing bases namely Teluk Pencalang (also known as Permatang) and Pasir Panjang Laut in Mukim Sitiawan that were more representative of the population of Mukim Lekir by reason of proximity. Therefore, this study regarded the fishing community of Mukim Lekir to include the fishers of those two bases, estimated at about 286 fishers. Consequently, those non-fishers in Permatang and Pasir Panjang Laut were also included in the non-fishers population of Mukim Lekir. To avoid any confusion arising from this adjustment, the word "Mukim Lekir proper" was used throughout this study to show the statistics compelled by the legal boundaries whereas fishers of Mukim Lekir included fishers from Permatang and Pasir Panjang Laut.

3.2.3 Sampling methods

The most popular form of direct extensive observation is by questionnaire: a small sample of a large community is examined and the conclusions drawn from it are generalized. This is valid only if the sample is representative (Duverger, 1964) by drawing it from carefully identified population. The manner in which the sample is drawn determines to what extent we can generalize from the findings (Dixon et al, 1992). The first step in the application of sampling methods is to define the population of interest, by specifying whether it is a target population of individuals, households, groups, institution, or whatever (Wright, 1979). Secondly, is to construct a sampling frame from which to select a random sample from the study population. The sampling frame is the source (or sources) that include the population of eligible people or groups (Czaja and Blair,1996).

The population of interest in this research was the fishers and non-fishers, defined and isolated in accordance with their employment status. Thus, the sampling frame of this survey consisted of the working segment of the population. According to the DOF's policy, a person is termed a fisher if he is a licensed boat owner or employed as a crew member of a licensed boat and concurrently being issued a fisher's identity card, whereas the Fisheries Development Authority Malaysia (FDA) stipulates that any person going out to sea fishing for no less than 150 days per annum is considered a fisher. To accommodate both agencies' definitions of a fisher, this research merged both definitions as a basis to define a fisher. To summarize, it means a person is a fisher if his fishing days are more than 150 days per annum or otherwise being issued a fisher's identity card by the DOF. Thus, a person is said to be a part-time fisher if only he has another job during his non-fishing days. On the other hand, a person that has not been issued a fisher's identity card by the DOF and fishing less than 150 days per annum is not a fisher, thus, in this respect considered unemployed unless he has another occupation. The list of persons issued with fisher's identity card was drawn from the DOFP's National Integrated Data Base Management System (NIDBMS) and cross-checked with the Annual Fisheries Statistic Year 2000, whilst the list of the unlicensed fishers was constructed by referring to the membership records of the Fishers Association of Southern Manjung. Merging the definitions given by DOF and FDA was to avoid any conflicting opinion on the definition of fisher between this study and the relevant government agencies.

The rest of the population, also known as non-fishers included persons pursuing various occupations in the public/private sectors, plantation workers, small business and farmers. They were grouped under two categories; the government sector and the non-government sector. Non-fishers were also affected directly or indirectly by the reclamation projects by being legitimate residents of the area. Their records were acquired from various sources, such as the Manjung District Office (MDO), Headman Office, Statistical Department, District Education Office and Town Council.

DOF has specified that the legal age of fishers is 18 years old and above (pertaining to the issuance of fisher's identity card) but make no mentioning of an age ceiling. The minimum age of 18 year old is also specified by Fisheries Associations as a prerequisite to be eligible as a member, again there is no age ceiling. However, FDA does not impose such age limitation in its definition. Considering all the legality factors such as labor law, citizen registration, juvenile law, this study adopted a minimum age of 18 years old as a limiting entry into fisheries without specifying an age ceiling. Thus, any person under 18 years old was excluded from this study; this was applied to non-fishers.

The population was stratified (Bartholomew, 1981; Black, 1999) according to different in employment categories because they were likely to give different views, attitudes and aspirations about the reclamation projects. For instance, the level of acceptance will vary according to working areas. It was expected that fishers would object to the reclamation project in the first instance since their fishing areas are affected directly while other occupational groups would be more optimistic. This was shown by Perunding Utama (1997) which, stated that :

> 'More than half of the fishermen surveyed were 'not sure' (62.2%) of the benefits the proposed project could bring. Most of the fishermen feared the loss of catch and jobs in their area. They were very sure of the impact of the loss of jobs to outsiders (73.3%) and main income (82.2%). They were not very positive on the employment opportunities (26.6%) that the project would bring.
>
> The other occupational groups such as farmers and businessmen were more positive about the employment opportunities and perceived that the project will not destroy jobs and income.'

For this survey, the population was first stratified according to occupation. Samples were taken from each stratum proportionally to their rate of occurrence in the population. A sample selected in this manner is also called a self-weighting sample, or a sample with probability proportional to size (Wright, 1979). The total population was the number of households in Mukim Lekir and the sample design is illustrated in Table 3.1.

Table 3.1: The stratification of Mukim Lekir's population

Occupation	Population Size	% in Population	Sampling Fraction	N in Sample	% in Sample
Government	294	13.17	0.35	103	13.21
Non-Government	1076+ 132* = 1,208	54.12	0.35	422	54.10
Fishers	444+ 286** = 730	32.71	0.35	255	32.69
Total population	2,232	100	0.35	780	100

Notes: (a) A sample of 780 is desired, and it is to be self-weighting

(b) The sampling fraction will therefore be the same for each stratum, and it will equal 780/2,232 = 0.35

(c) Each type of employment will be represented in the sample in the same proportion as it appears in the population.

(d) The population sizes of Mukim Lekir proper are based on Perunding Utama (1979).

(e) The additional 132* households are in Permatang and Pasir Panjang Laut surveyed to represent the other non-fishers segment.

(f) The additional 286** fishers live in Permatang and Pasir Panjang Laut.

The total sample size was restricted to 780 persons (35 % of the population) because of time and budgetary constraints. This was about the 600 minimum size recommended by Levin and Fox (1988) to guarantee a 95 % confidence interval no wider than 8 %, i.e., a 4 % (0.04) margin of error. In comparison, Tenaga Nasional (1997) selected 55 respondents out of 825 eligible residents at Kampong Penchalang, a village situated 3 km away from the reclamation project. Perunding Utama (1997) sampled 28 % in their socio-economic survey of Mukim Lekir.

The sample size of fishers from each locale was also based on the proportional method (Table 3.2)

Table 3.2 : The stratification of fishers of Mukim Lumut and Mukim Sitiawan

Mukim	Population Size	%in Population	Sampling Fraction	N in Sample	% in Sample
Lumut	766	53.42	0.35	268	53.49
Sitiawan	668	46.58	0.35	234	46.51
TOTAL	1,434	100	0.35	502	100

Notes: (a) A sample of 502 is desired, and it is to be self-weighting

(b) The sampling fraction will therefore be the same for each stratum, and it will equal 502/1,434 = 0.35

(c) Each type of employment will be represented in the sample in the same proportion as it appears in the population.

The selection of samples from the sampling frames was done by quasi-random sampling or systematic sampling. This method of sampling is chosen because given a random start and no periodicity, a systematic sample is just as good as a simple random sample, and it is easier to execute (Wright, 1979). Along with a complete and accurate list, two additional things are required for systematic sampling: the sampling fraction (or its inverse, the sampling interval) and a random start. The sampling fraction (*f*) is simply the ratio of the desired sample size (*N*) to the total number of elements in the population (*M*). The sampling interval is the ratio of the number of elements in the population (*M*) to the sample size (*N*):

$$f = \text{sampling fraction} = N/M$$

$$i = \text{sampling interval} = M/N$$

where N is the sample size and M is the population size.

In this survey, the sampling fraction was 1282/3666 and the sampling interval was 3666/1282 = 3. In the stratified sampling, each stratum has equal sampling interval, which is in this case of three (as an example, refer Table 3.1, where 294/103=3, 1208/422=3 and 730/255=3). To obtain a random start, a table of random numbers was used to select a number between 1 and i (the sampling interval). This ensures that every element in the population has an equal chance of selection and avoids the small bias that would be introduced if the first or last element in the population were always selected as starting points. The same treatment was also applied when selecting samples from sampling frame of Mukim Lekir, Mukim Lumut and Mukim Sitiawan.

3.2.4 *Research methodology*

During an interview or a questionnaire exercise, respondents are known to provide false answers for several reasons. They maybe reluctant to state their actual income since it exposes themselves to the income tax authority or they may say something that may affect themselves in the future. Further, all people are prone to exaggerating their successes and denying or down-playing their failures (Taylor and Bogdan, 1984). Interviews and questionnaires create attitudes in part because respondents commonly try to manage impressions of themselves to maintain their standing in the eyes of an interviewer (Lee, 2000). Therefore this study adopted the triangulation method that involves the use of different methods and sources to check the integrity of, or extend, inferences drawn from data (Ritchie and Lewis, 2003) or to increase the reliability of the results (Marsh, 1996;

Gummesson, 2000). Designing a study in which multiple cases are used, multiple informants or more than one data gathering technique can greatly strengthen the study's usefulness for other settings (Marshall and Rossman, 1989). In the triangulation method, the multiple data collection methods are used with the aim of compensating for the weakness of particular methods by drawing on the strength of others. For example, a statistical, quantitative survey of consumer needs could be supplemented by in-depth personal interviews with a small number of consumers and by focus group discussions. If all of these points converge to the same results, the chances are increased that "facts" have been obtained. If the results are contradictory, the use of a single method could be misleading. Nonetheless, divergent findings are equally important, but for another reason; that they signal the need to analyze a research problem further and to be cautious in interpreting the significance of any one set of data (Brewer and Hunter, 1989).

Kane (1991) provided four major research techniques; they are participant observation, interviews, questionnaires, and written and documentary sources. These research techniques or methods were adopted in this study and described below but introduced in order of the importance of this study. The questionnaires survey method is a quantitative method and served as the main research technique in this study, whereas observations, interviews and written reports are secondary and qualitative, as pointed out by Strauss and Corbin (1990). According to them, one might use qualitative data to illustrate or clarify quantitatively derived findings.

Questionnaires survey

Questionnaires were used to obtain opinion on the reclamation project. According to Hall and Hall (1996), the questionnaire is a tried and tested method of generating information and they added that social surveys using questionnaires is widely recognized as a standard method of collecting information. The choice of generating method depends on several factors. If cost is given high priority, then the mail questionnaire is more desirable than other methods such as personal interviews and telephone surveys. The mailed questionnaire is the cheapest, the telephone survey is of intermediate cost, and the personal survey is the most expensive (Miller, 1991). Other influencing factors are shown in Table 3.3.

Table 3.3 : Choosing among the mail questionnaire, personal interview and telephone survey.

Factors Influencing Coverage and Information Secured	Mailed Questionnaire	Personal Interview	Telephone Survey
Lowest relative cost	1	3	2
Highest percentage of return	3	1	2
Highest accuracy of information	2	1	3
Largest sample coverage	3	1	3
Completeness, including sensitive material	3	1	2
Overall reliability and validity	2	1	3
Time required to secured information	3	2	1
Ease of securing information	1	3	2
Total number of rankings, 1,2,3	2,2,4	5,1,2	1,5,1

Note: 1 = most favorable ranking; 2 = intermediate ranking; 3= least favorable ranking.

Source : Miller (1991)

Aspects such as illiteracy, poverty levels, awareness, interest and social status as such may result in poor response rate to mail questionnaire. Tenaga Nasional (1979) reported that nearly half of the respondents of Mukim Lekir received education up to primary school only. This is the lowest education level in the country. It also means that nearly half of the respondents had dropped-out of school over the age of 12 years old. Furthermore, only 69.1 % of the respondents possessed telephones in their houses. This creates bias as the remainder of the respondents do not have equal chance of being selected if the telephone survey method is used. Although the personal interview method is costly compared with other methods, it seems desirable and appropriate to the rural respondents where level of education is low and telephones are still not widely possessed. Personal interview is known to guarantee higher response rate than other methods (Lin 1976).

Questionnaire design

The questionnaire was designed to examine the respondents' level of satisfaction with their present livelihood, and their perception and expectation towards change. It consisted of questions or statements that were either open-ended or close-ended. It was divided into two parts; Part 1 specifically for the fishers and Part 2 for the non-fishers (Appendix 2). The differences between these parts were questions on employment status/fishing activities and the infrastructure for fishing activities. The rest of the questions were applied equally to all respondents.

Specifically, the questionnaire sought the following information:

- personal background characteristics such as name, age, sex, race, education level, employment status, fishing activities, marital status, household size, income, social status, etc;
- ownership of land and house;
- availability of basic utilities;
- availability of basic infrastructures;
- availability of basic amenities.

Apart from the demographic profiles, questions on certain aspects of community behavior were constructed, namely:

- awareness of the reclamation project;
- perception towards development;
- perception towards TJSB Social responsibility.

Questions were also posed to reveal impacts of the projects on job opportunity, properties value, standard of living, relocation of villagers, losing land ownership and disturbances or inconveniences encountered by the villagers.

Pre-testing the questionnaire

Before the questionnaire was delivered to the respondents, it was pre-tested to find out if the respondents would understand the questions and ensure the interviewer would be able to deliver the questions correctly and decisively. Pre-testing is much more needed where a population is known to comprise of people with a low level of education, and thus might encounter some difficulties understanding even a simple and direct question. Czaja and Blair (1996) suggested pre-testing so as to avoid ending up collecting interviews that have obvious measurement problems. Pre-testing is to avoid restarting the entire exercise after some problems are detected during implementation.

Pre-testing was carried out in two phases. Phase 1 was a consultation session with a group of fisheries officers (expert committee) each having some experience in socio-economic surveys or some knowledge on fishing community behavior. Their education levels ranged from Malaysian Certificate of Education (MCE - equivalent to British 'O' Level) to university degree with working experience of more than five years. Phase 2 was a testing of the questionnaire itself carried out on a group of 9 respondents comprising of fishers, non-fishers and government servants of equal proportion. Phase 2 was executed after the questionnaire had been thoroughly inspected, corrected and passed by the group of Phase 1. The Phase 1 group also consisted of four interviewers who were trained to conduct the personal interview exercise.

Tests of validity

One important criterion for a good measure is that it be valid; i.e., measure the expected data (Welch and Comer, 1988). Several tests of validity were utilized:

- **Face validity:** Earlier questionnaires used by Perunding Utama (1997) and Tenaga Nasional (1997) were examined to indicate similarities in questions and concept. This survey and both previous surveys were almost identical in questionnaire designs, concept and areas of study. Since such measure had been used by experts in the field before, suggests that the measure is being accepted as valid by other people.
- **Content validity:** Encompasses the totality of elements thought to be part of the concept that are being attempted to measure. The questionnaires were assumed to have content validity for two reasons: (1) similar to face validity, this survey was almost identical in questionnaire designs, concept and areas of study as carried out by Perunding Utama (1997) and Tenaga Nasional (1997), (2) the questionnaires had been examined by expert committee to ensure it adequately and completely assessed the concept being measured. For example, the measure of the population attitudes towards TJSB social responsibility had included a wide range of possible attitudes that attributed to social responsibility.

- **Predictive validity:** This test was executed by selecting two groups of people known to have wide or opposing views on the reclamation project. A group of three fishers were pilot tested against three workers of the reclamation project. As expected, fishers scored low on the attitudes and perception tests whereas the other group scored high. Thus, the questions forwarded to them were valid and applicable as a measure of attitudes and perception towards the reclamation project.

- **Construct validity:** The same groups of people employed in test of predictive validity were used. From previous research, it was found that fishers (type of occupation) were associated with anti-coastal development attitudes. When tested on the questionnaires, it was found fishers and non-fishers behaved differently to questions on attitudes. Hence, the questionnaire designed had passed the construct validity test. The questionnaire is said to be lacking in construct validity if the type of occupation is related to the general construct of coastal development attitudes, but not to an item purporting to measure these attitudes.

Tests of reliability

Reliability means that the information provided by indicators (e.g. a questionnaire) does not vary as a result of characteristics of the indicator, instrument, or measurement device itself (Neuman, 1997) and if applied time after time, will yield the same results (assuming no change in the variable being measured) (Welch and Comer, 1988).

Several specific tests have been developed to test for reliability in a measure. However, for this research a split-half technique was adopted. As suggested by Welch and Comer (1988), a questionnaire was administered to a group of subjects and then correlating the responses on one random half of the questionnaire with responses on the other random half. For example, a 6-item questionnaire dealing with attitudes towards reclamation project is split into two groups of 3 items and then administered each half to each individual. Let suppose the score of each item is 1 for positive attitude and 0 for negative attitude, then maximum score of an individual is 3. Thus if the people scored 3 on one half of the questionnaire would also score 3 on the other half, then the 6-item questionnaire is said to be reliable. Likewise, if people who score 3 on one half consistently seem to score only 0 or 1 on the other half, then it is assumes that the 6 items are not measuring the same things, thus the 6-item scale is not reliable. The questionnaire passed the reliability test when the people gave the same score on each group of questions (t= 43.8, df=8, P>0.05).

Data collection

The questionnaire survey was a collaborative effort between the DOF and the researcher. As a normal departmental procedure, a letter of consent and approval was obtained from the Director General of Fisheries Malaysia (reference number: Prk.ML.05/35 Jld.17(50) dated 8 July 2002). Consequently, the DOFP provided workers and other facilities to assist the process of collecting data by interview questionnaires.

Initially, a meeting was held with the Director of Fisheries, State of Perak to explain the research objectives and methodology. It was to ensure that he acquired a general overview of the research benefits to the fishing community and justify the manpower needs and other facilities such as transportation, printing of questionnaire materials, utilizing unpublished fisheries data, stationeries and other relevant assistance. A selection exercise to appoint a dedicated group of fisheries officers responsible to the exercise was also discussed. The group would answer direct to the researcher to ensure smooth operation exercise. Eight fisheries officer were selected from the FDOM since they already had good rapport and close relationships with Mukim Lekir residents, especially the fishers and the fishers of other Mukims. The interview exercise was planned to be completed over a 60 day period.

Prior to the commencement of the interview exercise, the researchers took 14 days for the preparation of sampling frames and the selection of samples through simple random sampling. Another 14 days were needed to carry out the validity and reliability tests on the questionnaire and pretesting it with a group of selected respondents. In the fifth week, a discussion-cum-training was held with the group of fisheries officers. Fisheries officers were trained to carry out the questionnaire exercise in accordance with normal and usual procedures for interviewing respondents. Lin (1976) suggested that interviewers should be trained so that they are able to perform interviews that require : (1) being accepted by the respondent; (2) providing clear statements, including explanation of questions, without leading the respondent or biasing the responses; (3) probing to obtain the proper responses; and (4) recording responses accurately. Other aspects considered in the training session were that the responsible researcher is considerate, does nothing to injure, harm, or disturb the subjects of research, keeps data collected on individuals and groups confidential, accurately records information, and reports the findings of the research in a public manner (Dixon, *et al.* 1992).

In the preparation of the interview schedule, it was assumed that the respondents were easily accessible; very cooperative; took less time to understand the questions; and they were virtually immobile (they were at homes most of the time).The nine interviewers (including the researcher) were allocated a total 1,740 samples to be interviewed within the given 60 working days. Saturday and Sunday were excluded to provide days off for the interviewers. Consequently every working day, 29 respondents were interviewed averaging about four respondents for each interviewer. On the average, each interview took between 40 - 60 minutes.

Monitoring the interviewers

Most of the time, the researcher was easily accessible to the interviewers. The personal attendance of the researcher was important in dealing with problems such as when the interviewer or the respondent was having difficulty agreeing on certain issues or questions.

3.2.5 Participant observation

During the questionnaire interviews, the nine interviewers were asked to observe, eavesdrop and to experience whichever appropriate the following items: crime, traffic, traffic accidents, sexual offences, fire, immigrants, illegal immigrants, outsiders, noise pollution, smoke pollution, dust pollution, water pollution and tranquility of the villages. These observations took about 48 days or about seven weeks and were recorded in Appendix 2 -Form A. An interviewer ticked the week column of the corresponding item if he found it to transpire during his presence in the survey areas. A tick would represent a day. In Appendix 2- Form B, each interviewer was asked to write his observations on the following items: sources of pollution, new infrastructures, rate of tourism, new shops or shopping complexes, social services provided by the power plant management and any social activity organized by them involving locals. There was an additional row to note down any interesting or peculiar happenings during tenure as an interviewer.

3.2.6 Interviews

The type of interview chosen was unstructured (Kane 1991), i.e. interview that has no set order or wording of questions, no schedule and is not looking for the same information from each person. Two interviews were performed on a representative of each working segment of the Mukim Lekir community. They were selected on an ad-hoc basis at their working place or any other place. The aim of the interview was to entice them to talk freely about their living condition, on environmental issues and perceptions on the reclamation and the power plant projects. All interviews were carried out by the author.

3.2.7 Written and documentary sources

In this study the word 'written evidence' was adopted as suggested by Gilham (2001), of two forms: *published* evidence of what other researchers have done or found, or relevant government or other official publications, and the *unpublished* documents and records that are found mainly in institutions. The two most important published research materials regularly consulted were the previous socio-economic surveys by Perunding Utama (1997) and Tenaga Nasional (1997) Other important documents were the annual official statistical reports published by the Department of Fisheries Year 1992 - Year 2002. The remaining publications were found in the Brynmor Jones Library of University of Hull. Unpublished materials were mostly obtained from the FDOM and FDA relating to fisheries activities in the district.

3.2.8 Data analysis

Demographic data were used to examine the community structure in the survey areas. A frequency count was used to determine the frequency distribution of each variable, regression of the variables of interest was made to identify relationship among them especially those pertaining to attitudes and perceptions toward the reclamation project. Statistical Package for the Social Sciences (SPSS) computer program was used to analyze the data. Participant observation and the interview data were analyzed qualitatively.

3.3 Results

3.3.1 Background

Pre-testing of the questionnaires was successfully accomplished with a minor alteration of the question B.13 where a respondent was asked about his canoe/boat's tonnage. This question was unanimously agreed to be dropped as it posed potential difficulty for the fishers to estimate the tonnage. Instead, the canoe/boat's horsepower would be sufficient to represent the canoe/boat's capability or its fishing effort. Questions pertaining to relocation of the community (M1 through M2) and losing land ownership (N1 through N7) were dropped since nobody was known to undergo such experience. The questionnaires were also subjected to several tests of validity and reliability. It effectively substantiated that the questionnaires were valid and reliable for this study.

The questionnaire interview processes commenced on the 15 July, 2002 and ended on the 31 August,2002; 12 days shorter than the planned 60-day exercise. A total of 1,236 respondents were interviewed but only 1,137 were accepted as valid. Most rejections were on the basis of non-compliance of some questions or tendering conflicting answers which led to illogical conclusions and failure to be categorized under any of the sectors. Of the total respondents accepted, 692 were interviewed in Mukim Lekir, whereas 445 fisher respondents were interviewed in Mukim Lumut and Mukim Sitiawan. This lower the planned sampling size of 35% of the community to 31%. Fisher and government sector respondents cooperated well, but the non-government group was somewhat skeptical and demanded more inputs from the interviewers. The distribution of the questionnaires received in each area is shown in Table 3.4.

Table 3.4: The number of accepted samples

AREAS	Planned N Samples	N Samples Interviewed	Number of Rejected Samples	Number of Valid Samples
Mukim Lekir				
1. Government Sector	103	90	None	90
2. Non-Government	422	385	8	377
3. Fishers	255	236	11	225
Mukim Lumut	268	247	9	238
Mukim Sitiawan	234	217	10	207
TOTAL	1,282	1,236	99	1,137

While respondents were being interviewed, the interviewers performed participant observation and recorded their observations in Forms A and B. Nine sheets of each form were successfully completed by the interviewers. During this exercise, the interviewers observed all happenings related to the livelihood of the villagers, the environmental disturbances and other physical activities.

A total of 700 fisher respondents were surveyed, of whom 98% or 686 respondents were full-time fishers. Following consulting with FDOM, only 67.5% were registered with the office and had been issued with the fisher identification cards. The other 32.5% of respondents were assessed for number of fishing days they made per year. Only 7% of the respondents failed the fisher status requirement by not fishing more than 150 days per year and not register with the DOF. They were disqualified thus reducing the number of the respondents to 670 fishers.

3.3.2 *Demographic characteristics*

Age

(i) Mukim Lekir

Fifty three percent of those surveyed were between 18 – 41 years old, 21.1% between 42 – 49 years old, 12.4% between 50 - 60 years old and 13.7% above 60 years old (Table 3.5). Thirteen percent of fishers and 17.2% of non-government are over 60 years old (Table 3.6), indicating an ageing working segment (Kee, 1992; Kamaruzzaman, 1997). The majority (86.6 %) of the government servants were under the age of 41 years old, which is explained by specific working age of 18 -55 years in government sector. By contrast, more than half of the fishers were above 42 years old. The non-government segment shows an even distribution in age structure, with nearly half, older than above 42 years (48.2%).

Table 3.5 : Age structure in Mukim Lekir

AGE Range(years)	Frequency	Percent	Cumulative Percentage
18 – 25	33	4.8	4.8
26 – 33	127	18.4	23.2
34 – 41	205	29.6	52.8
42 – 49	146	21.1	73.9
50 – 60	86	12.4	86.3
Above 60	95	13.7	100
TOTAL	692	100	

Table 3.6 : Age Structure of Working Segments in Mukim Lekir

AGE Range	Government Servants	Fishers	Non-Government
18 – 25	4 (4.4)	16 (7.1)	13(3.4)
26 – 33	28 (31.1)	34(15.1)	65(17.2)
34 – 41	46 (51.1)	42(18.7)	117(31.0)
42 – 49	9 (10.0)	59(26.2)	78(20.7)
50 – 60	3 (3.3)	44(19.6)	39(10.3)
Above 60	0 (0.0)	30(13.3)	65(17.2)
TOTAL	90(100)	225(100)	377(100)

(Figures in parentheses are percentages of the total)

Those persons not in the government or fishing sectors showed a more evenly dispersed age structure and worked in a range of occupations from agricultural, factory operators to owner-operator of small and medium size businesses. Education level plays an important role in a person's career but other factors such as capital to start a business, agricultural land ownership and job scarcity also contribute. Since fishing requires minimum capital input, expertise can be gained through on-the-job training and fish stocks are typically open-access resources (Hannesson, 1993:11) it is often the only choice to earn a living if no other jobs are available. This was illustrated by the high proportion (40.9 %) of fishers who were less than 41 years old and the high contribution of the youngest age group (18 - 25 years) in Mukim Lekir who were fishers.

(ii) Fishers in Mukim Lumut and Sitiawan

Of the 445 respondent surveyed, 62.8% were aged above 42 years old (Table 3.7). However, fishers over 50 years old comprised of 47.7% of the total population reaffirm the view that fishery sector is an ageing industry relative to other occupations.

Table 3.7 : Age structure of fishers in Mukim Lumut and Mukim Sitiawan
(Figures in parentheses are percentages of the total)

AGE Range	Lumut	Sitiawan	Total
18 – 25	10(4.2)	4(1.9)	14(3.1)
26 – 33	31(13.0)	9(4.3)	40(9.0)
34 – 41	56(23.5)	56(27.1)	112(25.2)
42 – 49	35(14.7)	32(15.5)	67(15.1)
50 – 60	41(17.2)	47(22.7)	88(19.8)
Above 60	65(27.3)	59(28.5)	124(27.9)
TOTAL	238(100)	207(100)	445(100)

Sex

(i) Mukim Lekir

All fisher respondents were male (Table 3.8). There was a substantial proportion (27.8 %) of women respondents in the government sector. No woman was employed on the non-government segment suggesting that they were not the breadwinners of the family. In this rural community, males were still dominant over females as far as wage earning is concerned. However, some economic activities were handled by women, such as selling fish, assisting males at food stalls, working in sundry shops and helping their husbands sorting fish.

Table 3.8 : Sex composition of Mukim Lekir
(Figures in parentheses are percentages of the total)

SEX	Government Servants	Fishers	Non-Government	Total
Male	65(72.2)	225(100)	377(100)	667(96.4)
Female	25(27.8)	0(0.0)	0(0.0)	25(3.6)
TOTAL	90(100)	225(100)	377(100)	692(100)

(ii) Fishers in Mukim Lumut and Sitiawan

All fisher respondents were male (Table 3.9), but women seem to dominate the post-harvest practices at landing places until the fish were sold on. Most fishers exercised family entrepreneurship that embroiled family members, including women. Nevertheless, male fishers were still the decision makers of fishing households. During the interviewing processes, most women were noticed so reserved about the whole matter and seemed to lack knowledge relating to the environmental values surrounding them.

Table 3.9 : Sex composition of fishers in Mukim Lumut and Mukim Sitiawan
(Figures in parentheses are percentages of the total)

SEX	Lumut	Sitiawan	Total
Male	238(100)	207(100)	445(100)
Female	0(0.0)	0(0.0)	0(0.0)
TOTAL	238(100)	207(100)	445(100)

Race

(i) Mukim Lekir

Of the total respondents surveyed, Malay dominated at 80.2% followed by Chinese (19.1%) and Indian (0.7%) (Table 3.10). In the government sector, 98.9% were Malay with few (1.1%) Indians represented. There were 18.2% and 24.1% Chinese respondents in fishers and non-government sectors, respectively, which were again dominated by Malays. No Indians were selected in the non-government sector.

Table 3.10 : Races composition of Mukim Lekir
(Figures in parentheses are percentages of the total)

RACE	Government Servants	Fishers	Non-Government	Total
Malay	89(98.9)	180(80.0)	286(75.9)	555(80.2)
Chinese	0(0.0)	41(18.2)	91(24.1)	132(19.1)
Indian	1(1.1)	4(1.8)	0(0.0)	5(0.7)
TOTAL	90(100)	225(100)	377(100)	692(100)

(ii) Fishers in Mukim Lumut and Mukim Sitiawan

A report released by the FDOM in 2002 indicated a dominancy of Chinese in commercial fishing whereas Malay fishers were inclined towards traditional fishing. Indians are characterized by their poor representation in both fishing categories. In terms of race distribution with respect to vessels ownership, Chinese owned 95.3 % of the commercial fishing vessels but Malays own 79.3 % of traditional fishing vessels. Chinese fishers are also prominent in respect to the ownership of traditional inboard engine vessels contributing 49 % of owners compared with 35.4 % Malay and 15.6 % Indians. Most Malays in the traditional fishing own canoes with outboard engine, thus signifies low levels of fishing effort linked to low income compared with their counterparts who man larger vessels.

The majority (66.7 %) of the fishers interviewed were Malay with 21 % Chinese. Indian respondents were represented by a small percentage (12.4 %) (Table 3.11). In Sitiawan there were no Chinese respondents.

Table 3.11: Races composition of fishers in Mukim Lumut and Mukim Sitiawan
(Figures in parentheses are percentages of the total)

RACE	Lumut	Sitiawan	Total
Malay	120(50.4)	177(85.5)	297(66.7)
Chinese	93(39.1)	0(0.0)	93(20.9)
Indian	25(10.5)	30(14.5)	55(12.4)
TOTAL	238(100)	207(100)	445(100)

(Figures in parentheses are percentages of the total)

3.3.3 Education level and employment opportunity

Mukim Lekir

Only 40.2 % of the respondents never continued their studies in the secondary schools or higher (Table 3.12); the majority either attained Lower Certificate of Education (LCE) or MCE at 27.5 % and 20.4 % respectively. Those who successfully completed their studies at higher learning institutions or universities make up 11.2 % of the respondents. A negligible proportion (2.2 %) of the respondents having Higher School Certificate (HSC) was to be expected since most individuals with MCE would either continue their studies to obtain a Diploma or take preparatory courses (matriculation) for a Degree, thus avoiding spending another two years in school to get the HSC. A very small number of respondents (0.9 %) never entered school at all, but none were illiterate.

Table 3.12: Education levels of Mukim Lekir

EDUCATION LEVEL	Frequency	Percent	Cumulative Percentage
Primary School	279	40.2%	40.25%
LCE	190	27.5%	67.6%
MCE	141	20.4%	88.0%
HSC	15	2.2%	90.2%
Diploma	36	5.2%	95.4%
University Degree	26	3.8%	99.1%
None of the Above	6	0.9%	100%
TOTAL	692	100%	

Fishers were the least educated group (Table 3.13), 65.2 % studied at primary schools only, and 2.7 % had no schooling. Fishers having LCE and MCE represented 32 % of the respondents. In contrast, a much higher education attainment was represented in the government sector, 28.9% having university degrees. The majority of the respondents working in the government sectors had either MCE or Diploma or University degree qualifications. The non-government sector was similar to the fishing sector with the exception of fewer respondents in the primary school group.

Table 3.13: Education levels of working segments in Mukim Lekir
(Figures in parentheses are percentages of the total)

EDUCATION LEVEL	Government Servants	Fishers	Non-Governmet
Primary School	1(1.1)	147(65.3)	130(34.5)
LCE	12(13.3)	48(21.3)	130(34.5)
MCE	26(28.9)	24(10.7)	91(24.1)
HSC	2(2.2)	0(0.0)	13(3.4)
Diploma	23(25.6)	0(0.0)	13(3.4)
University Degree	26(28.9)	0(0.0)	0(0.0)
None of the Above	0(0.0)	6(2.7)	0(0.0)
TOTAL	90(100)	225(100)	377(100)

(Figures in parentheses are percentages of the total)

The low level of education attainment among fishers was the main reason why they remained in the fishing sector, although some did acquire some level of minimum qualification, such as LCE or MCE . When asked if they would like to switch to another job, 85 % said they would but none were available in their villages. All were not willing to go elsewhere to look for a job. The only available employment opportunity was offered by the power plant project but none of those who applied were successful because of inadequate or unsuitable qualifications. As a result, most jobs in that project were grasped by outsiders and immigrants. Family members also failed to benefit from the power plant project as none of the respondent's offspring were employed. Primary school qualification was worthless as far as employment opportunity was concerned.

Fishers in Mukim Lumut and Mukim Sitiawan

The low education status in the fishing community was again illustrated by 70.1 % of the respondents who did not go beyong primary school while 3.4 % did not go to school (Table 3.14). However, education level was increasing with 16.0% with LCE and 10.6% with MCE. Higher school or university educated people were still marginalized in the fishing sector.

Table 3.14: Education levels of fishers in Mukim Lumut and Mukim Sitiawan
(Figures in parentheses are percentages of the total)

EDUCATION LEVEL	Lumut	Sitiawan	Total
Primary School	168(70.6)	144(69.6)	312(70.1)
LCE	45(18.9)	26(12.6)	71(16.0)
MCE	15(6.3)	32(15.5)	47(10.6)
HSC	0(0.0)	0(0.0)	0(0.0)
Diploma	0(0.0)	0(0.0)	0(0.0)
University Degree	0(0.0)	0(0.0)	0(0.0)
None of the Above	10(4.2)	5(2.4)	15(3.4)
TOTAL	238(100)	207(100)	445(100)

Although employment opportunities exist elsewhere for those with LCE and MCE qualifications, all fisher respondents with such qualification failed in their attempts to get other jobs elsewhere. When asked about their job satisfaction, 61.5% of the LCE holders dissatisfied and 72.7 % of MCE holders were dissatisfied. Low income was the main reason for their dissatisfaction. Most would like to stop fishing but getting jobs somewhere was the main problem. A small percentage tried looking for jobs in the power plant project but failed due to no vacancies and unsuitable qualification. Fishers failed to benefit from the project.

3.3.4 *Income and satisfaction level*

Mukim Lekir

There is no credible relationship between income and satisfaction level (Table 3.15). Only 31.1% of respondents surveyed were satisfied with their employment. Fishers were largely dissatisfied (55.5 %) whilst government servants were virtually all satisfied (however this idealism is stained by a meager 1.1% respondents seem unhappy with their work). The non-government segment were overwhelmingly (93.0 %) dissatisfied despite 20.7% earning more than RM1,001 (compared with 10.3 % of fisher respondents). Cross-tabulation between employment satisfaction and income levels of each working segment, suggested most fishers earning less than RM1,000 will probably voiced their dissatisfaction over their employment while most non-government, exhibited this behavior in all income brackets (Table 3.16). Those dissatisfied were asked to give their reason. Virtually all fishers and other non-fishers relate their dissatisfaction with the low income and their failure to get jobs that paid better corresponding to their academic qualification. This explains why the

Table 3.15: Employment satisfaction level of working segments in Mukim Lekir
(Figures in parentheses are percentages of the total)

SATISFACTION LEVEL	Government Servants	Fishers	Other Non-Fishers	Total
Very Satisfied	0(0.0)	7(3.1)	0(0.0)	7(1.0)
Satisfied	89(98.9)	93(41.3)	26(6.9)	208(30.1)
Somewhat Satisfied	1(1.1)	0(0.0)	0(0.0)	1(0.1)
Unsatisfied	0(0.0)	125(55.5)	312(82.7)	438(63.3)
Very Unsatisfied	0(0.0)	0(0.0)	39(10.3)	39(5.6)
TOTAL	90(100)	225(100)	377(100)	692(100)

Table 3.16: Cross-tabulation of employment satisfaction with income level of working segments in Mukim Lekir.
(Figures in parentheses are percentages of the total)

SATISFACTION LEVEL	Income Less than RM 1,000		
	Government Servants	Fishers	Other Non-Fishers
Very Satisfied	0(0.0)	4(1.8)	0(0.0)
Satisfied	21(23.3)	81(36.0)	26(6.9)
Somewhat Satisfied	1(1.1)	0(0.0)	221(58.6)
Unsatisfied	0(0.0)	117(52.0)	13(3.4)
Very Unsatisfied	0(0.0)	0(0.0)	39(10.3)
SATISFACTION LEVEL	Income between RM 1,001-RM 1,500.		
Very Satisfied	0(0.0)	0(0.0)	0(0.0)
Satisfied	26(28.9)	4(1.8)0	0(0.0)
Somewhat Satisfied	0(0.0)	0(0.0)	0(0.0)
Unsatisfied	0(0.0)	2(0.9)	26(6.9)
Very Unsatisfied	0(0.0)	0(0.0)	26(6.9)
SATISFACTION LEVEL	Income more than RM 1,501.		
Very Satisfied	0(0.0)	3(1.3)	0(0.0)
Satisfied	42(46.7)	8(3.6)	0(0.0)
Somewhat Satisfied	0(0.0)	0(0.0)	26(6.9)
Unsatisfied	0(0.0)	6(2.7)	0(0.0)
Very Unsatisfied	0(0.0)	0(0.0)	0(0.0)
TOTAL	90(100)	225(100)	377(100)

majority of non-government persons were dissatisfied, since 65.5 % held qualifications of LCE or above. Furthermore, the increase in income does not correlate well with satisfaction level since most non-government earn more than RM1,001. This is probably because those with qualification were considering the opportunity costs of not getting white collar jobs in government or private segments.

To explain the paradox of satisfaction levels between government servants, fishers and other non-fishers, those who were satisfied were asked to state their reasons. Virtually all government servants asserted that job security, working conditions and living style as their main reason of satisfaction, despite 53.3 % earning less than RM 1,500. The rest of the respondents simply stated the amount of income was sufficient to lead a normal or above average life style.

Fishers in Mukim Lumut and Mukim Sitiawan

When asked about their earning per month, 43.4% of the respondents took home less than RM500 and another 39.3 % said it was between RM501 – RM1, 000 (Table 3.17). The rest of the respondents represent a small proportion getting more than RM1, 001. Within the income bracket of less than RM500, 71 % voiced dissatisfaction whereas in the income bracket of RM501 – RM1,000, it was slightly higher at 72.6 % (Table 3.18). About 98.1 % of respondents within the income bracket of less than RM500 were dissatisfied because of low income. Only 1.9 % gave old age as their reason for dissatisfaction. Within the income bracket of between RM501 – RM1,000, the higher proportion of dissatisfaction was explained by academic qualification as previously reflecting their frustration over the lack of job opportunities. Nevertheless, 75% of all respondents that were dissatisfied were not willing to switch to another job. They did not foresee an employment opportunity within their area, nor would they relocate to another area to get a new job. Some of them had attempted to get employment in the reclamation/power plant projects, but none succeeded by reason of no available vacancies, unsuitable qualification or not having appropriate qualification. All were in unison that the reclamation/power plant projects did not benefit them in terms of employment opportunity. The other higher income brackets were satisfied.

Table 3.17 : Income structure of fishers in Mukim Lumut and Mukim Sitiawan

INCOME Range	Frequency	Percent	Cumulative Percentage
Lowest thru 500	193	43.4	43.4
501-1000	175	39.3	82.7
1001- 1500	25	5.6	88.3
1501 – 2000	15	3.4	91.7
2001 – 2500	21	4.7	96.4
2501 – 3000	16	3.6	100
3001 thru highest	0	0	
TOTAL	445	100	

Table 3.18 : Cross-tabulation employment satisfaction with income level of fishers in Mukim Lumut and Mukim Sitiawan
(Figures in parentheses are percentages of the total)

INCOME Range	Very Satisfied	Satisfied	Somewhat Satisfied	Unsatisfied	TOTAL
Lowest thru 500	4(2.1)	52(26.9)	128(66.3)	9(4.7)	193(100)
501-1000	5(2.8)	43(24.6)	102(58.3)	25(14.3)	175(100)
1001- 1500	0	25(100)	0	0	25(100)
1501 – 2000	0	15(100)	0	0	15(100)
2001 – 2500	0	21(100)	0	0	21(100)
2501 – 3000	0	16(100)	0	0	16(100)
3001 thru highest					
Total	9(2.0)	172(38.7)	230(51.7)	34(7.6)	445(100)

3.3.5 *Living style*

Earlier, despite earning less than RM1,000 per month, virtually all government servants were satisfied with their employment, i.e., they felt that their income was sufficient to meet their needs, in contrast to fishers and non-government groups. To investigate this paradox, this study examined the possibility of satisfaction driven not by income but through the ownership of material goods that were thought to be desirable in society and other factors that affect the living standards of the community. Was their living standards influenced by their ranking of life satisfaction?

All respondents surveyed place owning a house was their primary objective. However, only 52.2% were house owners while the rest either rented or stayed with parents or relatives. Within each employment segment, house ownership of government servants and fishers was similar, i.e., at 71.1 % and 72.4 % respectively. The non-government sector exhibited lower house ownership (44.8 %) (Table 3.19). The lowest rent recorded was RM60 per month and the highest was RM450 per month. In terms of house value, 63.5% of fishers had their houses valued at less than RM20,000, but for most non-government, (97.8 %) valued their houses below RM10,000. Conversely, government servants own higher valued houses when 58.7% of the respondents valued their houses between RM30,000 – RM50,000 (Table 3.20).

Table 3.19: House ownership of Mukim Lekir
(Figures in parentheses are percentages of the total)

HOUSE Owning	Government Servants	Fishers	Non-Government	Total
Owner	64(71.1)	163(72.4)	169(44.8)	396(52.2)
Tenant	19(21.1)	22(9.8)	78(20.7)	119(17.2)
Stay with parent/other	7(7.9)	40(17.8)	130(34.5)	177(25.6)
TOTAL	90(100)	225(100)	377(100)	692(100)

Table 3.20: House values of Mukim Lekir
(Figures in parentheses are percentages of the total)

HOUSE VALUE Range	Government Servants	Fishers	Non-Government	Total
Lowest thru 10,000	0	32(22.1)	351(97.8)	383(67.5)
10,001 – 20,000	0	60(41.4)	3(0.8)	63(11.1)
20,001 – 30,000	4(6.3)	28(19.3)	0	32(5.6)
30,001 – 40,000	22(34.9)	8(5.5)	1(0.3)	31(5.5)
40,001 – 50,000	15(23.8)	6(4.1)	3(0.8)	24(4.2)
50,001 – 60,000	8(12.7)	5(3.4)	0	13(2.3)
60,001 – 70,000	8(12.7)	0	1(0.3)	9(1.6)
70,001 – 80,000	4(6.3)	0	0	4(0.7)
80,001 – 90,000	1(1.6)	2(1.4)	0	3(0.5)
90,001 – 100,000	1(1.6)	4(2.8)	0	5(0.9)
TOTAL	63(100)	145(100)	359(100)	567(100)

The 10 most important materials goods selected as desirable by this community arranged in order of most desirable to the least desirable were car, motorcycle, air-conditioner, ASTRO (satellite channels), television/radio, telephone, refrigerator, washing-machine, stereo-system and bicycle (Table 3.21). The government servants had a greater ownership of these types of goods than fishers and other non-fishers segment.

Table 3.21 : Ownership of goods desirable by the Mukim Lekir community
(Figures in parentheses are percentages of the total)

GOODS arranged in order of most desirable to the least desirable	Government Servants	Fishers	Non-Government
Car	77(85.6)	56(25.0)	83(22.0)
Motorcycle	45(50.0)	180(80.0)	309(82.0)
Television/radio	90(100)	225(100)	377(100)
Refrigerator	90(100)	220(97.8)	358(95.0)
Telephone	90(100)	145(64.4)	239(63.4)
Washing machine	90(100)	100(44.4)	196(52.00
Air-conditioner	18(20.0)	0	0
Astro(Satellite channels)	27(30.0)	10(4.4)	43(11.4)
Stereo system	45(50.0)	50(22.2)	81(21.5)
Bicycle	80(88.9)	178(79.1)	324(85.9)
TOTAL	90(100)	225(100)	377(100)

Land ownership was scarce in this community, with less than 1% owning land for a purpose of other than housing. Agricultural land planted with coconuts and palm trees were mostly owned by outsiders or private companies. The State government owned all land areas near the shore.

The availability of public amenities in this area was another factor that highlights living standards. There is no doubt that public amenities were lacking in this area (between 45% - 50% of the respondents were not satisfied with public telephone services, post office, public transportation, clinic, hospital and police services). However, considering there were adequate and fully equipped public amenities in the nearby area of Mukim Sitiawan, this study found that those dissatisfied respondents were relating it to their displeasure of not having suitable and reliable transportation, because all those respondents that did not possess both the motorcars and motorcycles were dissatisfied. Only 43.5 % of respondents that possess either means of transportation were dissatisfied. This indicates that government servants, were the least affected by the lacking of public amenities, since all possess either means of transportation. Moreover, their working location, was mostly within urban areas had good public amenities.

The privileges of the government servants over fishers and non-government with respect to the possession of material goods is explained here. All of the government respondents owning a house bought it through a government loan scheme at low interest rate of 4% per annum, 85% of them bought their vehicles through the same scheme, and 75 % of other materials goods were bought through private hire-purchase scheme at interest rates between 10% - 15% per annum. These privileges were seldom enjoyed by non-government servants and the interest rates offered by private loan agencies were considered high (between 10% - 15% per annum). In June 2002, a survey was carried out to determine the interest rates on housing loan from three nearby banks, namely; Maybank, Public Bank and Bumiputera Commerce Bank. On the average, the interest rate was 7.2 % per annum with additional requirement of a guarantor and a proof of a stable income. All fishers and other respondents surveyed, bought their houses through their savings and none intending to buy a house succeeded in getting any loan from the bank. Their main obstacle was providing a guarantor and proving a stable income.

3.3.6 *Fishing activities*

Background

Over 88 % of fisher respondents had more than 10 years fishing experience (look Table 3.22). Thus the majority of them were experienced and well knowledged in fishing matters. Those fishing less than 10 years were mainly the younger age respondents between 18 – 41 years old (71.8 %), in contrast to the experienced group which were mainly (65.8 %) more than 42 years old. This confirms the perception of an ageing industry, but experienced work force.

Table 3.22: Cross-tabulation between age range and working years of fishers in Mukim Lekir, Mukim Lumut and Mukim Sitiawan
(Figures in parentheses are percentages of the total)

AGE Range	Lowest thru 9 years	10 years thru highest	Total
18 - 25	24(30.8)	6(1.0)	30(4.5)
26 - 33	14(17.9)	60(10.3)	74(11.2)
34 - 41	18(23.1)	134(22.9)	152(22.9)
42 - 49	4(5.1)	117(20.0)	121(18.3)
50 - 57	11(14.1)	121(20.7)	132(19.9)
Above 57	7(9.0)	147(25.1)	154(23.2)
TOTAL	78(100)	585(100)	663(100)

Gill-nets seemed to be the most common type of gear used by the respondents (Table 3.23). There were three types of gill-nets; namely the drift-nets, trammel nets and submerged gill-nets. Depending on the preferred target species and method of operation, 48.0% of the respondents used drift-nets with mesh-sizes ranging from 1.5 inches to 8 inches to catch both the demersal and pelagic species and adjusted the water depth fished for either surface or mid-water operations. Trammel nets were used mainly to catch high valued prawns, but only 15.9% of the respondents operated in this fishery. The mesh-size of the inner layer of this gear was normally between 1.5 inches and 1.75 inches while the outer layers were similar to that of the drift-nets. Submerged gill-nets were set on sea bed usually close to corals, thus it mainly caught high valued demersal species. Since the size of the targeted species was relatively large, mesh-size was between 3.5 inches and 4 inches. Only 0.9% of respondents used sub-merged gill nets because of difficulty in operation .Another commonly used gear was hooks and lines used by 15.8% of respondents. Gears such as the barrier nets, crab traps, portable traps and shell-fish collecting were used by 19.4% of the respondents. Practically all types of gear were operated by two people.

Table 3.23: Type of traditional fishing gears used in Mukim Lekir, Mukim Lumut and Mukim Sitiawan

GEAR Type	Frequency	Percent
Gill-Nets		
1. Drift-Net	319	48.0
2. Tremmel-Net	106	15.9
3. Submerged Gill-Net	6	0.9
Hooks and Lines		
1. Long-lines	47	7.1
2. Hand-lines	58	8.7
Others	129	19.4
TOTAL	665	100

Traditional fishing in Lekir water is multi-species because of the locality its in-shore and coastal at water depth averaging 17.8 m. Pong *et al* (1994) identified 100 species of commercial importance in Malaysia, of which 82 species were in coastal waters less than 120 m deep, 16 species in estuarine and coastal waters less than 100 m deep, one species in riverine and coastal waters less than 40 m deep and one species specifically in deep-water up to 200 m deep. However, 37 species were named by the respondents to be commonly caught in Lekir water. Nearly 50 % of respondents operating drift-nets caught pelagic species mainly, in order of magnitude, *Scomberomorus* sp., *Pampus* sp., *Chirocentrus* sp., *Rastrelliger* sp., *Megalaspis* sp., *Scomberoides* sp., *Eleutheronema* sp., *Alepes* sp. and *Caranx* sp. The demersal species caught by the drift-nets were, in order of magnitude, *Sphyraena* sp., Sciaenidae, *Chiloscyllium* sp., crabs, *Arius* sp., Dasyatidae, *Lutjanus* sp., *Epinephelus* sp., *Anodontostoma* sp., *Drepane* sp., *Rachycentron* sp. and *Pomadasys* sp. Virtually all fish caught by hook and line were demersal species, with: *Lutjanus* sp., *Epinephelus* sp., Dasyatidae and *Pomadasys* sp. the most important. Prawns of genus

Penaeus, *Metapenaeopsis* and *Parapenaeopsis* were commonly caught by the trammel nets.

The average number of fishing days per month was 20 days with a minimum of 8 days and maximum of 30 days. One fishing day means, depending on the fishing gears used and with the exception of portable traps, duration of a fishing operation inclusive of traveling hours to fishing grounds and return to base. The duration of fishing days at three fishing villages; Teluk Penchalang in Mukim Lekir, Pangkor in Mukim Lumut and Sitiawan in Mukim Sitiawan between 15 May – 15 June 2002 showed on average, gill-netters spent between 12 - 13.2 hr per fishing trip during night-time fishing or 8 - 9.8 hr fishing during the day (Table 3.24). About 70% of drift-netters preferred night fishing, but their pattern of fishing trip was influenced by tides; and more fish caught during neap tides than spring tides. Operators of other fishing gear spent on average between 7.2 – 12 hr per fishing trip with the exception of portable traps which were left on the bottom of the sea for between 2 –3 days.

Table 3.24: Duration of fishing day/fishing trip of fishers in Mukim Lekir, Mukim Lumut and Mukim Sitiawan.

GEAR TYPE	Teluk Pencalang	Pangkor	Sitiawan	Average Duration of Fishing day/Trip
Gill-Nets				
1. Drift-Net	12.5hrs(N), 7.0hrs(D)	10.0hrs(N) 7.5hrs(D)	13.5hrs(N) 9.5hrs(D)	12.0hrs(N) 8.0hrs(D)
2. Tremmel-Net	13.0hrs(N) 9.0hrs(D)	12.5hrs(N) 9.5hrs(D)	14.0hrs(N) 11.0hrs(D)	13.2hrs(N) 9.8hrs(D)
3. Submerged Gill-Net	12.5hrs(N) 10.0hrs(D)	12.0hrs(N) 9.5hrs(D)	None None	12.3hrs(N) 9.8hrs(D)
Hooks and Lines				
1. Long-lines	6.0hrs	6.5hrs	9.0hrs	7.2hrs
2. Hand-lines	6.5hrs	8.0hrs	9.5hrs	8.0hrs
Others				
1. Barrier Nets	8.0hrs	None	None	8.0hrs
2. Crab traps	12.0hr	None	None	12.0hrs
3. Portable Traps	None	72.0hrs		72.0hrs

*** hrs=Hours, N=Night, D=Day

Based on their immense fishing experience, most respondents agreed that catches exhibited seasonal variation. Eighty five percent of those fishing for more than 10 years, agreed that their catches were low towards the end of the year, but rising slowly during January to peak between June and August, and falling away towards the end of the year. This catch variation seems to be correspond with the Malaysian equatorial climate that is being dominated by tropical air masses. It is characterized by two distinct monsoon seasons with two shorter inter-monsoon periods. The North-East monsoon occurs between October and November whereas the South-West monsoon occurs between March and April (Dept. of Meteorological Services (DMS), Manjung). Rainfall studies by the DMS Manjung between 1981 and 1995 showed that the average rainfall was low between June and August relative to other months (Table 3.25). The annual wind rose diagram (Appendix 2, Figure 3A) for 1971-1990 shows the general wind flow pattern of the sea follows that of the North-East and South-West monsoons and the sea was calm for 38.6 % of the time.

Table 3.25: The Average Rainfall and Rainday by Month (1981-1995) at Sitiawan,Perak.

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dis.
Rain-Fall(mm)	151.0	109.4	152.3	167.2	137.0	83.0	104.4	105.8	177.3	194.0	286.2	220.0
Rainday	14	11	14	15	14	9	10	11	17	20	20	17

Source: DMS, Manjung.

Fishing grounds of the respondents surveyed were mostly within the five nautical miles limit measured from the shorelines, except those operating submerged drift-nets who fished around a cluster of islands situated 7 – 8 nautical miles from the shore. With the exception of drift-nets, hook and line and portable traps, fishers using boat seines, barrier nets, crab traps and collecting shell-fish operated in shallow water. Fishing vessels used were of two types; canoes fitted with an outboard engine and boat with inboard engines. The engine horsepower (hp) of the canoes ranged between 2 and 60 hp, with 70.1 % are less than 30 hp Traditional fishing boats were larger than canoes and they were mostly fitted with inboard engine between 60 and 200 hp (Wang Yok Han, pers. comm.). In 2000, there were 802 canoes and 96 boats in South Manjung (Unpublished Report of FDOM,2001).

Relocation of fishing grounds

There has been a change in the location of the fishing grounds since the commencement of the land reclamation project. All the respondents were made to understand beforehand that their previous fishing grounds were meant to be before the beginning of the project and their new locations were during and after their completion. They were shown two maps illustrating zoned fishing grounds and were asked to marked with a pen their previous (Figure 3.2) and present (Figure 3.3) locations of fishing grounds

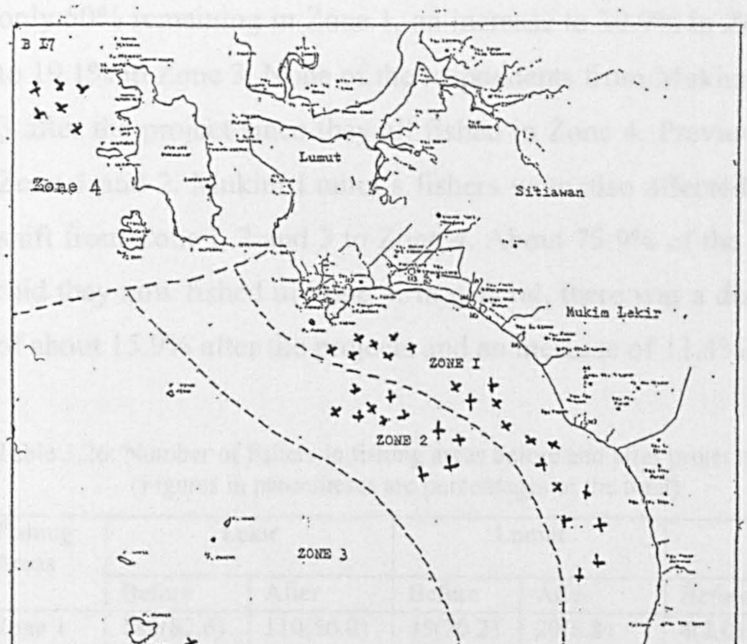


Figure 3.2: Previous fishing locations as marked by fishers

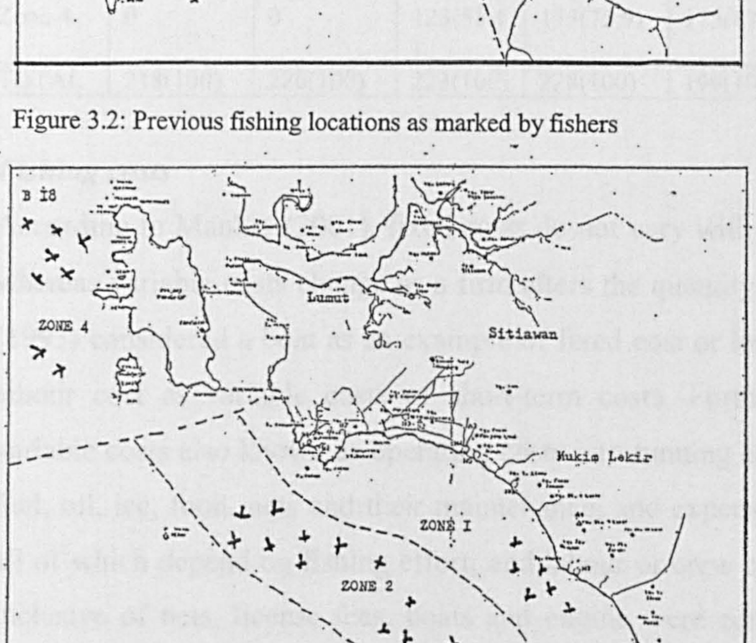


Figure 3.3: Present fishing locations as marked by fishers

Previously, 82.6% of fishers from Mukim Lekir fished in Zone 1, 16.5% in Zone 2 and a small number in Zone 3 (Table 3.26). After the project, this pattern shifted outward, with only 50% remaining in Zone 1, an increase to 30.9% in Zone 2 and a considerable increase to 19.1% in Zone 3. None of the respondents from Mukim Sitiawan fished in Zone 1, 2 and 3 after the project since they all fished in Zone 4. Previously, about 12.1% used to fish in Zone 1 and 2. Mukim Lumut's fishers were also affected by the project with a noticeable shift from Zone I, 2 and 3 to Zone 4. About 75.9% of the respondents from Mukim Lumut said they now fished in Zone 4. In general, there was a decrease of fishing effort in Zone 1 of about 15.9% after the projects and an increase of 11.4% in Zone 4.

Table 3.26: Number of fishers in fishing areas before and after projects in Lekir Water
(Figures in parentheses are percentages of the total)

Fishing Areas	Lekir		Lumut		Sitiawan		Total	
	Before	After	Before	After	Before	After	Before	After
Zone 1	180(82.6)	110(50.0)	45(20.2)	20(8.8)	4(2.0)	0	229(35.7)	130(19.8)
Zone 2	36(16.5)	68(30.9)	30(13.5)	20(8.8)	20(10.1)	0	86(13.5)	88(13.4)
Zone 3	2(0.9)	42(19.1)	25(11.2)	15(6.6)	0	0	27(4.2)	57(8.7)
Zone 4	0	0	123(55.1)	173(75.9)	175(87.9)	207(100)	298(46.6)	380(58.0)
TOTAL	218(100)	220(100)	223(100)	228(100)	199(100)	207(100)	640(100)	655(100)

Fishing costs

According to Mankiv (2001), fixed costs do not vary with the quantity of output produced whereas variable costs change as a firm alters the quantity of output produced. Hannesson (1993) considered a boat as an example of fixed cost or long-term costs, and fuel cost and labour cost as variable costs or short-term costs. Furthermore, Tai (2001) segregated variable costs also known as operating costs into running costs, which include the costs for fuel, oil, ice, food, nets and their maintenance, and expenses for fish aggregating devices, all of which depend on fishing effort; and labour or crew costs. In this study, fishing gears inclusive of nets, license fees, boats and engine were considered as fixed costs whereas operating costs were fuel, food and other provisions, baits, maintenance costs, ice, crew costs and monthly loan payback payment. The fishing profit was gauged by deducting the operating costs from the revenue where revenue was simply the value of sales, and was equal to the price of the product multiplied by the quantity sold (Mohr, *et al.* 1995).

To obtain individual fixed cost, each respondent who owned a boat or a canoe was asked to state the amount they paid in purchasing the boat/canoe, engine and fishing gear. Most fishers could not recall each item price but were able to provide total fixed costs, excluding license fees, which were used in this study. Operating costs were gathered by asking the respondents to state costs of each fishing trip itemized as follows: fuel cost, food and other provisions, ice, baits, repair and maintenance costs, crew costs and monthly loan payback payment.

The majority of the canoes, about 61.9 %, were priced less than RM10,000 each, whereas 90.4 % of the boats were priced more than RM10,500. On the average, the fixed cost of each canoe owner was RM6,593.30 inclusive of the value of fishing gears, while for boat owners, the average fixed cost was RM27,952.17 (Table 3.27). The licensing fee for each canoe was RM1.00 per annum and RM2.00 per annum for the boat, made payable to the DOF Perak.

Table 3.27: Average fishing costs

COST	Canoe		Boat	
	Fixed (RM)	Operating (RM)	Fixed (RM)	Operating (RM)
Mean	6,593.30	49.4	27,952.17	105.6
Std. Deviation	4,863.00	30.3	19,271.37	51.8
Minimum	700.00	15.0	2,000.00	30.0
Maximum	35,000.00	150.0	60,000.00	200.0
N(No. of Samples)	438	537	115	133

It was perceived that, on the average, the operating costs were made up of 70% fuel cost and 30% of other costs, depending on crew number, amount of ice used, baits and maintenance cost. Accordingly, the average operating cost of a canoe was RM49.4 per fishing trip and RM105.6 for boat operations (Table3.27). All respondents surveyed remunerated the crew by a sharing system. Normally, a crew share per fishing trip was as followed:

$$\text{Crew Cost} = \text{Profit} * \text{Crew Share Ratio}$$

where, Profit = Revenue – Operating Costs. Crew share ratio of traditional fishing gears was 0.4 for the West Coast of Peninsular Malaysia (FAO, 2001).

The owner of the canoe or boat will keep the other portion of the profit (60%) but deductions were made to pay off loan either to the bank or middleman. Thus, owner's earning was determined by equation:

$$\text{Owner's Income(Net)} = (\text{Profit} * 0.6) - \text{loan payback payment}$$

Annual total fixed costs of the fishery community in South Manjung was determined as the product of the total number of canoes and boats in operation with the average value of canoe and boat respectively. Likewise, annual total operating costs were the product of the average operating cost per fishing day of both the canoe and boat and the total number of fishing days per year and the total number of canoes and boats. Accordingly, the total fixed costs was RM 7,971,234.90 and operational cost was at RM1,391,900. The average operational cost of canoes and boats was preferred because the available data on revenues for previous years did not discriminate between canoes and boats.

Fish prices

Fish prices as disclosed by fishers were ex-vessel prices, i.e., the value they got directly from selling fish to the traders or middlemen (Table 3.28), but with species graded following the grading system of DOF. Although 84.6% of fisher respondents said that their catch was worse lately, 92.4% were satisfied with the high prices but since their catch was low, most were still dissatisfied.

Table 3.28: Average ex-vessel fish prices for commonly caught species in Lekir water (2002).
NA=Not available

SPECIES	Common Name	Average Price (RM/kg)
Grade 1		
Pampu chinensis	Chinese pomfret	40.20
Pampus argentus	Silver pomfret	25.27
Formio niger	Black pomfret	16.27
Eleutheronema tetradactylum	Fourfinger threadfin	13.74
Chirocentrus dorab	Dorab wolf-herring	8.00
Epinephelus sp.	Grouper	19.70
Lutjanus johni	John's Snapper/Snapper	19.13
Pampus sp.	Small pomfret	NA
Scomberomorus sp.	Spanish Mackerel	10.5
Average price of Grade 1 fishes		19.10
Grade 2		
Hilsa macrura	Long-tail shad	NA
Ilisha elongata	Shads/Slender shads	NA
Lutjanus malabaricus	Red snapper	16.50
Spilotichthy pictus	Sweetlip	NA
Carangoides malabaricus	Horse mackerel	13.00
Lates calcarifer	Giant sea perch	15.29
Atropus atropus	Kuweh trevally	NA
Average Price of Grade 2 fishes		14.94
Grade 3		
Pomadasys hasta	Lined silver grunter	9.30
Alepes sp.	Crevalle/Trevally/Scad	7.50
Sillago sihama	Silver whiting	8.75
Chiloscyllium sp.	Catshark	3.91
Lutjanus russelli	Russel's snapper	5.22
Sphyraena jello	Banded barracuda	5.98
Rachycentron canadus	Black kingfish/Cobia	4.67
Muraenesox cinerus	Silver conger eel	3.50
Johnieops sina Nibesoldadu/Otolithes rubber	Croaker	2.23
Rastrelliger sp.	Mackerel	2.11
Cynoglossus macrolepidotus	Large-scaled tongue sole	3.10
Loligo sp.	Squids	2.75
Plotosus canius	Canine catfish eel	6.10
Scomberoides sp.	Talang queenfish	3.58
Megalaspis cordyla	Hard tail scad	4.00
Drepane punctata	Spotted sicklefish	4.21
Anodontostoma chacunda	Chacunda gizzard shad	0.85
Liza sp.	Mullet	9.00
Caesio xanthonotus	Fusilier	8.92
Arius sp.	Catfish	2.90
Pseudorhombus malayanus	Malayan flounder	4.33
Rastrelliger brachysoma	Indo-Pacific mackerel	2.00
Crabs	Crabs	6.24
Average Price of Grade 3 Fishes		4.71
Penaeus sp.	Prawns/Shrimps	20.48
Shellfish	Shellfish	0.48

Income determination

Income data are never been easily nor accurately obtained (Perunding Utama, 1997).For example, U.S. Bureau of Labor Statistics admits that its statement on the wage and salary of full-time fishers is based on limited information (BLS, 2004). Generally, fishers do not keep income records. Many surveys rely on memory and honesty (Perunding Utama, 1997; Tenaga Nasional, 1997 and Anon., 1998A) when stating their incomes. Therefore, apart from recording what fishers claimed to be their incomes, this study attempted to gauge their income via indirect methods using fisheries data on landings, costs, fish prices and number of fishing days. The main reason is to explore many possibilities of constructing income structures of fishers, thus providing alternative avenues for different research purposes or administrative uses of government agencies.

Fisher earnings or income per monthly basis was gauged by three methods; first, by asking each respondent to state his estimated net income each month. This is to be known as 'declared' income by respondents. Since this is only an estimation and there is a possibility of biases, this study explored a second method through enumerating data on landings per fishing trip, fish prices and number of fishing trips per month to deduce the income of each respondent or 'calculated income' (for thorough discussions on revenues, costs and profits see Gravelle and Rees,1990; Dobson *et al.* 1998 and Sloman, 2004). In the questionnaire design, each respondent was asked to state five fish species commonly caught by him, the ex-vessel price of each species, the average total amount of fish caught and the total operating cost per fishing trip. An average ex-vessel price was then calculated to represent the price of fish received by each fisher. Thus, the individual fisher income per month was calculated using:

$$\text{Revenue per Month} = L * P * D$$

$$\text{Operating Costs per month} = C * D$$

Where ,

L = Amount of fish caught per fishing trip (in kg)
P= The average ex-vessel fish price
D= Fishing trips per month
C= Operating cost per fishing trip

$$\text{Therefore, Profit} = [L * P * D] - [C * D]$$

Crew Costs = Profit * 0.4

Owner Income per month = Profit * 0.6

The third method of income determination is an over generalization since it assumes each fisher having equal fishing effort, catching the same fish stocks and sharing equal ratio of profit. This holistic approach is gauged by perusing the 2001 Info Perikanan Perak (DOF Annual Statistical Report) of the landing and revenue figures. Nevertheless, it provides a general representation of fishing revenues of the community and an indicator of how it is being distributed.. This income is to be the average 'income of the population'. The average monthly income of each fisher is thus deduced by the following equation:

$$\text{Average Fish Price per kg} = \sum_{i=1}^{n} r_i \div \sum_{i=1}^{n} L_i$$

$$\text{Operating Costs per Year} = \sum_{i=1}^{n} c_i * 12 \text{ months}$$

$$\text{Revenue per Year} = \sum_{i=1}^{n} l_i * \sum_{i=1}^{n} r_i \div \sum_{i=1}^{n} L_i$$

Therefore, Profit per Year = Revenue per Year - Operating Cost per year

A Fisher's Income Per Month = (Profit/N)/12

Where,
r_i = Revenue of month number i = 1,,, n=12

L_i = Landings of the month number i = 1 ,,, n=12

l_i = Landings of South Manjung for month number i = 1 ,,, n=12

c_i = Monthly operating costs of fishing trip number i = 1,,,n

N = Total number of traditional fishers in South Manjung.

Over 80 % or 554 owner-operator fishers stated their incomes (Table 3.29). On average, each boat owner earned RM860.00 per month while crews earned RM561 (Table 3.30). These average incomes are quite consistent with owner earning 60% of the profit.

Table 3.29: Boat ownership among fishers in South Manjung
(Figures in parentheses are percentages of the total)

	Mukim			Total
	Lekir	Lumut	Sitiawan	
Boat Owners	200 (88.9)	194 (81.5)	160 (77.3)	554 (82.7)
Boat Crews	25 (11.1)	44 (18.5)	47 (22.7)	116 (17.3)
Total	225 (100)	238 (100)	207 (100)	670 (100_

Table 3.30: Average income as declared by boat owners and crews (in RM)

N	Minimum	Maximum	Mean	Std. Deviation
Boat Owners 553	180	3000	860.4	631.6
Boat Crews 114	100	1200	560.9	281.3

There was a statistically significance difference exists in terms of incomes determined by the two methods (F=26.6, t= 7.5, df= 1338 , p= 0.000). The declared income structure of fishers (Table 3.31) was lower, than calculated income with 85.4% of the respondents declaring that their incomes were less than RM1,000. The calculated method suggests only 59.5% respondents earned less than RM1,000. On the average, income determined by the declared method was RM809.2 (± RM599) whereas by calculated method was RM1,082.1 (± RM 729).

Table 3.31: Income structure of fishers (declared and calculated methods) (in RM)
(Figures in parentheses are percentages of the total)

Income Bracket	Mukim			Total
	Lekir	Lumut	Sitiawan	
Declared Method				
Lowest thru 500	72 (32.0)	68 (28.6)	124 (59.9)	264 (39.4)
501 - 1000	130 (57.8)	95 (39.9)	83 (40.1)	308 (46.0)
1001 - 1500	6 (2.7)	25 (10.5)	0 (0.0)	31 (4.6)
1501 - 2000	11 (4.9)	15 (6.3)	0 (0.0)	26 (3.9)
2001 thru highest	6 (2.7)	35 (14.7)	0 (0.0)	41 (6.1)
Total	225 (100)	238 (100)	207 (100)	670 (100)
Calculated Method				
Lowest thru 500	27 (12.0)	59 (24.8)	45 (21.7)	131 (19.6)
501 - 1000	80 (35.6)	99 (41.6)	88 (42.5)	267 (39.9)
1001 - 1500	75 (33.3)	50 (21.0)	30 (14.5)	155 (23.1)
1501 - 2000	18 (8.0)	10 (4.2)	15 (7.2)	43 (6.4)
2001 thru highest	25 (11.1)	20 (8.4)	29 (14.0)	74 (11.0)
Total	225 (100)	238 (100)	207 (100)	670 (110)

Since each boat owner operator has a crew member, the calculated income of the latter was 40 % of profit. Thus, if a boat owner claimed that his income was RM600.00, then his crew earns RM400.00. Hence, to provide an overall picture and representation of the incomes structure of the population by the declared and calculated methods, the following equation is used to obtain the average income;

$$\text{Average income} = \frac{\sum_{i=1}^{n} O_i + \sum_{i=1}^{n} C_i}{N}$$

Where,

O = income of a boat owner number i=1 ,,, n= 554

C = income of a boat crew number i =1 ,,, n=554

N = number of boat owner + number of boat crew

= 1,108

The average income by the declared method was RM716.6 (± RM555) with 85.7% of respondents earning less than RM1,000 whereas by the calculated method, the average income was RM901.3 (± RM646.5) with only 63.4% respondents earning less than RM1,000. (Tables 3.32).The two of income structures determined by these methods were significantly different (F= 21.6, t= -7.5, df= 2446, p= 0.000).

Table 3.32: Income structure of fishers based on declared and calculated incomes of boat owners (in RM)
(Figures in parentheses are percentages of the total)

	Status		Total
	Boat Owners	Boat Crews	
Declared Method			
Lowest thru 500	191 (34.5)	359 (64.8)	550 (49.6)
501 - 1000	271 (48.9)	129 (23.3)	400 (36.1)
1001 - 1500	26 (4.7)	32 (5.8)	58 (5.2)
1501 - 2000	25 (4.5)	34 (6.1)	59 (5.3)
2001 thru highest	41 (7.4)	0 (0)	41 (3.7)
Total	554 (100)	554 (100)	1108 (100)
Calculated Method			
Lowest thru 500	105 (19.0)	128 (23.1)	233 (21.0)
501 - 1000	218 (39.4)	252 (45.5)	470 (42.4)
1001 - 1500	139 (25.1)	106 (19.1)	245 (22.1)
1501 - 2000	35 (6.3)	28 (5.1)	63 (5.7)
2001 thru highest	57 (10.3)	40 (7.2)	97 (8.8)
Total	554 (100)	554 (100)	1108 (100)

The population average income, on the other hand was much lower at about RM574.9, which is expected since the average fish price is inclusive of fish prices ranging from the lowest RM0.26 to the highest RM 14.00 per kg. Nevertheless, each method of income determination has its own value according to specific purposes. When data on costs and earnings are lacking, the researcher has to depend on the fisher's memory and sincerity to construct an income structure of the population. The calculated income is constrained by time parameters and is only reliable to describe the income structure during that period of time, since fishing is known to be seasonal unless a comprehensive data collection exercise has been carried out during the entire year. Consequently, it is prone to deliver an unrealistic picture of the income structure if it were to generalize over the long term. The population average income method does not include the income structure since it gives an average income only, but it is convenient way and a realistic one of describing the total revenues of the community and useful in economic analyze

If fishing profits are to be distributed equally among all fishers of South Manjung, then each should earn RM574.85 per month based on year 2001 data collected by FDOM. However, this holistic approach is an oversimplification since it is known that individual incomes are influenced by many factors such as boat tonnage, horse-power, types of gear used, fishing experiences, fish prices and weather of the day. Moreover, with the absence of income structure, it is almost impossible to describe fairly income distribution among the population. Nevertheless, it does suggest that the fishing community is in destitute state, as its *per capita* income is slightly above the poverty threshold.

It appears that boat owners and crews declared their income quite consistently with the profit sharing system commonly exercised by the fishing community. The lower incomes reflect their general poor standard of living. The higher incomes estimated by the calculated method did not warrant them to grudge against the projects since there is no notable decline in income structure compared with before the projects. Perunding Utama (1997), before the commencement of the land reclamation project reported that about half of the fishers earned less than RM500 whereas the calculated method revealed that only 19.6 % of fisher were within that income bracket. The Tenaga Nasional (1997) survey, despite the income structure study being confined to smaller areas adjacent to the power plant and fishers, found that 78.2% of the respondent earned less than RM1,000; a higher percentage compared with the 63.4% by the calculated method. Furthermore, the calculated average income of RM901.3 was higher than the RM747.9 average income gauged by the FAO

(2001) survey on 10,725 drift-netters in the West Coast of Peninsular Malaysia. The calculated method offers high incomes structure that does not reflect the plight of the fishers. With these discrepancies, the declared method is considered more acceptable than the calculated method, thus adopted in this study.

An accurate method of income determination will be when data on landings, fish prices, costs, fishing trips are collected on a regular basis throughout the year. The FDOM regularly collects all of the data except costs which are vital component to estimate fishing profit. Although other data can be extracted from the FDOM data base, this study had to rely on the respondents' accurate and reliable account on their spending during each fishing trip. Assuming that all other data were accurate, then it is suspected that they had generally under-declared their operating costs, which was the only reason for their higher incomes structure. This draws attention of the need to include cost data in the FDOM statistics.

3.3.7 *Awareness of the land reclamation and the power plant projects*

Virtually all fisher respondents were knowledgeable about the happenings at sea and land pertaining to the reclamation works, and later on the construction of the power plant. This may due to the wide publicity, planned and proper dissemination of information and fishers involvement with consultants during the preparation of the EIA reports. TJSB and DKSB opened up an information center at the Mukim Sitiawan Penhulu's (Headman) office at Sitiawan town every Thursday from 9.00 am until 12.00 pm The purpose of setting up the information center was to project a positive image of the proposed reclamation and power station projects by: (1) informing interested parties about the proposed reclamation and power station projects including their current status; (2) noting concerns or complaints regarding the projects; (3) clarifying issues of concerns regarding both projects, including answering questions on job opportunities (Tenaga Nasional, 1997). As such there is no doubt that they were fully aware of the projects from the beginning. However, a small fraction of non-fishers, (about 0.5 %) seem to be naïve and unacquainted. Further enquiries revealed that they live a distant from the project site or had never visited the area or were plain ignorant. Since their number is small, this study regarded them as outliers that deviated from the general pattern of the community. It is unlikely that anyone can miss the huge structure of the power plant that is visible from a distant. Despite such irregularity, non-fishers awareness was similar to that of fishers, mainly because of their interest in surrounding activities and the efficiency of the media.

3.3.8 Perception towards development

Two questions were asked to the respondents to test whether their perception towards development been altered since the commencement of the projects The first was how they ranked their perception on the land reclamation project followed by a second question of the purpose of such project, that was, to build a power plant. Table 3.40 shows that The majority of government servants and non-fishers were supportive about the reclamation project and even more supportive of the building of the power plant. However, more than half of the fishers were not supportive of either projects. (Table 3.33).

Table 3.33: The perception towards development of Mukim Lekir
(Figures in parentheses are percentages of the total)

	Government Servants		Non-Fishers		Fishers	
	Land Reclamation	Power Plant	Land Reclamation	Power Plant	Land Reclamation	Power Plant
Very Supportive	0 (0)	0(0)	0(0)	0(0)	0(0)	0(0)
Supportive	68(75.6)	73(81.1)	26(6.9)	52(13.8)	58(25.8)	58(25.8)
Somewhat Supportive	16(17.8)	14(15.6)	273(72.4)	260(69.0)	31(13.8)	31(13.8)
Unsupportive	6(6.7)	3(3.3)	39(10.3)	65(17.0)	124(55.1)	121(53.8)
Very Unsupportive	0(0)	0(0)	39(10.3)	0(0)	12(5.3)	15(6.7)
TOTAL	90(100)	90(100)	377(100)	377(100)	225(100)	225(100)

When the same questions were put to the fishers of Mukim Lumut and Mukim Sitiawan, they provided different views from that shown by their colleagues in Mukim Lekir (Table 3.34). The majority of fishers from Mukim Lumut and Mukim Sitiawan did not support the land reclamation project but contradictorily supported the power plant project.

Table 3.34: Fishers' perception towards development
(Figures in parentheses are percentages of the total)

	Mukim Lumut		Mukim Sitiawan	
	Land Reclamation	Power Plant	Land Reclamation	Power Plant
Very Supportive	0(0)	0(0)	0(0)	0(0)
Supportive	25(10.5)	132(47.5)	14(6.8)	75(36.2)
Somewhat Supportive	65(27.3)	78(27.3)	85(41.1)	95(46.9)
Unsupportive	148(62.2)	72(25.2)	98(47.3)	10(4.8)
Very Unsupportive	0(0)	0(0)	10(4.8)	25(12.1)
TOTAL	238(100)	238(100)	207(100)	207(100)

The next question was posed to the respondents asked them to state their reasons for support or otherwise on both projects. Most government servants and non-fishers thought that land reclamation was essential for the building of the power plant which, would benefit the country, whereas fishers, with the exception of Mukim Lekir fishers, opposed the land reclamation project since it deprived them of their fertile fishing grounds but agreed that the power plant was necessary for the development of the country. Mukim Lekir fishers thought that the land reclamation project had destroyed their fishing grounds, and the power plant project did not benefit them in term of work opportunity and other benefits, which should be conferred to them being the natives of the area.

3.3.9 *Disturbances*

According to Mankiw (2001), an externality arises when a person engages in an activity that influences the well-being of a bystander and yet neither pays nor receives any compensation for that effect. If the impact on the bystander is adverse, it is called a negative externality, or positive externality if it is beneficial to the bystander. Disturbances to the community are a form of negative externalities caused by the projects being a nuisance to their normal livelihood. Eleven items were identified as possible negative externalities of the projects; crime rate, traffic congestion, traffic accidents rate, sexual harassment, fire outbreak, immigrants, noise pollution, smoke pollution, dust pollution, water pollution and disruption to tranquility.

More than 50 % of the respondents agreed that there has been an increase in traffic related disturbances such as accidents and congestion, an influx of immigrants, especially illegal workers hired by the local sub-contractors, and pollution (noise and smoke). Other disturbances raised less attention suggesting they are not a real problem. However, the majority of fisher pointed to water pollution as their main problem, which is reasonable since their livelihoods are dependent on it.

3.3.10 *Perception towards TNB Janamanjung Sdn. Bhd. social responsibility*

In socio-economic survey carried out by Tenaga Nasional (1997), a set of seven question-items relating to social responsibility were asked to respondents (Table 3.35). They were generally the kind of benefits expected to be acquired by the community from the existence of the power plant. More than 90 % of the respondents agreed that the power plant would benefit them (item number 1, 2, 5, 6 and 7) except in tourism where only 63.6 % agreed it would develop in the area and 72.7 % agreed that shopping complexes would be built to accommodate their needs. Adopting and applying similar set of questions, this study found there was an unmistakable shift in attitudes since the survey by Tenaga Nasional (1997). Less than 50 % agreed that the power plant would bring them benefits with two benefits (shopping complexes and employment opportunity) voted less than 25 % by the respondents.

Table 3.35: The comparison between surveys made by Tenaga Nasional (1997) and this study on TNB Janamanjung social responsibility(Percentages).
A= Tenaga Nasional (1997), B= this study

Level of Agreeable	Very disagreeable		Disagreeable		Somewhat Agreeable		Agreeable		Very Agreeable		TOTAL	
	A	B	A	B	A	B	A	B	A	B	A	B
(1)Environmental Friendly	1.8	7.5	9.1	45.7	10.9	8.4	63.6	38.2	14.5	0.3	100	100
(2)Provide Infrastructure	0	5.6	1.8	45.2	3.6	38.0	65.5	11.0	29.1	0.1	100	100
(3)Tourism Center	1.8	8.2	18.2	57.8	16.4	26.2	61.8	7.8	1.8	0	100	100
(4)Shopping Complexes	0	7.9	7.3	68.4	20.0	18.1	63.6	5.6	9.1	0	100	100
(5)Social Service	0	6.6	1.8	44.2	1.8	41.5	76.4	7.7	20.0	0	100	100
(6)Employment Opportunity	0	15.2	0	59.7	1.8	15.6	65.5	9.5	32.7	0	100	100
(7)Local People Involved in the activities	0	5.6	0	44.9	1.8	43.1	76.4	6.4	21.8	0	100	100

3.4 Discussion

The socio-economic surveys conducted by Perunding Utama (1997) and Tenaga Nasional (1997) on Lekir population provided important information on community's status in terms of bio-data, land ownership, employment pattern, standard of living, and their perception towards change and development before the implementation of the land reclamation project. To obtain information on how the project had altered the community's livelihood, particularly of fishers, another survey was carried out. Information gained from the respondents were analyzed to compare and contrast if the predicted benefits envisaged by Perunding Utama (1997) had met its target or otherwise.

At the initial planning stage of the project, Perunding Utama invited local leaders and some selected residents to attend a dialogue session held on the 17 December 1996. In summary, the residents stated their main concern as follows;

1. Whether fishing areas will be destroyed and fishers might be displaced by these projects and have to seek other jobs;
2. accessibility to the open sea for fishing;
3. whether the creation of a 150 m channel from the coast to the island is sufficient and if their fish, cockles and prawns cultivation along the coast will be harmed;
4. how the locals could benefit from these projects, and
5. the emergence of new social problems as a result of "outsiders" moving to these settlements.

Perunding Utama (1997) predicted that the initially planned project of reclaiming 8,094 ha would result an extensive development in Mukim Lekir following investors buying the newly created lands at competitive prices. For the State Government of Perak and the community of Manjung district, the project's contribution to them were;

1. the realization of the state's government objectives of achieving its planned tourism development projects;
2. to develop and turn Manjung in general and Lekir area in particular, into a developed and modern tourist area; and
3. to provide returns to the state government and the locals in term of:
    - i. Providing new businesses and job opportunities;
    - ii. Providing new residential areas so as to meet the increase in population;
    - iii. Providing new and better infrastructure facilities to the locals;
    - iv. Providing new opportunities for Malaysian and states' investors, and
    - v. Creating new growth areas for future urban and regional expansion.

However, the planned 8,094 ha project was never accomplished as it was hindered by the East Asian financial crisis in 1997 (MIDA, 2004). Only Phase I was completed to provide a place for the power plant while further extension of the project remained uncertain. Although the reclaimed land had reduced to 405 ha, its impact on the livelihood of the community was substantial and notable. Moreover, there is evidence that the impacts on the livelihood of fishers are much more crucial than how it was claimed by the project proponents (Table 3.36).

Table 3.36: Between prediction and reality.

Direct Socio-economic Effects	Predicted by Perunding Utama (1997)	As Revealed by this Study
1. Value of land around the project area.	1. There are potential for future tourism development along the Lekir coast. Fisher could operate 'ikan bakar' (fish barbeque) restaurants instead of selling their catches to middlemen which do not provide them with a good source of income. Chalets and small hotels could be built to attract those that are moving into new development areas. These induced developments will help increase property value in the area.	1. Since the proposed 8,094 ha had reduced to 405 ha for the location of the power plant, there was no obvious effect on tourism industry in the area. Thus fishers and other tourism-related businesses were not benefited. The existence of the power plant also did not result in increase of property value.
2. Employment opportunities.	2. The project will create jobs directly and many more jobs indirectly especially in the service and ancillary industry.	2. Low education level was the main reason for fishers to be employed by the power plant. Skilled workers were brought in from outside the area.
3. Income of local residents	3. The development of the project is expected to generate additional income to the area. Directly, this will be in the form of salaries and wages earned by the workers as well as receipts from purchases of local material inputs for the project. Additionally, income would also be generated through the secondary (indirectly) effects of the project resulting from the expansion of the economic and commercial activities in the area. Other multiplier effects would be increased rentals of housing, and development of seafood-based industries as well as cottage industries which would augur well for the area as a whole.	3. Since the power plant did not offer any employment opportunity, fishers and non-fishers remained earning their wages through fishing and other type of occupations.

4. In-migration of people and traffic condition.	4. A positive effect can be seen in terms of increased demand for housing, goods and services which could benefit Lekir area. During the construction period, there will be more vehicles using the road to bring materials and equipment to the site. These might entail road improvement in some areas as traffic gets heavier with future development. Some effects on tranquillity are expected.	4. It was observed that the neighbouring Mukim Sitiawan had benefited from housing demand, goods and services. Majority of the power plant's workers preferred to live in Mukim Sitiawan which offered better facilities. However, tranquillity in Mukim Lekir was disturbed as a result of increasing traffic moving in and out of the power plant.
5. Impact on fishing areas	5.The process of reclamation may create erosion and might damage the fishing activities around the coast. The propose site will not directly affect any mangrove forest	5. Relocation of fishing grounds and the decline in fish catches were the main problems. Contrary to Perunding Utama (1997) prediction, mangroves were seen to be degraded.

At this point, the benefit gained by house or land owners is not yet apparent. During the land reclamation works and the construction of the power plant, all workers, with the exception of three of them together with their families, were observed to stay in the neighboring Mukim Sitiawan where houses were more easily available than in Mukim Lekir. Moreover, the distant from work place to their rented houses was much shorter. Since there was no competition between the locals and project workers for housing in Mukim Lekir, the renting rate was kept constant. Only one person was observed to benefit by building barracks on his land to be rented to the three families.

Low education level had prohibited fishers and non-fishers to be employed by the power plant. According to Tenaga Nasional (1997), during the peak construction period, the manpower requirement was about 3,000 workers . As to why local residents were unable to be employed, might be due to the following reasons, apart from the low education level problem; (1) some respondents complained that the sub-contractors responsible in hiring workers preferred immigrants than locals because of low salaries accepted by the former, and (2) lack of experience in construction works. During the operational stage of the power plant, Tenaga Nasional (1997) stated that about 400 workers were needed but only 10 of them were administration staff (low educational requirement) while the rest comprised of highly qualified workers. This had further limited the opportunity of the locals.

Both Perunding Utama (1997) and Tenaga Nasional (1997) admitted that fishers catch might be affected by the project. However, Perunding Utama (1997) predicted that fish decline would be temporary . As it is seen, the sign of recovery is nowhere to be seen and the short-term effects as claimed is yet to be proven. In addition to the declining catches as experienced by fishers since 1997, they were also confronted with fishing activity problems such as relocation of rich fishing grounds and increased of fishing distant. Though fuel cost had been observed to be stable over the years, increase in distances had brought to increase in fuel cost. The once rich fishing grounds were replaced by less fertile areas resulting in further reduced in catches.

Within the small number of respondents surveyed by Tenaga Nasional (1997), majority of them agreed that TJSB would contribute better prospect to the community with respect to improved environment, infrastructures such as roads, creating tourism centre, emergence of shopping complexes, social services, employment opportunity and the involvement of locals with other TJSB's activities. However, the experienced respondents as surveyed by this study did not think so. More than half of them said that TJSB had not implemented fully their social responsibilities to the community. During the construction of the power plant, it was observed that there was an increased in traffic resulting in more motor accidents, congestion and pollutions (noise and smoke); and the influx of immigrants hired by local sub-contractors that perceived as depriving locals from getting the jobs. Fishers pointed out that the power plant had introduced some kind of water pollution that affect their catch. Tourism center and shopping complexes yet remained to be seen. In the mean time, most respondents did not notice any of the social services and activities involving locals provided by TJSB.

After several years since the commencement of both projects, this study asked the respondents their perceptions based on their actual experiences. As expected, both the government servants and non-fishers were still positive about the projects and even more supportive on the building of the power plant. They perceived the vast benefit that the power plant could bring to the state and nation as a whole. On the other hand, fishers generally were unsupportive of the land reclamation project that appeared to deprive them of their fishing grounds. However, with the exception of Mukim Lekir fishers, more than half of them were supportive about the purpose of the land reclamation, that is, to build the power plant. They too acknowledged the importance of electrical energy to the development of the nation. The perception of the Mukim Lekir fishers towards both projects was identical that majority of them were unsupportive of the land reclamation and the power plant. These differences of perception between fishers could be due to the fact that fishers of Mukim Lekir did not anticipate the immediate benefit they could get by being the natives of the area where the power plant was built, for example with respect to employment opportunity.

This study suggests that the social impacts resulting from both the land reclamation and the power plant projects are persistent and affecting fishers more than any other group. It has not subsided nor has it given an indication of any improvement of the livelihood of the fishers. Although government servants and non-fishers were seemed unaffected by the projects, they too indirectly were receiving bad consequences of the projects such as high fish prices, pollutions, illegal immigrants and traffic congestion. The completed Phase 1 was small as compared to the proposed 20,000 acres land reclamation, but the impacts on fishers were already tremendously intolerable. Further on, this study took the opportunity to interview three fishers by letting them to talk freely on their livelihood (Appendix 2). It is concluded that fishers' livelihood were indeed shifting from bad to worst.

CHAPTER 4: THE STUDY OF BEFORE AND AFTER IMPACTS:
Detecting the Source of Intervention

4.1 Introduction

The trawl surveys carried out in Lekir waters in 1996, 2002 and 2003 showed a declining trend in total biomass (Chapter 2). The surveys also indicated a decrease of trash fish in waters nearer to the shore and thus implying a deteriorated breeding and nursery ground. Most fishers felt that their declining catches and consequently, their income, was due to the works of the reclamation and power plant projects (Chapter 3). The majority of them agreed that the mangroves, which they acknowledged as beneficial to their fishes, were also affected. Evidence for the impact on fisheries resources is unambiguous, at least from the fishers' perspective and moreover, is supported by the scientific surveys. Thus, it can be questioned whether there is sufficient justification to put the entire blame on those projects.

Fish and mangrove abundances have deteriorated during and after the commencement of the land reclamation and power plant projects. The 'island', a term used to indicate the combination effects of both projects is the alleged causal factor, mainly by depriving fishers of their rich fishing grounds and creating environmental disturbances that are detrimental to the mangroves and fishes. Before the presence of the 'island', fish and mangroves resources were already in the deteriorating state. In such a case, it could be contemplated that even without the intervention, the resources will continue to degrade and therefore it could not be blamed in entirety. For example, in the case concerning 'land reclamation by Singapore in and around Straits of Johor', between Malaysia and Singapore before the ITLOS in 2003, Singapore's representative argued that the blame could not be entirely on their action as the fish decline could be due to fishing over-exploitation and mangroves were anyway already in a diminishing state due to bad resource management. Thus, while acknowledging that both resources were already in the degrading state before the 'island' (Perunding Utama, 1997), the objective of this chapter is to determine whether the fishing decline and mangrove degradation were made worst by presence of the 'island'. This can be achieved by comparing data from impacted and control sites (Smith, 2002). If there is a difference in abundances between the impacted and the control populations, before and after the introduction of the 'island', then it can be deduced that the difference is probably caused by the 'island' itself.

4.2 Definition of impacts

Many terms are used to describe impacts resulting from non-natural acts. The phrases anthropogenic disturbance (Underwood, 1992), or anthropogenic activities (Schmitt and Osenberg, 1996), or human activities (Mapstone, 1995; and Piltz, 1996), or human environmental impacts "intervention" (Stewart-Oaten, 1996A), or human impacts (Thrush *et al.*, 1994; and Jones and Kaly, 1996), carry virtually the same meaning, implying that society is the cause or source of environmental impact. It can be unintentional, such as oil spills from the sunken ship, or planned such as the building of a power plant. The state of the natural environment can be changed or altered by the planned activities, where "alteration" indicates a long-term change, like the installation of the power plant, sewage outfall or oil platform, rather a short-term change, like an accident or the temporary effects of building the power plant (Stewart-Oaten, 1996B). Since short-term change attracts less attention from the society, this study is more concerned about the long-term change that prolongs the economic loss to society.

The first step in the before and after study processes is to define the intervention (Osenberg *et al.*, 1996A). Two activities that have major potential impacts to the environment are sand sourcing and reclamation works (Perunding Utama,1997). A direct effect of sand and gravel extraction is the loss of the spawning and nursery habitat for fish which are fished intensively (Clark, 2002). The most immediate effect of the reclamation works is reduced fish catch as a result of reduced number of fishing trips, area of operation and damage to the spawning or nursery /feeding areas. The estuarine areas, usually backed by mangrove vegetation, besides functioning as nursery areas for fish and shrimp (Odum, 1993) larvae and juveniles of many species (Weinstein, 1979; Boehlert and Mundy, 1988), also serve as spawning areas for some engraulids, clupeids, most catfishes and sciaenids (Sasekumar and Lim, 1994). Penaeid shrimps, for example, will be affected severely if there is change in the environmental factors. They are dependent upon varying physical, chemical and biological factors for their survival because the wide range of factors that they must contend with during their life cycle, ranging from the open oceans to the tidal estuary (Couch, 1979). In

Vedaranyam (southeast India), there was a 40% loss of mangrove forest, which coincided with an 18% decline in fishery resources within a 13-year period between 1976 and 1989 (Padmavathi, 1991). A study on three areas with different levels of species richness and coverage revealed that the number of species and yield of finfish were greater in the mangrove-rich area than in the mangrove-low and poor areas (Kathiresan and Rajendran, 2002). A severe or sudden perturbation of any of these factors, combined with pollutant stress, may affect total stress or injury in penaeid shrimps.

4.3 Before and after study

The Before-After-Control-Impact study, or BACI, was introduced by Green (1979) to detect impact by observing, say, abundance before the introduction of the disturbance and then compare it with the abundance after at the impact site. Green suggested a design with at least one time of sampling before and at least one after the impact begins, at least two locations differing in degree of impact, and measurements on an environmental as well as a biological variable set in association with each other. A significant change in abundance can then be attributed to the presence of the disturbance. However, any differences from before and after the potential disturbance occurred, may not necessarily be related to (caused by) the human activity (Hurlbert, 1984). This type of design has the pitfall that there may be no relationship between the observed event and the changes in the response variable - the change may be entirely coincidental (EPA, 2002A).This design was later extended by Stewart-Oaten *et al.* (1986) who argued that the assessment problem can be solved by taking replicates over time, and only by sampling at many different times, both before and after start-up, can the variability due to all sources, both sampling error and random population fluctuations be estimated. The design requires collecting samples simultaneously at both the impact site and a nearby control site several times before and after impact and thus the word "paired" emerged for sampling at both sites at the same time. Hence, BACIP is an acronym used for the paired design to differentiate it from the unpaired design. Since the state of the system in the absence of the effect cannot be observed after the disturbance, there is need to estimate statistically with the observed (perturbed) condition (Stewart-Oaten, *et al.* 1992). The BACIP design accomplishes this by collecting samples at both the impact site and a nearby control site where they are sampled simultaneously, thus pairing them. The samples are collected at intervals (time series) before and after the disturbance and the time series data serve as replicates in the assessment design.

Further extension of the Before-After impact design also known as "Beyond BACI" design was proposed by Underwood (1992) who argued that any location-specific temporal difference that occurs between the two locations will be interpreted as an impact even if it has nothing to do with the human disturbance, and thus suggested the use of multiple control sites. The set of locations chosen to serve as controls must simply represent the range of the habitats of the one that might be disturbed (the impact location) (Underwood, 1994). "Beyond BACI" design is therefore a series of random samplings in time and space in the impacted zone and in two or more controls, which would be tested through asymmetric analysis of variance (ANOVA) (Santos *et al.*, 2002).

The BACI experimental design is administered to perform the task where statistical tests are required to determine that there was no difference between the before and after impacts. This is called a null hypothesis and is symbolized by H_0. The opposite of the null hypothesis is H_A where it indicates there is a difference between before and after impacts. Since the BACI design compares the average value of some variable in two or more samples, then H_0: $\mu_1 = \mu_2$ and H_A: $\mu_1 \neq \mu_2$, where μ_1 and μ_2 are the means of populations being tested.

4.4 Data collection

For BACIP to crystallize, there must be before and after data. Normally data are collected for a specific reason, as in a monitoring programme (Spellerberg, 1991). In many cases, the interest to collect data only arose after the introduction of the intervention. As such, without before data, a minimal BACI design is impaired. In this study, data collection faced two obstacles. (1) Although population surveys were carried out by Perunding Utama (1997) and Tenaga Nasional (1997) on Lekir mangroves prior to the intervention, their studies lacked details in species number and distribution. (2) Although before data in fish landings exist, the control site was limited to a single place inhibiting a "Beyond BACIP" design. Therefore, lacking the before data prevents a BACIP study on the mangroves whereas the study was confined to a BACIP design with one control site for fish landings.

Lack of data showing that an activity is detrimental to the environment does not mean that the activity is benign; it often means there is simply lack of data (Richmond, 1995). Typically, disturbance occurs at an unexpected time and place or only attracts interest when it is endured, for example, when a population change was realized or in this particular case, the before data were insufficient. As such, the before data are unavailable. The unavailability of the before data has deprived this mangrove study of the optimality of before-after studies but according to Green (1979), where no before-impact data can be collected, the impact effects must be demonstrated and described from spatial patterns. If data at the impact site and several control sites are available and collected several times, then this impact versus reference sites (Stewart-Oaten and Bence, 2001) may be the only choice when before data suitable for before-after studies are unavailable, where the effect of the alteration is the difference between the impact value, which is affected by the alteration, and its prediction based on the controls, which are not. The term "reference" refers to those systems that are least impaired by anthropogenic effects (EPA, 2002A).

4.5 Organization of this chapter

In this chapter, the changes in of mangrove and fish abundances are dealt separately in two sections. In the first section, diversity measures are used to describe mangrove ecology. Lack of before data prohibits the use of BACI, but benefits of data collected during this study. The second section describes the BACIP study on fish populations.

4.6 Section 1 : Mangroves study

4.6.1 Background

Mangroves represent a subtropical and tropical coastal ecosystem dominated by halophytic trees, shrubs, and other plants growing in brackish to saline tidal waters of the genera Rhizophora, Brugiera, Sonneratia and Avicennia (Bann, 1999, Mitsch and Gosselink, 2000) and according to Blaber (2000), mangroves generally match the 20^{o}C isotherms in both hemispheres, suggesting that water temperature is the most significant influence. They are among few emergent woody plants that tolerate the salinity of the open sea (Odum, 1993) when their root systems are regularly flooded by saline water (Christensen, 1983).

However, Rodèhn (2002) does not agree that the definition to be taxonomy-specific, rather the species have together the adaptations for being able to live in this extreme environment, such as salt tolerance, adaptations to live in loose wet soil and periodic tidal fluctuations. In Malaysia, Japar (1994) recorded 104 mangrove species of which 38 are categorized as exclusive species, 57 are non-exclusive species and nine-associated biota. The exclusive mangroves (Table 4.1) are species restricted to the mangrove habitat; the non-exclusive may be important in the mangrove habitat but not restricted to it; and the associated biota include, for example, bryophytes and pteridophytes (Saenger *et al.*, 1983). These are the species being directly impacted by the destruction of the mangrove habitats. However, the word mangroves in this study refers to the exclusive mangroves species, unless otherwise stated

Table 4.1: List of exclusive mangrove species in Malaysia

Number	Exclusive Species	Number	
1	*Acanthus ebracteatus* Vahl	20	*B. sexangula* (Lour.) Poir.
2	*A .ilicifolius* L.	21	*Ceriops tagal* (Perr.) C.B. Rob.
3	*Finlaysonia obovata* Wall	22	*C.decandra* (Griff.) Ding Hou.
4	*Avicennia alba* Bl.	23	*Kandelia candel* (L.) Druce
5	*A. marina (*Forsk.) Vierh.	24	*Rhizophora apiculata* Bl.
6	*A.officianalis* L.	25	*R. mucronata* Lam.
7	*A. lanata* Ridl.	26	*R. stylosa* Griff.
8	*Lumnitzera littorea* (Jack) Voigt.	27	*Scyphiphora hydrophyllacea* Gaertn. F.
9	*L. racemosa* Willd.	28	*Sonneratia alba* J.Smith
10	*Excoecaria agallocha* L.	29	*S. caseolaris* (L.) Engler
11	*Cynometra ramiflora* L.	30	*S. griffithi* Kurz
12	*Intisa bijuga* (Colebr.) O. Ktze.	31	*S. ovata* Backer
13	*Xylocarpus granatum* (L.) Koenig	32	*Heritiera globosa* Kostermans
14	*X. moluccensis* (Lam.) Roem.	33	*H. littoris* Dryand. in Aiton
15	*Aegiceras corniculatum* (L.) Blanco	34	*Brownlowia tersa* (L.) Kosterm.
16	*Bruguiera cylindrica* (L.) Bl.	35	*Nypa fruticans* (Thunb.) Wurmb.
17	*B.gymnorrhiza* (L.) Lam.	36	*Phoenix paludosa* Roxb.
18	*B. hainessi* C.G.Rogers	37	*Acrostichum aureum* L.
19	*B. parviflora* W.& A. ex. Griff.	38	*A. speciosum* Willd.

The wood of mangroves is very hard and commercially valuable. Mangroves of the *Heritiera*, *Xylocarpus* and *Rhizophora* species are used to make high quality sawn timber, fuel wood, charcoal and unsawn poles and other usages such as a source of tanning in the tanning industry, exploited for the lignocellulose for the manufacture of chipboard, pulpwood (newspaper and cardboard) or synthetic materials (e.g. rayon) (Ng and Sivasothi, 2001). At Matang forest, where sustainable management is practiced, the value of the mangrove timber per unit area per annum is US $3,300/ha for firewood and US $9,000/ha for charcoal on 30-year rotation (Sasekumar and Lim, 1994).

Mangrove associations are subject to mortality from a number of different natural and human-induced causes. They exist under delicately balanced conditions involving a somewhat predictable steady sedimentation rate, minimal water movement, a certain tidal regime, and water and soil of certain salinity (Nybakken, 1997). Any alteration of these naturally-balanced ecological patterns produces corresponding changes in the mangrove community. Long stretches of coastline in many regions of the world have been impacted by the emplacement of seawalls, jetties, groins, railroads and other artificial structures that have altered natural patterns of sedimentation, erosion and water flow (National Research Council (US), 1995). Although Perunding Utama (1979) alleged that the Lekir coastline south of the Phase I reclaimed land would not be affected by coastal erosion and accretion, observations made in June 2002 and June 2003 suggested otherwise. A substantial amount of heavy accretion was observed to take place causing apparent destruction of some mangroves (Plate 4.1).

Plate 4.1 : Barren area -it used to be a densely populated mangrove area of Kg Permatang.

4.6.2 Mangrove surveys in Peninsular Malaysia

Mangrove surveys of the Peninsular Malaysia were reported as early as 1928 by Watson who described the relationship between distribution of mangroves species and frequency of tidal flooding. In his monograph, he suggested that the restrictions of given mangroves species to certain portions of a swamp are determined by their tolerance to tidal inundation. Much attention had been given by early ecological workers to Matang mangrove reserve located on the west coast of Peninsular Malaysia (see Noakes, 1952; Dixon, 1959; Carter, 1959; Macnae, 1968; Diemont and Von Wijngarrden, 1975). Silvius *et al*. (1986) identified the main vegetation types to be *Rhizophora* sp. (bakau) of which more than 80% of the mangroves are mainly *R. apiculata* (api-api) due to afforestation. Other species were *Avicennia - Sonneratia* (api api - perepat), *Bruguiera cylindrica* (berus) which occurs close to the coast mostly behind the *Avicennia - Sonneratia, B. parviflora* (lenggadai) and *B. gymnorhiza* (tumu) which is the climax mangrove forest type, preceeding the inland forest. Smith (1992) produced a schematic plan of the complex pattern of species zonation typical of an estuarine mangrove area of western Peninsular Malaysia. Christensen (1983) observed that on open accreting shores, *A. marina* and *A. Alba* are pioneers, followed by a belt of *B. cylindrica*.

4.6.3 Historical state of Lekir mangroves

Between 27– 29 December 1996, Tenaga Nasional (1997) carried out floral surveys at five sampling points between Bukit Batu Tiga and Permatang. In the same year, Perunding Utama (1997) conducted similar surveys at Kg. Pasir Panjang Laut, Kg. Tanjung Kepah, Kg. Teluk Pulai and Kg. Pasir Belanda (Figure 4.1) and identified 15 mangroves species. Their brief description and analytical findings on mangroves are summarized below.

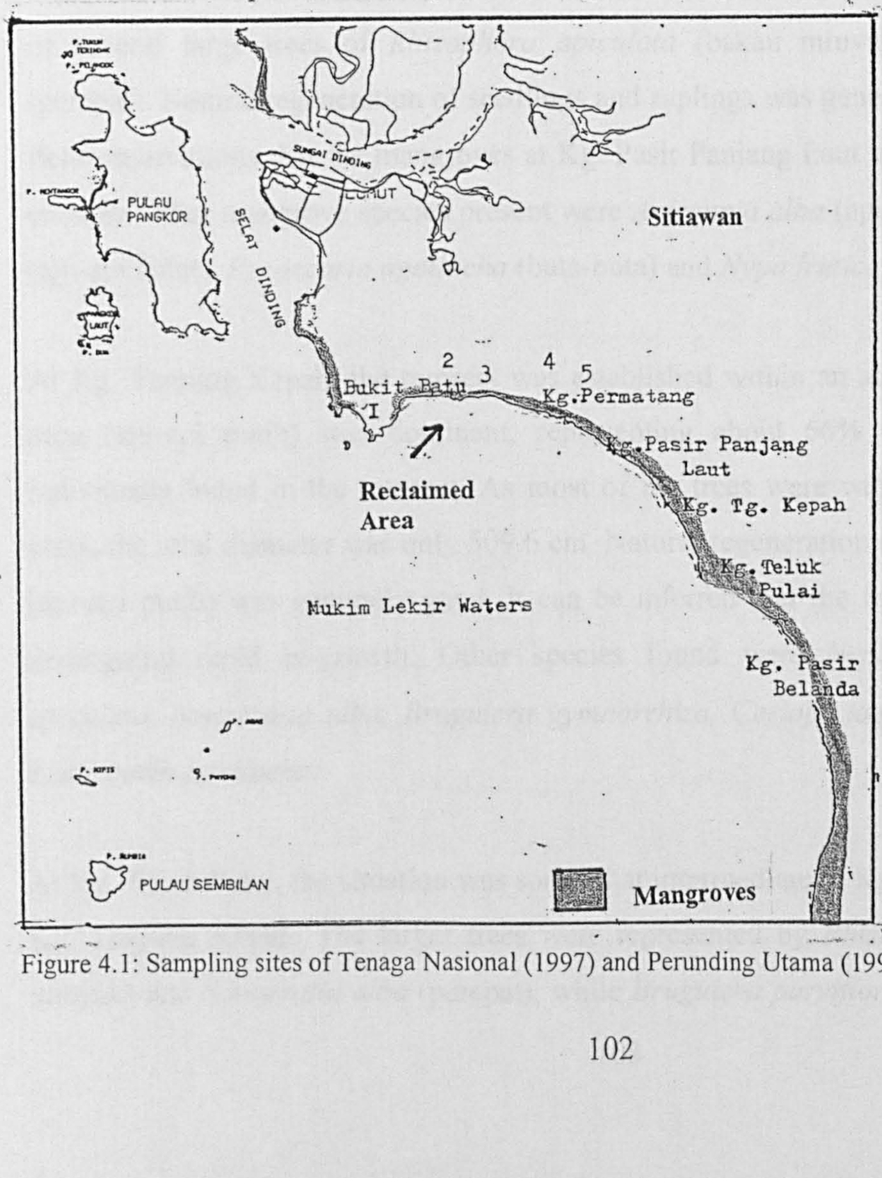


Figure 4.1: Sampling sites of Tenaga Nasional (1997) and Perunding Utama (1997).

Tenaga Nasional (1997)

The mangrove area was deficient in species, and the dominant species were of little economic value. Seven mangroves species were identified in the sampling area. Three species were especially common; *Avicennia alba* (api-api hitam), *A. marina* (api-api jambu) and *Sonneratia alba* (perepat). The commercially valued species of *Rhizophora* were lacking, and only a few of *Rhizophora apiculata* (bakau minyak) trees can be seen in the back-mangrove area. Some other mangrove areas were represented but limited in distribution within the study site. Nipah (*Nypa fructicans*) is common at river mouths and back-mangroves. The species formed pure stands in some areas, but these were mostly disturbed. This mangrove belt was inter-spaced with coconut, oil palm and shrubs. Some mangrove vegetation had been cleared for prawn culture.

Perunding Utama (1997)

At Kg. Pasir Panjang Laut, three species were recorded within the transect. The total diameter at breast height (dbh) was 692 cm and this was mainly attributed to the presence of several large trees of *Rhizophora apiculata* (bakau minyak) and *Sonneratia alba* (perepat). Natural regeneration of seedlings and saplings was generally poor and reaffirmed field observations that the mangroves at Kg. Pasir Panjang Laut were experiencing coastal erosion. Other mangrove species present were *Avicennia alba* (api-api puteh), *A. officinalis* (api-api ludat), *Excoecaria agallocha* (buta-buta) and *Nypa fruticans* (nipah).

At Kg. Tanjung Kepah, the transect was established within an accreting forest. *Avicennia alba* (api-api putih) was dominant, representing about 66% of the total number of individuals found in the transect. As most of the trees were within 5 to 15 cm dbh size class, the total diameter was only 509.6 cm. Natural regeneration of mainly *Avicennia alba* (api-api putih) was generally good. It can be inferred that the forest was still young and undergoing rapid re-growth. Other species found were *Nypa fruticans, Rhizophora apiculata, Sonneratia alba, Bruguiera gymnorrhiza, Ceriops tagal, Derris uliginosa* and *Excoecaria agallocha.*

At Kg. Teluk Pulai, the situation was somewhat intermediate to Kg. Pasir Panjang Laut and Kg. Tanjung Kepah. The larger trees were represented by *Rhizophora apiculata* (bakau minyak) and *Sonneratia alba* (perepat), while *Bruguiera parviflora* (lenggadai) formed the smaller under- storey species. *R. apiculata* and *B. parviflora* were dominant. A total of 73 individuals with a total dbh of 985.8 cm was recorded in the transect. Generally, natural regeneration was poor. Other species found were *Nypa fruticans, Sonneratia alba, Bruguiera gymnorrhiza, Derris uliginosa, Rhizophora mucronata* (bakau kurap), *B. sexangula* (tumu putih), *Avicennia alba, A. marina* and *A. officinalis.*

Similar to Kg Teluk Pulai, at Kg. Pasir Belanda, the larger trees were represented by *Rhizophora apiculata* (bakau minyak) and *Sonneratia alba* (perepat), while *Bruguiera parviflora* (lenggadai) formed the smaller under-storey species. The dominant species were *Avicennia alba, A. officinalis* and *R. apiculata.* The forest was dense in terms of the total number of trees found in the transect. A total of 87 individuals with a total dbh of more than 1,015 cm was recorded. Natural regeneration was fairly good attributed to seedlings and saplings of *Bruguiera parviflora* (lenggadai). Other species found were *Nypa fruticans, Sonneratia alba, Bruguiera gymnorrhiza, B. cylindrical, Derris uliginosa, Rhizophora mucronata* (bakau kurap), and *Sonneratia caseolaris.*

4.6.4 Materials and methods

Study site

The four selected sites or stations surveyed by Perunding Utama (1979) namely Kg. Pasir Panjang Laut, Kg. Tanjung Kepah, Kg. Teluk Pulai and Kg. Pasir Belanda; each between Lat. 4^{o} 9.8^{1} and Lat. 4^{o} 10.8^{1}; Lat. 4^{o} 7.0^{1} and Lat. 4^{o} 7.3^{1}; Lat. 4^{o} 4.38^{1} and Lat. 4^{o} 4.88^{1} ; and Lat. 4^{o} 2.82^{1} and Lat. 4^{o} 3.28^{1} respectively were selected (Figure 4.2). They were chosen for their economic and ecological importance (Mendoza and Alura, 2001). For ease of identification, Station 1 refers to Kg. Pasir Panjang Laut, Station 2 is Kg. Tanjung Kepah, Station 3 is Kg. Teluk Pulai and Station 4 is Kg. Pasir Belanda. Station 1 and Station 2 were the impact sites (also denoted as P1 and P2 respectively) whereas Station 3 and Station 4 were control sites (C1 and C2 respectively). Two criteria were used for the determination of the sites (impact or control sites); one was by virtue of distance from the 'island', and second, was qualitative observation of the researcher. Crawford and Johnson (2003), Santos *et al.* (2002) Lewis *et al.* (2002), Krassula (2001), Rybczyk *et al.* (2002) and Guillemete, *et al.* (1999) advocated location or distance from impact source as a factor for choice of control sites source.

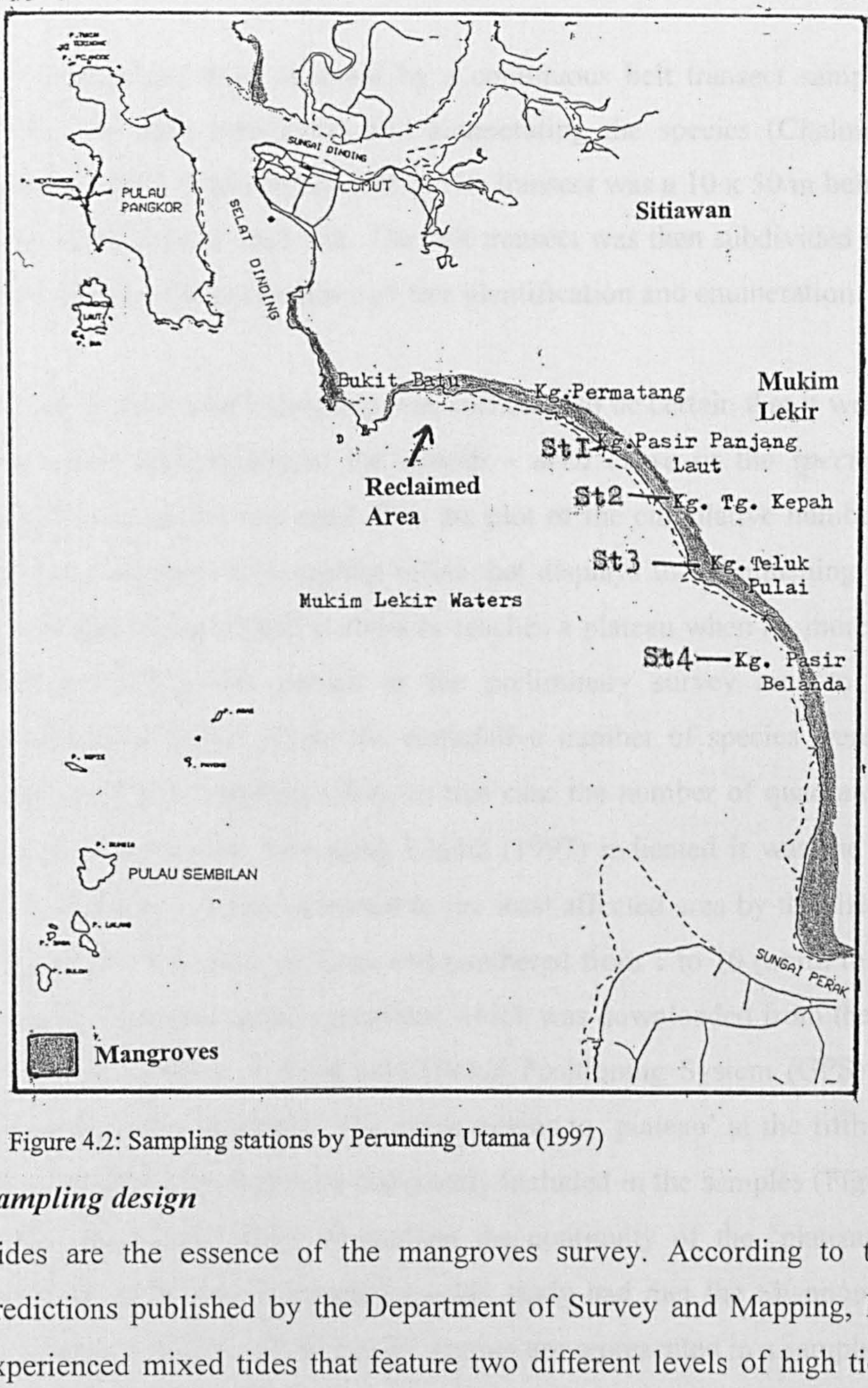


Figure 4.2: Sampling stations by Perunding Utama (1997)

Sampling design

Tides are the essence of the mangroves survey. According to the 2004 Tide Table predictions published by the Department of Survey and Mapping, Malaysia, Lekir coast experienced mixed tides that feature two different levels of high tides and two different levels of low tides. The higher of the two high tides is called *higher high water* (HHW); the other is called *lower high water* (LHW), whereas there is a similar nomenclature for the low tides - *lower low water* (LLW) and *higher low water* (HLW) (Gross,1977). The three sampling dates were chosen because the LLW tides occurred during the daytime, i.e.

between 12.23 a.m. - 1.34 p.m. This gave ample survey time to complete the task before the next cycle of high tides.

The mangroves were assessed by a continuous belt transect sampling techniques (Dale, 1999) and then identifying and enumerating the species (Chalmers and Parker, 1989, Bullock, 1997, Greenwood, 1997). The transect was a 10 x 50 m belt aligned perpendicular to the shore line at each site. The belt transect was then subdivided into a grid of five 10 x 10 m squares for convenience of tree identification and enumeration.

To decide how much sampling was sufficient to be certain that it would include all or most species in each locations, the *species - area curve* or the *species accumulation curve* (Henderson, 2003) was used. It is the plot of the cumulative number of species, collected against a measure of sampling effort that displays the diminishing rate of increase of the accumulation curve until it stops or reaches a plateau when no more new species is found. Station 4 (C2) was chosen as the preliminary survey area to construct the species accumulation curve, where the cumulative number of species were collected against the measure of the sampling effort, in this case the number of quadrates in a belt transect. It was chosen because Perunding Utama (1997) indicated it was the most species richness area. Moreover, it was predicted to the least affected area by the 'island'. The transect was divided into ten equal sections and numbered from 1 to 10 (north to south) and second, by using the random number generator which was downloaded from the internet[1] to select one of the 10 sections. A hand-held Global Positioning System (GPS) was used to assist in determining the positions. The curve begins to 'plateau' at the fifth square indicating that all or most species had been adequately included in the samples (Figure 4.3). An additional sixth square was added to confirm the continuity of the 'plateau'. Thus, the quadrate sampling technique as adopted by this study had met the Shannon-Weiner Index critical assumption (Stiling, 1999) that all species are represented in a sample and that the sample is obtained randomly. Moreover, species richness provides an extremely useful measure of diversity when a complete catalogue of species in the community is obtained (Magurran, 1988). Therefore, this sampling technique was repeated for other survey sites.

[1] At http://www.randomnumbers.info/index.jsp a random sampling can be done by providing desired random numbers against the samples number.

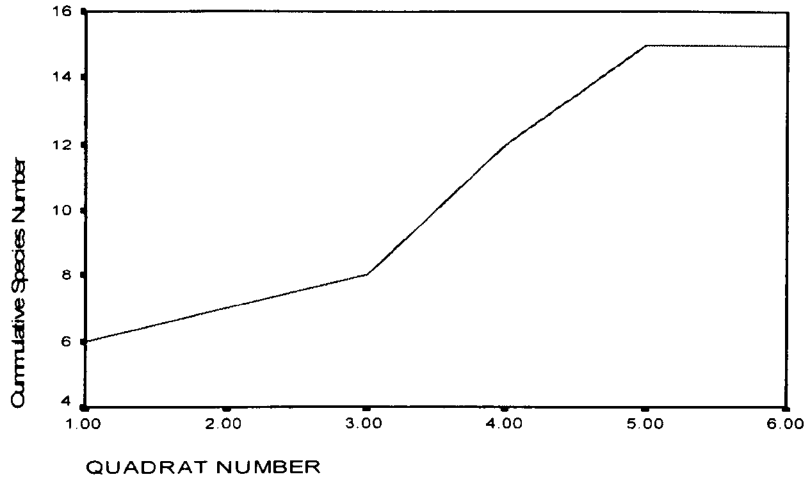


Figure 4.3: Species accumulation curve

Measures of diversity

Describing and explaining patterns of species diversity and understanding the consequences of diversity loss are central themes in ecology (Huston, 1994). Biodiversity or simply referred as diversity in this study, is a function of the number of species present (species richness), the evenness with which the individuals are distributed among these species (species evenness or equitability), and the interaction component of richness and evenness, that is heterogeneity (diversity) (Ludwig and Reynolds, 1988). Both the species richness and equitability of a data set may be summarized with a single number - a diversity index, which can be useful in comparing localities (Henderson, 2003), where low values indicate stressed conditions as a result of the low number of species present and/or dominance by one particular robust species (Clark, 2002).

Diversity measures are widely used for monitoring the impact of environmental pollution and they take into account two factors: species richness, i.e. number of species; and evenness (sometimes known as equitability), i.e. how equally abundant the species are (Magurran, 1988). Whittaker (1972) classified diversity into three categories: the Alpha (α) diversity measuring the diversity of species within a community of habitat; the Beta (β) diversity measuring the rate and extent of change in species along a gradient from one habitat to others; and Gamma (γ) diversity measuring the richness in species of a range of habitats in a geographic area. The β diversity is by far the most widely studied scale of differentiation diversity and indeed the term is often applied to any investigation that looks at the degree to which the species composition of samples, habitats or communities differ (Southwood, 1978). The purpose of comparing between sites in this study is a β diversity approach that measures α diversity along a recognized gradient or at least a linear transect (Henderson, 2003) and extended to the use of similarity measures.

There is no one perfect index (Stiling, 1999). Since this study is interested in making comparison between sites, as proposed by Stiling, the diversity indices chosen must also possess a discrimnant ability, i.e. how capable they are of detecting subtle differences between sites. The simple species richness has excellent discrimnant ability while the Shannon-Weiner, Brillouin, and Berger-Parker indices fare less well (Margurran, 1988). However, on the study of seasonal variations of macroinvertebrates from the Ravellaa stream, Ravera (2001) concluded that the Simpson index has the highest discrimnant ability between stations as well as for the sampling dates. Table 4.2 illustrates a comparison of the performance and characteristics of most important indices as given by Stiling.

Table 4.2: A comparison of the effectiveness of different diversity indices

Index	Discrimnant Ability	Sensitivity to Sample Size	Biased towards Richness (R) or Dominance of a Few Species (D)	Calculation	Widely Used
S(species richness)	Good	High	R	Simple	Yes
Shannon	Moderate	Moderate	R	Intermediate	Yes
Brilloun	Moderate	Moderate	R	Complex	No
Simpson	Moderate	Low	D	Intermediate	Yes
Berger-Parker	Poor	Low	D	Simple	No

Adapted from Stiling (1999).

Since none of the indices displays superior performance and characteristics, the choice of which indices fits this study was based on certain criteria: that indices are widely used, show good discrimnant ability and pose less complex calculation. Thus, S (species richness) indices such as Margalef (1969) and Menhinick (1964), Shannon-Weiner index and Simpson index were used for the analysis of diversity data.

Description of whole communities by one statistic of diversity runs the risk of losing much valuable information (Stiling, 1999). Clark (2002) proposed that data may be analyzed by three methods of univariate analysis, graphical methods and multivariate analysis. In univariate analysis, diversity indices are calculated for each replicate sample, allowing statistical comparison of means between disturbed and control sites. A visual representation of the community is provided by the graphical methods where the proportional abundance (usually on a logscale) is plotted against rank of abundance. One method is to construct *k*-dominance curve by plotting percentage cumulative abundance against species rank *k* on a logarithmic scale (Lambshead *et al.*, 1983). On the other hand, the aim of multivariate analysis is to determine how closely related the sites are in their species composition to detect any divergence from the control community structure. The hierarchical agglomerative clustering or in short cluster analysis was chosen to generate dendograms that show a classification or clustering of samples into groups which are mutually similar and to determine how often an individual of unknown species or sex would be attributed to the correct group respectively (Dytham, 2003). In this study, cluster analysis was used to identify homogenous subgroups of cases in a population by utilizing similarity indices.

(i) Richness indices

Margalef's index (R_1) and Menhinick's index (R_2) are simple measure of species richness and are expressed as;

$$R_1 = \frac{(S-1)}{\ln N} \qquad \text{and} \qquad R_2 = \frac{S}{\sqrt{N}}$$

where S is the number of species and N the number of individuals.

(ii) Diversity indices

The density indices used in this study were the Shannon-Weiner and Simpson indices. Shannon-Weiner's diversity index of function H^l , also referred as the Shannon-Weaver assumes that all species are represented in the sample and are randomly sampled (Stiling, 1999). The function is defined as:

$$H^l = -\sum_{i=1}^{S_{obs}} p_i \log_e p$$

Where, p_i is the proportion of individuals in the ith species; S_{obs} is the actual number of species observed and $\log_e$ is the natural logarithm. Values of H^l for real communities typically fall between 1.5 and 3.5. The Shannon evenness is given by $J = H^l / \ln S$, where S is the number of species and ln is the natural logarithm.

Following Magurran (1988), Simpson's index (D) gives the probability of any two individuals drawn at random from an infinitely large community belonging to different species as:

$$D = \sum p_i^2$$

where p = the proportion of individuals in the ith species. In order to calculate the index, the form appropriate to a finite community is used:

$$D = \sum \left(\frac{n_i(n_i - 1)}{N(N-1)} \right)$$

where n_i = the number of individuals in the ith species and N = the total number of individuals. As D increases, diversity decreases and Simpson's index is therefore usually expressed as 1 - D or 1/D.

(iii) Similarity indices

The use of diversity measures in this study was to describe the α diversity and the β diversity. In the α diversity measure, the aim is to describe changes in species composition, species richness and relative abundance over a period of time whereas in β diversity, the extent of similarity and dissimilarity between communities is quantified employing similarity indices. In the multivariate statistical techniques, cluster analysis uses similarities between samples and groups of samples to build a dendrogram (Clark, 2002). For example, a chosen control site situated further away from the impacted area is expected to display higher species diversity than the one closer to it. As such, both sites cannot be 'similar' in nature.

Particularly widely used similarity indices are the Sorensen index and Jaccard index which are based on presence-absence data. Following Spellerberg (1991);

(Sorensen) $$C = \frac{2w}{A+B} * 100$$

(Jaccard) $$J = \frac{w}{A+B-w} * 100$$

where C or J is the index of similarity, w is the number of species common to both samples (community) and A is the number of species in sample one and B is the number of species in sample two. Both indices are represented by the percentage value where zero percent indicates maximum dissimilarity whereas 100 per cent the maximum similarity between communities. Although the indices are simple to calculate, they do not take into account the abundances of species (Magurran, 1988). A modified Sorensen coefficient by Bray and Curtis (1957) included abundances and has become widely used in plant ecology (Henderson, 2003). The modified coefficient essentially reflects the similarity in individuals between habitats and is given by;

$$C_n = \frac{2jN}{aN + bN}$$

where aN is the total number of individuals in sample A, bN is the total number of individuals in sample B and jN is the sum of the lower of the two abundances recorded for species found in both samples.

In a study by Ravera (2001) on the macroinvertebrate community in Ravella River, he made the assumption that: (a) stable communities have a high diversity value and unstable ones a low diversity; and (b) stability, and thus diversity, is an index of environmental integrity and it decreases with the environmental degradation. This study adopted similar assumptions, although the relationship between diversity and stability remains contentious, as put by Levin and Wilson (1980) that it is largely due to the many and complex definitions of diversity. Since the state of condition of mangroves under study was not known before the impact, the chosen base line year serves as a point of reference for measuring population degradation. A community is seen to be stable if no change can be detected in the population sizes and numbers of species as measured from the base line year or otherwise. This study is not in tandem with, for example, Exxon's view that recovery occurs by the reestablishment of a healthy biological community in which the plants and animals characteristic of that community are present and functioning normally, since it pays little attention to densities and age structures of the population (Stiling, 1999). Unstable mangrove communities produce less primary wood in the form of biomass and litter-fall. In the study of species *Rhizophora apiculata* in the Matang forest, West Malaysia, there was an increased trend of annual net productivity (biomass + litter-fall) from age 5 to 10 years old, but then decreased to plateau between 15 and 25 years old (FAO, 1994). The primary production of mangroves is an important food source for many aquatic resources (Sasekumar and Lai,1983, Thong and Sasekumar, 1984) and decreased production may affect the stability of other aquatic fauna that survive on it. It is then important to uphold the contention that diversity is positively correlated with stability against any definition of stability that denounces the importance of densities and number of species.

Again, due to time, man-power and monetary constraints, this study placed specific attention to only the key species of mangroves, which are the true species or the exclusive species. The choice, as proposed by Clark (2002), was made on the basis that they are those of high conservation interest; most are of commercial value; their presence or absence in certain environments has major repercussions in the community; and their high sensitivity to pollution (or change of environmental parameters) make them indicator species where their presence or absence may provide a warning signal to the existence of the environmental impacts. Thus, only the exclusive species underwent the quantitative measures for the purpose of comparing between sites and between times.

4.6.5 Results

The Lekir mangroves exhibited degradation from heavily degraded in the north to less degraded in the south. The mangrove belt along the coast was estimated to be 24 km in length and between 25 m and 55 m wide. The mangroves in Tg Kepah were separated by sand-muddy beach of about 100 m long. The total mangroves area was estimated to be 97 ha. At the landward side of the mangroves, land vegetations were seen to dominate, but at

Kg. Tg Kepah , Kg. Teluk Pulai and Kg. Pasir Belanda, mangroves and land vegetations were demarcated by a stretch of bund built to prevent erosion.

Plates 4.2, 4.3 and 4.4 show the state of the mangroves at Kg Tanjung Kepah, Kg Pasir Panjang Laut and Kg Permatang, respectively, on 23 February 2004. All three sites exhibited some level of deterioration, compared with Plates 4.5, 4.6 and 4.7 showing apparently undisturbed mangrove areas situated about 20 km south of the 'island'. According to several respondents of the socio-economic survey, they initially observed the death of the mangroves about a year after the commencement of the land reclamation works due to sudden accretion. Plate 4.8 taken on 17 August 2002, shows a water channel about 100 m wide between the reclaimed land and the mainland. This channel was clogged by heavy accretion (Plate 4.9), which shows evidence of perturbation resulting from the 'island'.

Plate 4.2 : Mangroves of Tg Kepah

Plate 4.3: Mangroves of kg Pasir Panjang Laut

Plate 4.4: Mangroves of kg Permatang

Plate 4.5: Undisturbed mangroves I

Plate 4.6: Undisturbed mangroves II

Plate 4.7: Undisturbed mangroves III

Plate 4.8: Unclogged channel between the 'island' and mainland

Plate 4.9: Clogged channel between the 'island' and mainland.

In 2002, 15 exclusive mangrove species were recorded, together with 11 non-exclusive species and eight non-mangrove vegetations, which were mostly present behind the mangrove habitat (Table 4.3). True species richness was lower at station 1 (8 species) and station 2 (12 species) than station 3 (13 species) and station 4 (15 species), but higher in non-true species and non-mangrove species. A total of 1,748 individuals were counted in all sites in 2002. Between 2003 and 2004, species abundance was observed to decline from 1,583 to 1,483 individuals respectively. Individual loss was more prominent in station 1 and station 2, whereas at stations 2 and 3 the changes were negligible. Changes in species richness were also small, i.e. either one or two species had disappeared from each station after the end of the monitoring. At site 1, *S. alba* was the dominant species followed by *R. apiculata* and *R. mucronata*, whereas at site 2 the dominant species was *A. alba* followed by *R. apiculata* and *S. alba*. Resemblance in species dominance is more apparent between site 3 and site 4, where *R. apiculata* and *A. alba* were dominant at both sites. The third dominant species at sites 3 and 4 were *A. offinalis* and *B. parviflora*, respectively. Species richness and dominance described by Perunding Utama (1997) resembled that found in this study, indicating a stable species richness composition of the habitats. Even after three

Table 4.3 : The presence or absence of species in each station as recorded in 2002. Note: P=Present, N=Absent.

SPECIES	Stations			
	1	2	3	4
Exclusive species				
Avicennia alba	P	P	P	P
Avicennia marina	P	N	P	P
Avicennia offinalis	N	P	P	P
Bruguiera cylindrica	N	P	P	P
Bruguiera gymnorrhiza	N	P	P	P
Bruguiera parviflora	N	P	P	P
Bruguiera sexangula	N	N	P	P
Ceriops tagal	N	P	P	P
Derris uliginosa	N	P	P	P
Excoecaria agallocha	P	P	N	P
Nypa fruticans	P	P	P	P
Rhizophora apiculata	P	P	P	P
Rhizophora mucronata	P	P	P	P
Sonneratia alba	P	P	P	P
Sonneratia caseolaris	P	N	N	P
Non-Exclusive Species				
Acrotichum aureum	P	P	P	P
Clerodendron inerma	P	N	N	N
Ficus sp	P	N	N	N
Hibiscus tiliaceus	P	P	P	P
Ipomea pescaprae	P	N	N	N
Pandanus odoratssimus	P	P	N	N
Pluchea indica	P	P	P	P
Pongamia pinnata	P	P	N	N
Scaevola taccada	P	P	N	N
Terminalia cattapa	N	P	P	N
Vitex pinnata	P	P	N	N
Non-mangroves				
Eupatorium odoratum	N	P	N	N
Fagrae fragrans	P	N	N	N
Flagellaria indica	N	N	N	P
Ishaemum camara	N	P	N	N
Lantana camara	P	P	N	N
Morinda citrifolia	P	A	P	P
Phoenix palodosa	N	P	N	N
Ximenia americana	P	N	N	N

years duration, there was no significant change in species richness although stations 1 and 2 had lost two of their species. The slight abundance changes at stations 3 and 4 were expected as both were controls situated further away from the impacted areas.

True species abundance was greater at the seaward area and declined as it approached the landward area, where non-mangrove species dominated. The presence of non-true species was without distinct pattern but seen intermixed with the true species. Table 4.4 is the raw-data matrix showing the individuals and species numbers of the true mangrove species in three consecutive years at each stations. The numbers at station 1 and station 2 decreased markedly in 2004, in contrast to the individuals at station 3 and 4 that increased in number (although slight decrease is seen at station 4 between 2002 and 2003).

Table 4.4: The raw-data matrix of individual and species number at each station.

	Quadrats	Stations							
		1		2		3		4	
		Ind.	Sp.	Ind.	Sp.	Ind.	Sp.	Ind.	Sp.
2002	5	45	3	162	4	211	6	168	6
	4	36	5	90	6	146	5	170	5
	3	30	4	73	6	64	5	69	5
	2	14	4	19	4	112	6	98	8
	1	15	3	19	2	120	6	87	6
	Total	140		363		653		592	
2003	5	33	3	101	4	218	6	152	6
	4	20	5	59	6	146	5	166	5
	3	14	4	66	6	98	5	69	5
	2	10	4	19	4	82	6	94	6
	1	13	3	16	2	120	6	87	6
	Total	90		261		664		568	
2004	5	13	2	49	4	189	6	154	6
	4	7	2	48	5	177	5	176	5
	3	7	2	38	4	98	5	74	5
	2	9	3	9	2	108	6	98	6
	1	10	2	16	2	120	6	83	6
	Total	46		160		692		585	

A declining pattern of the species abundance was also evident (Table 4.4), with abundance apparently becoming less each year for station 1 and 2 site but not the other stations. However, abundance at station 1 (closest to the impacted area) declined more rapidly than station 2 which was situated further away from the impacted area. In term of percentages, station 1 declined more rapid than station 2, contrasting the increased pattern in stations 3 and 4 (Table 4.5). Thus, sites 3 and 4 were less impacted than sites 1 and 2.

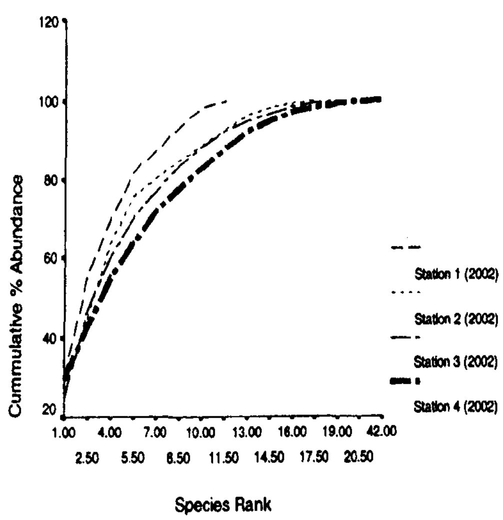
Table 4.5: The rate of abundance changes in percentages.

Year	Site 1	Site 2	Site 3	Site 4
2002	140	363	653	592
2003	90 (-35.71)	261 (-28.10)	664 (+1.68)	568 (-4.05)
2004	46 (-48.89)	160 (-38.70)	692 (+4.22)	585 (+2.99)

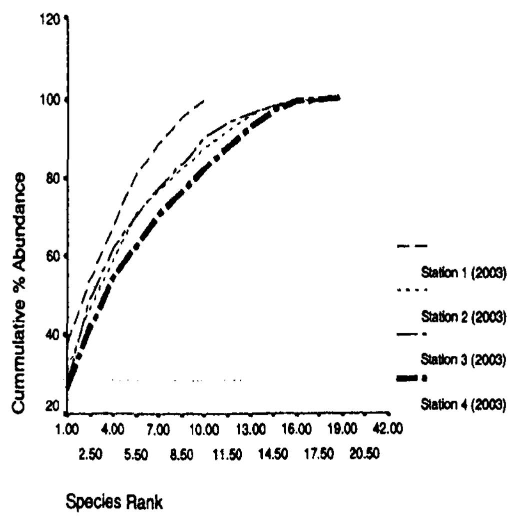
Note : Figures in parenthesis are rate of change in percentages. The (-) sign is the rate of decline where the (+) sign is the rate of increase.

k-dominance graphs (Figure 4.4) give visual representation of community response to spatial and temporal variations, showed the community structure was less diverse at station 1 than other stations. Little difference was found between stations in 2003 (Figure 4.4b), except at station 1 where the diversity decreased further. In 2004, the diversity of station 1 further decreased and station 2 deviated slightly from station 3 indicating a lesser diversity. Station 3 and 4 remain virtually unchanged in their diversities throughout the three years duration. Changes in diversity at each station (Figure 4.5) confirm the marked loss at station 1 and slightly change at station 2.

(a)



(b)



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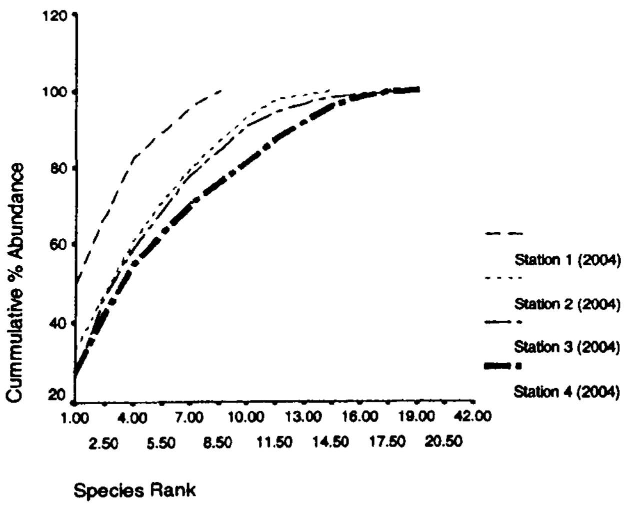
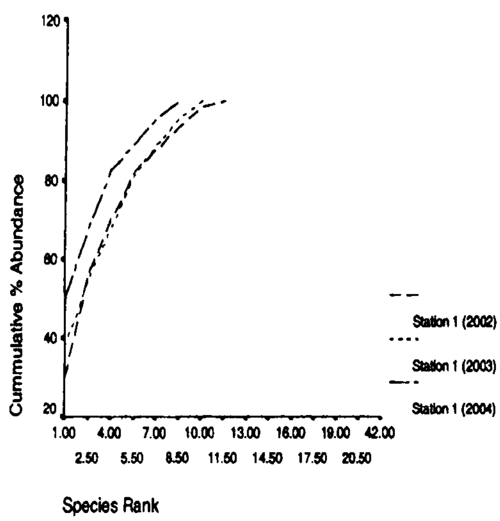
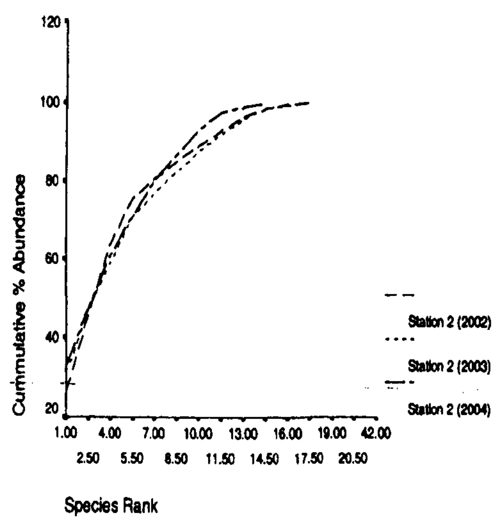


Figure 4.4: Diversity changes between stations and periods. Graph (a) shows diversity changes in 2002, Graph (b) in 2003 and Graph (c) in 2004.

(a)



(b)



(c) (d)

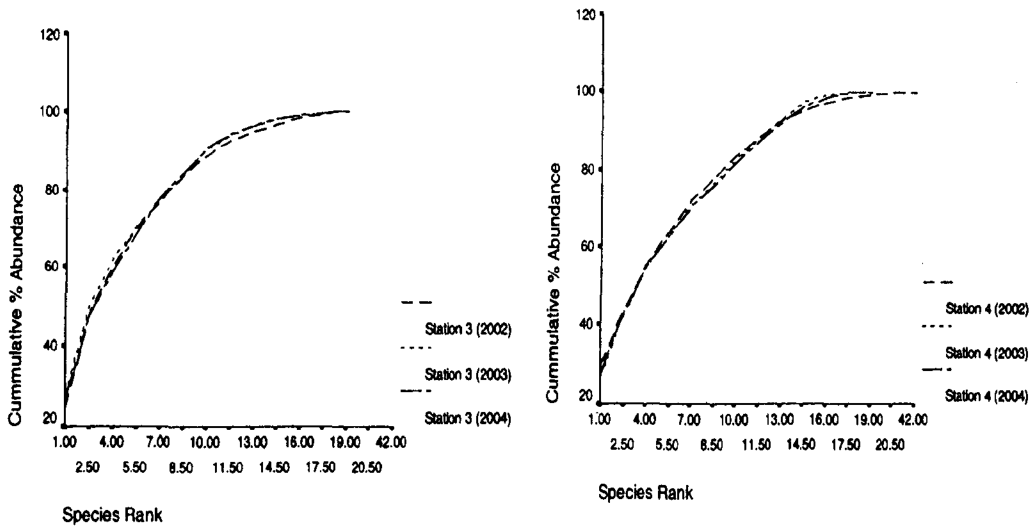


Figure 4.5: Diversity changes in each station from 2002 to 2004. graphs (a), (b), (c) and (d) are stations 1,2,3 and 4 respectively.

The simple species richness measures, the Margalef and Menhinick indices, showed little correspondence (Table 4.6), although both measure the same entity. Generally, they exhibited an opposite direction in magnitude when each station was compared. For example, in 2002, the Margalef index decreased from Station 4 to Station 1 (R_1= 2.193, R_1= 1.851, R_1= 1.867, and R_1=1.417 respectively) as opposed to Menhinick index (R_2= 0.616, R_2= 0.509, R_2= 0.63, and R_2= 0.676 respectively). In 2004, the Margalef indices increased from Station 1 to Station 4 (R_1= 1.306, R_1= 1.773, R_1= 1.835 and R_1= 1.883 respectively) but the reverse was found in Stations 1, 2 and 3 for the Menhinick indices (R_2= 0.885, R_2= 0.791 and R_2= 0.494 respectively). On the other hand, the evenness *J* measures were more consistent with stations closer to the impacted areas become lower than those further away. The *J* values for Stations 1 and 2 decreased over the three-year period (*J*= 0.857 and *J*= 0.821, *J*= 0.884 and *J*= 0.836, *J*= 0.798 and *J*= 0.806 respectively), but increased for Stations 3 and 4. Near the impacted areas, species less susceptible to the disturbance were replaced by more resistant species that later dominated. In 2004, *Sonneratia alba* covered 50% at Station 1 while in Station 2, *Avicennia alba* dominated. (33%). In contrast, both Stations 3 and 4 exhibited ascending *J* values from 2002 to 2004. At an individual level, both Stations 1 and 2 exhibited similar trends in evenness increasing in 2003 but dropping back in 2004. Stations 3 and 4, on the other hand, both increased from 2002 to 2004. The overall view is that, Stations 1 and 2 have lower evenness values than Stations 3 and 4, implying the degraded condition in the former compared with improving condition in the latter.

Table 4.6 : Diversity indices in each year at every station.

SPECIES	Year 2002				Year 2003				Year2004			
	ST-1	ST-2	ST-3	ST-4	ST-1	ST-2	ST-3	ST-4	ST-1	ST-2	ST-3	ST-4
Avicennia alba	17	97	160	78	12	81	146	87		53	142	87
Avicennia marina	8		12	12	4		6	12			12	14
Avicennia offinalis		14	84	25		14	84	25			84	25
Bruguiera cylindrica		14	44	1		11	44	1			44	1
Bruguiera gymnorrhiza		17	24	34		14	24	32		14	24	32
Bruguiera parviflora		2	12	74		2	12	74		2	65	74
Bruguiera sexangula			33	29			3	33			3	33
Ceriops tagal		13	3	3		10	3	3		10	3	8
Derris uliginosa		17	16	16		16	16	27		11	16	27
Excoecaria agallocha	8	7		5	6	7			3	7		
Nypa fruticans	2	42	43	48		30	43	44	2	16	43	44
Rhizophora apiculata	36	69	150	176	12	42	184	151	3	23	184	161
Rhizophora mucronata	20	4	6	32	15	2	43	33	8	2	6	33
Sonneratia alba	42	67	66	51	34	32	56	46	23	22	66	46
Sonneratia caseolaris	7			8	7				7			
individual numbers	140	363	653	592	90	261	664	568	46	160	692	585
species richness	8	12	13	15	7	12	13	13	6	10	13	13
Margalef's index	1.417	1.867	1.851	2.193	1.333	1.977	1.847	1.892	1.306	1.773	1.835	1.883
Menhinick's index	0.676	0.63	0.509	0.616	0.738	0.743	0.504	0.545	0.885	0.791	0.494	0.537
Shannon-Weiner index	1.782	2.041	2.137	2.218	1.721	2.078	2.142	2.202	1.43	1.855	2.231	2.214
Simpson index	5.135	6.179	6.56	6.941	4.768	6.218	6.169	7.313	3.35	5.792	6.481	7.231
Evenness	0.857	0.821	0.833	0.819	0.884	0.836	0.835	0.856	0.798	0.806	0.87	0.863

In terms of diversity measures, the Shannon-Weiner and Simpson indices provided similar ascending values from Station 1 to Station 4 in all years, except in 2003, when Simpson value was slightly higher in Station 2 than in Station 3 (Station 1, H^1= 2.078 and Station 2, H^1= 2.142 whereas at Station 1, D= 6.218 and Station 2, D= 6.169). Thus, Station 1 and 2 closer to the impacted areas are less diverse than Station 3 and 4, which acted as controls. The pattern of diversity measures at each station over the years were not consistent. Station 1 exhibited descending pattern from 2002 to 2004, but the other stations were variable (Table 4.6). Station 2, for example, had a higher diversity value in 2003 than in 2002 (H^1= 2.041 to H^1= 2.078 and D= 6.179 to D= 6.218), but then decreased to a value lower than 2002 in 2004 (H^1= 1.855 and D= 5.792), which is the reverse of Stations 3 and 4. Thus Stations, 1 and 2 are similar in the sense that they both became less diverse in 2004 compared with 2002, whereas Stations 3 and 4 improved in 2004.

Although species richness indices failed to provide a meaningful inference about the differences between spatial and temporal variations between stations, other measures such as evenness and diversity indices effectively dissociated stations into more distinctive grouping. Low evenness and diversity values were observed at stations nearer to impacted areas whereas higher values were found at the less impacted stations.

ANOVA was carried out to examine whether the average values or levels of one variable (the means of the dependent variable) differ significantly across the categories of another variable or variables (the independent variables) (Miller *et al.* 2002). To meet the ANOVA assumption of equal variances among samples, the abundance data and the chosen Shannon-Weiner indices (Table 4.7) were tested for normality.

Table 4.7:Contingency table depicting number of individuals in each station. The numbers in parenthesis are the Shannon-Weiner indices.

YEAR	STATIONS			
	1	2	3	4
2002	45(1.0) 36(1.49) 30(1.30) 14(1.15) 15(1.06)	162(1.16) 90(1.70) 73(1.72) 19(1.30) 19(0.34)	211(1.34) 146(1.48) 64(1.0) 112(1.54) 120(1.28)	168(1.38) 170(1.51) 69(1.46) 98(1.71) 87(1.16)
2003	33(0.80) 20(1.54) 14(1.30) 10(0.95) 13(0.98)	101(1.08) 59(1.69) 66(1.73) 19(1.30) 16(0.38)	218(1.47) 146(1.47) 98(0.76) 82(1.40) 120(1.30)	152(1.35) 166(1.50) 69(1.27) 94(1.43) 87(1.18)
2004	13(0.54) 7(0.60) 7(0.68) 9(1.06) 10(0.61)	49(0.99) 48(1.56) 38(1.34) 9(0.53) 16(0.38)	189(1.39) 177(1.93) 89(0.76) 108(1.49) 120(1.28)	154(1.37) 176(1.48) 74(1.36) 98(1.48) 83(1.18)

Following Wheater and Cook (2003), abundance data were found to be non-normal thus log-transformed (Natural Log) to normalize the data. Using the one-sample Kolmogorov-Smirnov test (Dytham, 2003), the transformed data provided $P>0.05$, indicating the data were not significantly different from a normal distribution. Shannon-Weiner indices were also tested and found to be normally distributed thus did not require any transformation.

Using one-way ANOVA, significant difference were found in abundance among the stations over the three years ($F_{3,16}$= 6.918, $P<0.05$ in 2002, $F_{3,16}$= 15.305,$P<0.05$ in 2003 and $F_{3,16}$= 37.236,$P<0.05$ in 2004) but not in diversity ($F_{3,16}$= 0.529,$P>0.05$ in 2002, $F_{3,16}$= 0.380,$P>0.05$ in 2003) except in 2004 when diversity differences were noted ($F_{3,16}$= 4.458,

$P<0.05$). The post hoc comparison of abundances for 2002 revealed that Station 1 was significant different from Station 3 ($P=0.02$) and Station 4 ($P=0.01$), but not with Station 2 ($P=0.85$). However, Station 2, Station 3 and Station 4 did not differ significantly from each other indicating the occurrence of Station 2 in both groupings. In 2003, significant differences were found between the Station 1 and the other stations and similarly for Station 2, but St3 and St4 were similar ($P= 0.658$). Similar pairing structures were found in 2004 as in 2003. The differences between stations are summarized by lines linking the means that are not significantly different in Figure 4.6.

Abundance	Yr1	St1	St2	St3	St4
	Yr2	St1	St2	St3	St4
	Yr3	St1	St2	St3	St4
Diversity	Yr3	St1	St2	St3	St4

Figure 4.6: One-Way ANOVA: The lines linking the stations that are not significant.

Those stations close to the impacted areas (Station 1 and Station 2) differed significantly from those that situated further away (St3 and St4), particularly relative to abundance. In diversity, changes were noticeable only in the third year where St1 differed significantly from St3 and St4, whereas St2 was between the two groups.

A two-way ANOVA test was carried out to determine the spatial and temporal influences on the well-being of mangroves. (Table 4.8 for abundance and Table 4.9 for diversity, where the sign 'X' signifies the interaction between the independent variables). There was no significant temporal influence on abundance (F=2.791, $P=0.71$) and diversity (F=1.841, $P=0.170$) but spatial influence was significant (abundance: F=48.312, $P=0.000$, diversity: F=3.836, $P=0.015$), and there was no interactive effect of the two independent variables on either the former or the latter. However, the ANOVA provided different results when the independent variables Yr 1 Vs Yr 3 and stations were tested on the abundance. It showed that there were significant differences between the abundances in Yr 1 and Yr 3 (F=5.434, $P=0.026$), and between stations (F=33.044, $P=0.00$) but there was no interactive effect.

Table 4.8: Two-way ANOVA on abundance

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Years	1.673	2	.837	2.791	.71
Stations	43.434	3	14.478	48.312	.000
Years X Stations	2.362	6	.394	1.313	.269
Yr1 vs Yr2	.277	1	.277	.812	.374
Stations	21.037	3	7.012	20.597	.000
Yr1 vs Yr2 X Stations	.392	3	.131	3.84	.354
Yr2 vs Yr3	.578	1	.578	2.276	.141
Stations	36.828	3	12.276	48.313	.000
Yr2 vs Yr3 X Stations	.856	3	.285	1.123	.354
Yr1 vs Yr3	1.655	1	1.655	5.434	.026
Stations	30.184	3	10.061	33.044	.000
Yr1 vs Yr3 X Stations	2.294	3	.765	2.511	.076

Table 4.9: Two-way ANOVA on diversity

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Years	.438	2	.219	1.841	.170
Stations	13.69	3	.465	3.836	.015
Years X Stations	.592	6	.099	.829	.553
Yr1 vs Yr2	.038	1	.038	.323	.574
Stations	.303	3	.101	.865	.470
Yr1 vs Yr2 X Stations	.012	3	.004	.035	.991
Yr2 vs Yr3	.203	1	.203	1.640	.209
Stations	1.344	3	.448	3.619	.023
Yr2 vs Yr3 X Stations	.444	3	.148	1.196	.327
Yr1 vs Yr3	.416	1	.416	3.581	.068
Stations	1388	3	.463	3.980	.016
Yr1 vs Yr3 X Stations	.432	3	.144	1.238	.312

Consequently, locations and periods have independent effects on the community structure. The interaction can be explained by the interaction line plot (Figure 4.7) that shows the significant effects of location between Yr1 and. Yr3: stations 3 and 4 supporting the highest number of individuals (about the same means) followed by station 2 and then station 1 being the lowest. The periods Yr 1 and Yr 2 has a similar effect on all four stations, decreasing the number of individuals by about the same proportion for each station, with the exception of station 3, which slightly increased (the fact that the lines are nearly parallel). Thus it demonstrates that the effect of periods does not depend on the location of the stations, but is consistent for each station. On the other hand, significant interaction is present when the lines on a two-way plot are not parallel (Wheater and Cook). Post Hoc comparison tests further illustrate the differences between stations and periods. For all stations in all years and other multiple combinations, the lines linking means suggests that there are three groups of stations formed (Figure 4.8). St1 was significantly different from

S2,St3 and St4. Similarly St2 was significantly different from St1, St3 and St4. However, St3 and St4 were not significantly different from each other, thus grouped together.

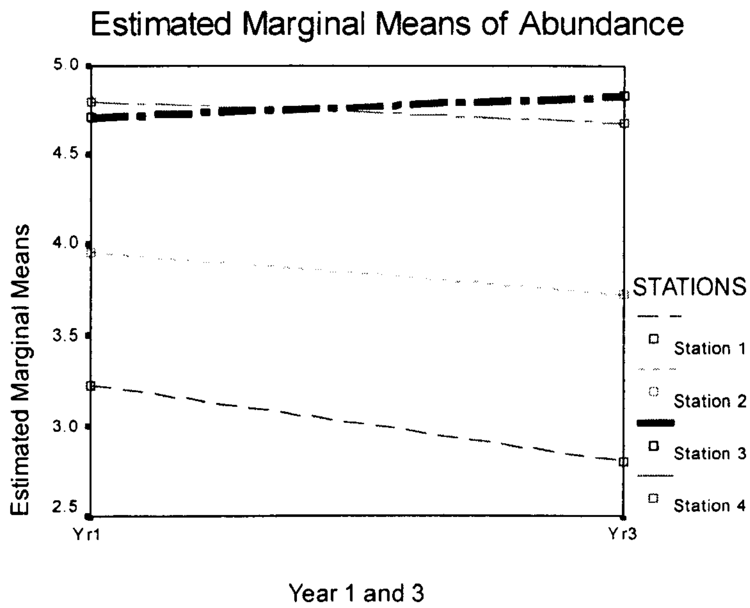


Figure 4.7: Interaction line plot of abundance

Abundance	All Years	St1	St2	St3	St4
	Yr1 vs. Yr2	St1	St2	St3	St4
	Yr2 vs. Yr3	St1	St2	St3	St4
	Yr1 vs. Yr3	St1	St2	St3	St4

Figure 4.8: The lines linking means of abundance
Note: Each line links stations that are not significantly different in means.

On diversity, the lines linking means not significant different are constructed after the post hoc comparison tests (Figure 4.9). In all years, pairs that were not significant different were St1 and St2 (P= 0.263), St2 and St3 (P= 0.162), St2 and St4 (P= 0.061), and St3 and St4 (P= 0.621). St2 is linked with St1 and both the St3 and St4. Although the linked stations between Yr2 and Yr3, and Yr1 and Yr3 are the same, there is tendency for the latter to change the linkage pattern to St1 St2 St3 St4 since the different between St2 and St4 was small (P= 0.053).

Diversity	All Years	St1 St2 St3 St4
	Yr1 vs. Yr2	not significant
	Yr2 vs. Yr3	St1 St2 St3 St4
	Yr1 vs. Yr3	St1 St2 St3 St4

Figure 4.9: The lines linking means of diversity
Note: Each line links stations that are not significantly different in means.

The output of three similarity indices, Jaccard, Sorrensen and a modified Sorensen for each sample in each station were compared (Table 4.10). To illustrate visually how each station is related in term of similarity or their levels of affinities, cluster analysis was carried out (Figure 4.10-[a], [b] and [c]). Both Jaccard and Sorensen indices produced similar dendogram patterns: in Yr1, St2, St3 and St4 clustered while St1 was separated. In Yr2 and Yr3, St3 and St4 were linked unchangely followed by St2 linking St3 and St4 while St1 remained discrete. In Yr3, the affinity between St2 and both St3 and St4 became weak. A different dendrogram pattern was observed when the modified Sorensen index was used. Although its dendrogram patterns were similar to Jaccard and Sorensen for Yr2 and Yr3, the latter exhibited a different pattern. Instead, St1 and St2 were clustered together denoting greater similarity, while St3 formed another much weaker affinity cluster with St1 and St2. St4 was dissimilar from the other stations.

Table 4.10: Similarity coefficients of Jaccard, Sorensen and Modified Sorensen.

Jaccard												
Periods	Yr1				Yr2				Yr3			
Stations	St1	St2	St3	St4	St1	St2	St3	St4	St1	St2	St3	St4
St1	1	0.38	0.36	0.53	1	0.36	0.33	0.33	1	0.45	0.27	0.27
St2	0.38	1	0.79	0.8	0.36	1	0.79	0.79	0.45	1	0.6	0.64
St3	0.36	0.79	1	0.87	0.33	0.79	1	1	0.27	0.6	1	1
St4	0.53	0.8	0.87	1	0.33	0.79	1	1	0.27	0.64	1	1
Sorensen												
Periods	Yr1				Yr2				Yr3			
Stations	St1	St2	St3	St4	St1	St2	St3	St4	St1	St2	St3	St4
St1	1	0.56	0.53	0.7	1	0.53	0.5	0.5	1	0.63	0.42	0.42
St2	0.56	1	0.88	0.89	0.53	1	0.88	0.88	0.63	1	0.75	0.78
St3	0.53	0.88	1	0.93	0.5	0.88	1	1	0.42	0.75	1	1
St4	0.7	0.89	0.93	1	0.5	0.88	1	1	0.42	0.78	1	1
Sorensen (Quantitative)												
Periods	Yr1				Yr2				Yr3			
Stations	St1	St2	St3	St4	St1	St2	St3	St4	St1	St2	St3	St4
St1	1	0.56	0.35	0.38	1	0.51	0.24	0.27	1	0.45	0.12	0.15
St2	0.56	1	0.71	0.76	0.51	1	0.56	0.63	0.45	1	0.38	0.43
St3	0.35	0.71	1	0.95	0.24	0.56	1	0.92	0.12	0.38	1	9.21
St4	0.38	0.76	0.95	1	0.27	0.63	0.92	1	0.15	0.43	9.21	1

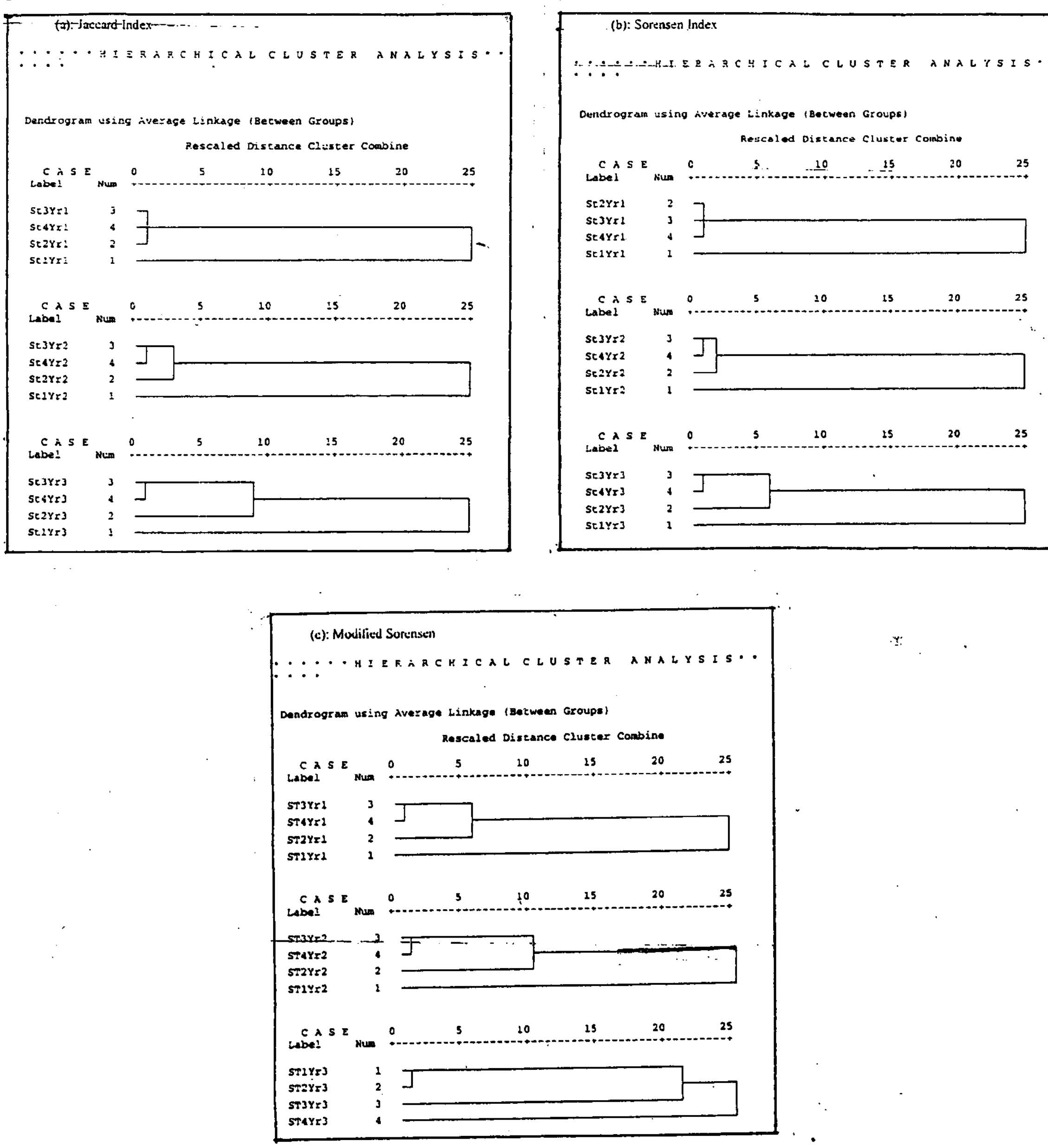


Figure 4.10: Dendograms of the Cluster Analysis using (a) Jaccard, (b) Sorensen and (c) Modified Sorensen similarity indices.

4.6.6 Discussion

Gradual changes in the plant communities of the mangroves after the development of the island, albeit slowly. The main changes were loss of species, which were greater at stations 1 and 2, close to the development area. At the stations further away from the development, little change was evident, suggesting the degradation was due to the island development.

However, this may suffice for a *prima facie* case. Adair and Groves (1998) suggest supplementary data or analyses should be included to either support or reject the original hypothesis and prevent arguments such as demanded by Professor Reisman[2], "Can we have some more data?". In this respect, ecologists appraise ecological communities in term of diversity (Magurran, 1988; Stiling, 1999; Hogarth, 1999; Clark, 2002 and Henderson, 2003), and it has become a standard feature of modern tropical forest inventories (Rennolls, 1997; Vanclay, 1998; and Rennolls and Laumonier, 1999). UNEP (2000) proposed diversity indices as one of the three principal approaches (the others being saprobic indices, and biotic indices and score) to biological assessment that utilize taxonomic and pollution tolerance data. Thus, several diversity measures were used to promote robust evidence of the impact. For instance, the unsupported use of graphs and tables is usually inappropriate and the investigator is required to use the data to decide whether the evidence for the hypothesis is strong enough for some action to be taken (Stewart-Oaten, Murdoch and Parker, 1986). Cantera, Thomassin and Arnaud (1999) in their study of faunal zonation and assemblages in the Pacific Colombian mangroves combined several diversity indices to point out more accurate and comprehensive results. The three categories of species diversity measures described in sequence were species abundance model (*k*- dominance), species richness indices and indices based on the proportional abundance of species, the Shannon-Weiner and Simpson indices. ANOVA was then used to test the spatial and temporal variations between stations and periods on two criteria; the abundance and a chosen Shannon-Weiner indices. Finally, a cluster analysis projecting a dendrogram was carried out to display how different or similar the stations were in each period using the similarity indices of Jaccard, Sorensen and modified Sorensen. A classification dendrogram grouped stations into assemblages based on their inherent similarities.

The use of *k*-dominance graphical representation successfully illuminated how each station reacted over periods and differed from each other. Changes in diversity were found from Yr1 to Yr3, with St1, the nearest to the impact site having the least diverse community compared with other stations, especially in St4, which was the furthest away. Individual *k*-dominance graphs of each station also indicated that diversity degradation was greatest at St1, slightly degraded in St2 and virtually unchanged in St3 and St4. In general, R_1 values

[2] Professor Michael Reisman acting on behalf of Singapore in a case concerning land reclamation by Singapore in and around the Straits of Johor, 25-27 September 2003 (Look also in Chapter 1).

illustrated that as stations moved away from the impacted area, they exhibited higher diversity. Similar results were found for the Shannon evenness index (*J*), with higher diversity at stations further away from the impacted area. For Shannon-Weiner index (H^1) and Simpson index (D) although in Yr2 there was evidence that diversity had improved (at St2) or become less (St3 and St4), the community's stability then changed in Yr3, with a clear demarcation between St1 and St2, and between St3 and St4, with the former displaying decreased diversity and the latter an increased diversity.

Evidence for impacts on the mangroves was best demonstrated by the emergence of species dominancy. *Sonneratia alba,* which was initially dominant (30%) at St1 in Yr1, increasingly dominated in Yr2 (38%) and Yr3 (50%). At St1, *Nypa fruticans* was not found in Yr2 but reappeared in Yr3, whereas two species *Avicennia alba* and *A.marina,* were lost. Other species that were lost in Yr3 were *Avicennia offinalis* and *Bruguiera cylindrical* at St2 and *Sonneratia caseolaris* and *Excoecaria agallocha* at St4. Dominance was inversely related to evenness; and that high dominance is accompanied by low evenness, because species of low tolerance to impacts at St1 were being replaced by much fitter species that later tended to dominate the area. Thus, it was established that although St4 lost two species in Yr3, no dominancy was observed suggesting it is a low impacted area. However, St2, which was the next nearest station to the impacted area displayed prominent species dominancy, with *Avicennia alba* becoming dominant (33%) in Yr3.

The preceding data analysis incorporating several diversity measures, graphical representations and similarity indices established five indicators of impact. (1) In the base line year (Yr1), stations were different from each other and that their population diversities differed with an increasing value from St1 to St4. The choices of impacted stations (St1 and St2) and control stations (St3 and St4) were thus validated. (2) Yr2 was presumed to be a transition period between Yr1 and Yr3 where changes in diversity measures were non-significant. (3) In Yr3, station assemblages near the impacted area were affected more (less diverse) than those situated further away (more diverse). The change in diversities were prominent at impacted stations, in contrast to control stations where they were almost unscathed. (4) Mangrove population degradation was a slow process that a three year monitoring effort was statistically insufficient to discriminate fully. (5) At the impacted stations, there was no sign of population recovery, as opposed to the unaffected stations.

4.7 Section 2 : Fish landings - before and after study

4.7.1 Introduction

A fishery is an activity leading to harvesting of fish, and it may involve capture of wild fish or raising of fish through aquaculture (FAO, 1980). Fletcher *et al.* (2002) however specified it as a unit determined by an authority or other entity that is engaged in raising and/or harvesting fish, and the unit is defined in terms of some or all of the following: people involved, species or type of fish, area of water or seabed, method of fishing, class of boats and purpose of the activities. In Malaysia, the Fisheries Act 1985 interprets fisheries as one or more stocks of fish, which can be treated as a unit for the purposes of their conservation, management and development, and includes fishing for any such stocks, and aquaculture. For the purpose of this study, fish landings are the amount of wild fish captured by an act of fishing using various types of gears and all catches are assumed to be landed (no discarding). Fish means any aquatic animal or plant life, sedentary or not, and includes all species of finfish, crustacean, mollusca, aquatic mammal, or their eggs or spawn, fry, fingerling, spat or young, but does not include any species of otters, turtles or their eggs (Fisheries Act 1985).

Malaysia supports multi-species fisheries. A bottom trawl-survey conducted by the DOF Malaysia between 15 September to 9 October 1997 in the west coast of Peninsular Malaysia recorded a total of 225 species representing 81 families, of which 46 species were considered trash fish (Department of Fisheries Malaysia, 2000). The 1996 survey done by Perunding Utama (1997) in waters closer to the shore of Mukim Lekir, recorded 77 species while the survey done by this study recorded only 30 species in 2002 and 43 species in 2003. The higher number of species caught by the 1997 survey was due to wider coverage of survey areas. The 1997 survey however, caught less fast-swimming pelagic species, contributing only 11.2% of the total catch rate in contrast to the 2002 and 2003 surveys. The dominant demersal fish groups were Synodontidae (*Saurida undosquamis, S. tumbil, S. longimanus)* Loliginidae (*Loligo duvaucelli, L. chinensis, L. singhalensis),* Priacanthidae (*Priacanthus tayenus, P. macracanthus)*, Nemipteridae (*Nemipterus japonicus, N. delagoae, N. bleekeri),* Mullidae (*Upenus sulphureus, U. bensasi),* Sciaenidae (*Pennahia macrophthalmus, Johnieops sina)* and Trichiuridae (*Trichiurus lepturus*), while the dominant pelagic species were Carangids and *Sphyraena* spp. Other species present in Malaysian waters are listed in Pong *et al.* (1994).

While trawlers are considered to less selective in terms of species and size harvested, other fishing gears are species-specific, especially anchovy purse-seiners. By studying the data on the species caught by gears presented in the Annual Fisheries Statistics of Perak 1992 – 2001, it can be inferred that major commercially important fish groups caught by purse-seiners are Carangidae (*Alepes* sp., *Atule mate, Decapterus* sp., *Megalaspis cordyla, Selar crumenophthalmus, Selaroides leptolepis)* and Scombridae (*Auxis thazard, Euthynnus affinis, Thunnus tonggol, Rastrelliger* sp.), other seines are Penaeidae (*Parapenaeopsis* sp., *P. sculptilis)* and Mugilidae (*Liza* sp., *Valamugil* sp.), drift/gill nets are Scombridae (*Rastrelliger* sp.), Ariidae (*Arius* sp.), Clupeidae (*Ilisha elongata),* Sciaenidae (*Johnieops sina, Nibea soldadu, Otholithes rubber, Pennahia macrophthalmus)* and prawns, portable traps are Plotosidae (*Plotus canius),* Siganidae (*Siganus canaliculatus),* Serranidae (*Epinephelus* sp.), Carangidae (*Alectis indicus, Atropus atropus, Carangoides malabaricus, Caranx sexfasciatus),* hook and lines are Dasyatidae (*Dasyatis zugei, Gymnura poecilura),* Ariidae (*Arius* sp.), Plotosidae (*Plotus canius),* Lutjanidae (*Lutjanus johni)* and Pomadasyidae (*Pomadasys hasta),* bag nets are prawns, jelly fish, Penaeidae (*Parapenaeopsis hungerfordi, P. tenella,P. coromandelica, P. hardwickii, P. uncta, P. maxillipedo)* and Loliginidae (*Loligo duvaucelli, L. chinensis, L. singhalensis),* barrier nets are Bothidae (*Pseudorhombus malayanus),* Plotosidae (*Plotus canius),* crabs, Latidae (*Lates calcarifer)* and Sillaginidae (*Sillago sihama),* push/scoop nets are prawns, Penaeidae (*Parapenaeopsis sculptilis, Penaeus indicus, P. merguiensis)* and crabs, and special traps for catching mangrove crabs and finally shellfish collecting.

4.7.2 Materials and methods

Data manipulation

Most fisheries data were obtained (unprocessed) from statistical documents prepared by fisheries assistants of the FDOM. The specific format used to record monthly fish landings was in the official form number: 'SMPP 1/8_Pin.1/96'. In addition to fish landing data, other data collected were number of vessels sampled (vessels in operation), fishing trips per month, fishing trips per day, nets casting per trip, average duration of per nets casting per trip and fishing days per month. Apart from these raw data, some were obtained from: (1) the Annual Fisheries Statistics published by the Department of Fisheries Malaysia, which are publicly circulated and sold at RM 10.00 each; and (2) the Annual Fisheries Statistics published by the Department of Fisheries, State of Perak which are not publicly circulated. Permission to use uncirculated data and the raw data kept at the office of Department of Fisheires of Perak in Ipoh was granted by the Director of Fisheries through a letter of consent to pursue research dated 9 August 2002 with reference number: Prk. Pk. 006/2 (116).

The collection of data and sampling methods followed the guidelines presented by Tuoo (1999). In the guidelines, the population is defined as all fishing vessels and the total fishing trips that made. All fishing vessels in Malaysia are stratified according to their fishing bases in each district in the respective States (Figure 4.11). In each district, vessels are further stratified into the types of gear used, and the number of samples withdrawn from each type of gear is given by Figure 4.12. Trawlers and purse-seiners are then stratified in accordance to their engine capacities (in terms of horse-power, hp). Since many aspects of environmental degradation can only be detected and accurately assessed when there are sufficient data to reveal long-term trends as opposed short term fluctuations, the use of time-series data is particularly relevant to identify both impacts and changes in cyclic data together with broad correlative relationship (Thrush, *et al.1* 1994). This study used time-series data consisting of monthly fish landings and number of vessels in operation over several years. Data were for two years before the impact and two years after the impact which was considered sufficient to demonstrate changes of fish abundance (Crawford and Johnson, 2003, Benedetti-Cecchi 2001). Table 4.11 gives the raw-data matrix showing the time-series data of fish landings and number of vessels in operation taken from two places; South Manjung (Impacted site) and North Manjung (Control site) between 1996 and 1999. As the two sites differed in fishing effort (different number of vessels and fishers), fish catch standardization was made by calculating the Catch-per-unit-effort (CPUE=catch[landings]/number of vessels) in each month. Accordingly, the change in fish abundance before and after the impact was made by using the CPUE values (Table 4.11).

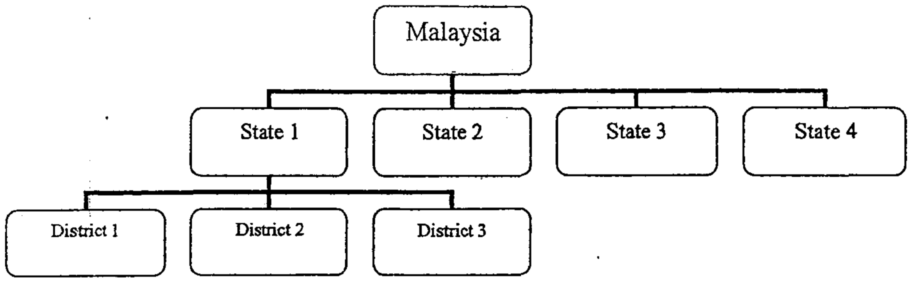


Figure 4.11: Stratification of districts in each State.

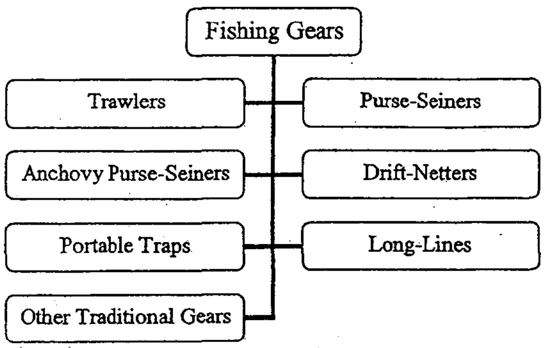


Figure 4.12: Stratification of gears in each district.

Table 4.11: Time-series data of fish landings

Periods	North Manjung(NM)	South Manjung(SM)	Number of vessel in NM	Number of vessels in SM	CPUE of NM	CPUE of SM	Log(CPUE) NM	Log(CPUE) SM
Jan.1996	389.84	446.05	400	515	0.9746	0.866117	-0.0257281	-0.1437358
February	438.12	603.69	400	515	1.0953	1.172214	0.0910283	0.1588939
Mac	669.69	888.83	400	515	1.674225	1.725883	0.51535037	0.5457391
April	428.69	635.62	400	515	1.071725	1.234214	0.0692695	0.210434
May	600.99	648	400	515	1.502475	1.258252	0.40711375	0.2297238
June	616.8	814.56	400	515	1.542	1.58167	0.43308028	0.4584812
July	618.69	928.44	400	515	1.546725	1.802796	0.43613979	0.5893389
August	466.2	649.87	400	515	1.1655	1.261883	0.15315018	0.2326054
September	560.7	733.48	400	515	1.40175	1.424233	0.33772146	0.3536334
October	499.38	662.48	400	515	1.24845	1.286369	0.22190278	0.2518235
November	608.59	776.31	400	515	1.521475	1.507398	0.41968026	0.410385
December	490.39	675.26	400	515	1.225975	1.311184	0.20373645	0.2709309
Jan.1997	370.98	535.62	421	455	0.881188	1.177187	-0.1264847	0.1631275
February	306.89	398.35	421	455	0.728955	0.875495	-0.3161435	-0.1329664
Mac	678.93	791.88	421	455	1.61266	1.740396	0.4778852	0.5541124
April	853.51	1012.44	421	455	2.02734	2.225143	0.70672442	0.7998211
May	639.59	610.72	421	455	1.519216	1.342242	0.41819451	0.2943412
June	836.14	934.71	421	455	1.986081	2.054308	0.68616323	0.7199389
July	676.8	618.21	421	455	1.607601	1.358703	0.47474297	0.3065308
August	576.53	523.48	421	455	1.36943	1.150505	0.31439454	0.1402014
September	377.89	356.14	421	455	0.897601	0.782725	-0.1080297	-0.2449735
October	393.42	392.23	421	455	0.934489	0.862044	-0.0677551	-0.148449
November	502.51	457.67	421	455	1.19361	1.005868	0.17698271	0.005851
December	545.27	477.61	421	455	1.295178	1.049692	0.25864825	0.0484971
Jan.1998	411.23	364.46	315	515	1.305492	0.707689	0.26658003	-0.3457501
February	438.12	404.14	315	515	1.390857	0.784738	0.32992021	-0.2424055
Mac	599.34	394.33	315	515	1.902667	0.765689	0.64325641	-0.2669788
April	599.56	326.45	315	515	1.903365	0.633883	0.64362341	-0.4558901
May	624.12	461.95	315	515	1.981333	0.89699	0.68377002	-0.1087102
June	643.23	586.27	315	515	2.042	1.138388	0.71392972	0.1296135
July	645.34	547.17	315	515	2.048698	1.062466	0.71720467	0.0605926
August	544.12	576.71	315	515	1.727365	1.119825	0.54659717	0.1131726
September	500.44	536.15	315	515	1.588698	1.041068	0.46291507	0.0402471
October	588.78	518.2	315	515	1.869143	1.006214	0.62547996	0.0061944
November	677.12	421.2	315	515	2.149587	0.817864	0.76527587	-0.2010591
December	500.34	344.14	315	515	1.588381	0.668233	0.46271523	-0.4031183
Jan.1999	456.66	451.79	326	529	1.400798	0.854045	0.33704175	-0.157771
February	455.99	380.98	326	529	1.398742	0.720189	0.3355735	-0.3282416
Mac	667.11	417.62	326	529	2.04635	0.789452	0.71605757	-0.2364165
April	588.88	371.87	326	529	1.80638	0.702968	0.59132505	-0.3524441
May	629.56	305.25	326	529	1.931166	0.577032	0.65812378	-0.5498573
June	633.21	399.87	326	529	1.942362	0.755898	0.66390474	-0.2798489
July	607.22	393.04	326	529	1.862638	0.742987	0.62199378	-0.297077
August	577.9	329.31	326	529	1.772699	0.622514	0.57250346	-0.4739889
September	564.43	307.97	326	529	1.73138	0.582174	0.54891899	-0.5409861
October	667.81	321.31	326	529	2.048497	0.607391	0.71710632	-0.498582
November	587.31	316.67	326	529	1.801564	0.59862	0.58865541	-0.5131282
December	608.91	400.25	326	529	1.867822	0.756616	0.62477309	-0.2788991

The Beyond BACIP study requires the use of more than a single control site. This study did not apply Underwood's Beyond BACIP, instead resorted to the BACIP design for two practical reasons: (1) another control site was impossible to generate since the next possible candidate lacked the required time-series data before and after the impact; (2) although Underwood (1992, 1994) asserted that the use of a single control site arose "for reasons that are completely illogical," and that multiple controls are needed to "solve problems caused by the lack of spatial replication," it has been refuted by Stewart-Oaten and Bence (2001) because in their opinion, variation among "control" sites is irrelevant to the assessment problem, because the goal concerns a change at a particular non random place. Smith (2002) added that since the measurement in Beyond BACIP must be made at additional control sites, this draws resources away from the impact site and as a result, the test for an impact has lower power as well.

The BACIP design requires that the observed difference between the impact and control sites during the before period be compared with the one after period. The difference obtained in each date constitute time-series data that permit comparison between before and after impact using the appropriate *t*-test. However, three assumptions have to be satisfied; the additivity, independence and normality. The CPUE data between the control and impact sites at each date before impact were tested with the Tukey test for non-additivity and found to be additive ($F= 1.20$, $P>0.05$). For the independence requirement, the most likely violation is positive serial correlation: observations (differences) close in time may tend to be close in value (Stewart-Oaten *et al.* 1992). Serial correlation in the data must not exist because, the disturbance effect, u_i (also known as error term, e_i) is influenced by the disturbance term relating to other observations (Gujarati, 1995). The Durbin-Watson test, which is the widely used test of autocorrelation (Green, 1990) or serial correlation (both terms treated synonymously by Gujarati, 1995) was applied to the data ($d=1.59$) and no positive serial correlation was found.

The difference in CPUE was tested for normality by equality of variances method (Wheater and Cook, 2003) and followed by a one-sample Kolmogorov-Smirnov test.(F_{max} = 5.23, df= 11, k= 4). The one-sample Kolmogorov-Smirnov tests, confirmed that all data in each year were normally distributed (P>0.05).Therefore data transformation was unnecessary and parametric t-tests could be used.

The Study sites

The impact site is defined by an area of approximately 50 nm^2 enclosed within boundaries of $Lat.4^0 10.5' N$ at the northern end, N $Lat.4^0 0.0' N$ at the southern end, and $Long.100^0 35.0' E$ at the west edge (Figure 4.13) in which an impact source is located, whereas, the control site of approximately 46 nm^2 is enclosed by boundaries of

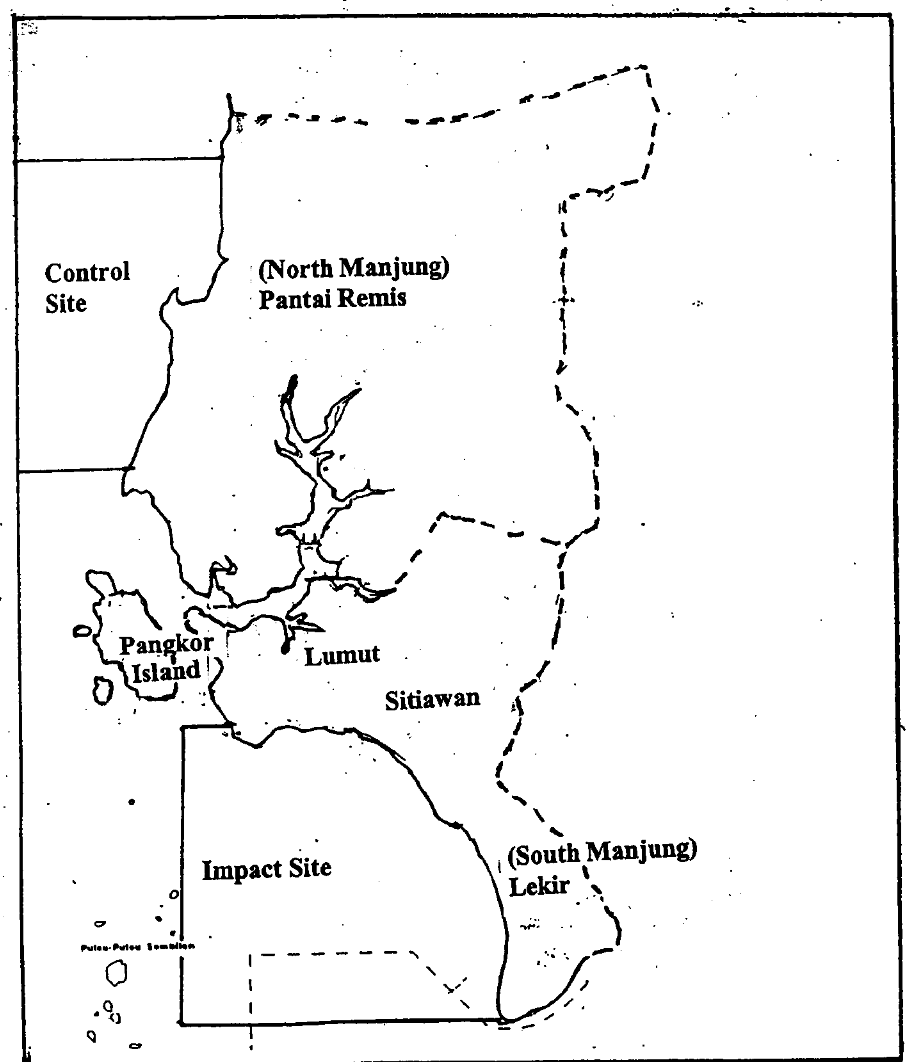


Figure 4.13: The location of control and impact sites

$Lat.4^0 27.5' N$ at the northern end, $Lat.4^0 18.9' N$ at the southern end and $Long.100^0 29.0' E$ at the west edge. The distant of the control site to the impact source is about 14 nm (25.9 km) (taking a middle point at the control site). For ease of identification, C1 is the control site in 1996 (thus C2 in 1997, C3 in 1998, C4 in 1999) and I1 is the impact site in 1996) (thus, I2 in 1997, I3 in 1998 and I4 in 1999).

Statistical test for the control site selection

Table 4.12 illustrates some physical characteristics between the impact and control sites before the impact. Beside both having identical climate, the CPUE between control and impact sites were similar; average CPUE of C1= 1.33 t/vessel (sd= 0.23) compared with I1= 1.40 t/vessel (sd= 0.26), and C2 = 1.34 t/vessel (sd= 0.43) compared with I2= 1.04 t/vessel (sd= 0.38). Moreover, mangrove communities observed at both sites differed markedly such that, some degradation was seen at the impact site whereas at the control site, the mangroves were undisturbed. Thus, it is justified to assume that the control and impact sites were similar before the intervention. Complete resemblance is not an issue since, according to NOAA (2004), an important and useful feature of the BACIP design is that treatment (Impact) and control population do not need to be ecologically "the same", they simply need to track changes in their shared environment (example, in weather and climate) in the same way. NOAA added that pairs of populations are selected that seem similar in major respects, but they do not need to be identical in all respects; they just need to respond similarly to much of the temporal environmental variation, especially to variation with effects lasting more than one year. To further strengthen the choice of the control site, a preliminary statistical test of independent-samples *t*-test was carried out on CPUE to detect any differences in means between sites and at each period before the impact. According to Santos *et al.* (2002), if the samplings carried out at the impacted zone and at the control zones before the impact are not different, it allows for the BACI study to continue since any differences between before and after impact would not be caused by natural differences inherent in spatial and temporal variation of the ecosystem. One of the requisites for the BACI method is the similarity between control zones and the impacted zones in term of spatial and temporal variation before the occurrence of the impact (Schwarz, 1999).

Before the impact, both the control and impact sites were similar (paired *t*-test: t= -0.041, df= 23, P>0.05), endorsing the selection of the control site as suitable.

Table 4.12: Characteristics comparison between control and impact sites before impact.

Sites	Number of Traditional Vessels	Number of Fishers	Size of Area Nm^2	Average Catch(Landings)/ Average Catch per unit Effort (CPUE)	Climate	Mangroves Diversity
Control	1996-400 1997-421	800 842	46	1996-532.34 tonnes(1.33) 1997-563.21 tonnes(1.34)	*	Unknown But observed undisturbed
Impact	1996-515 1997-455	1,030 910	50	1996-705.22 tonnes(1.40) 1997-592.42 tonnes(1.04)	*	Largely Unknown

Notes: Data are recorded two years before impact (1996 and 1997). Number in parenthesis is the CPUE.
(*) Both sites experiences a warm, humid, typical equatorial climate with little seasonal variations. The heaviest rainfall period occur in May and September, both during inter-monsoon periods. However, relative humidity and temperature vary within a stable range. The North-East monsoon occurs between October-November whereas South-West monsoon Occurs between March-April (Malaysian Meteorological Service Department, Sitiawan).

4.7.3 *Results*

The CPUEs at the control and impact areas were significantly different before and after the impact (D_{before}=-0.0014; D_{after}= 1.0065; t-test= -18.6, df= 23, P<0.0001). These sites were similar for the 24 months before the impact (Figure 4.14) but diverged thereafter with a moderate increase at the control site and a moderate decrease at the impact site.

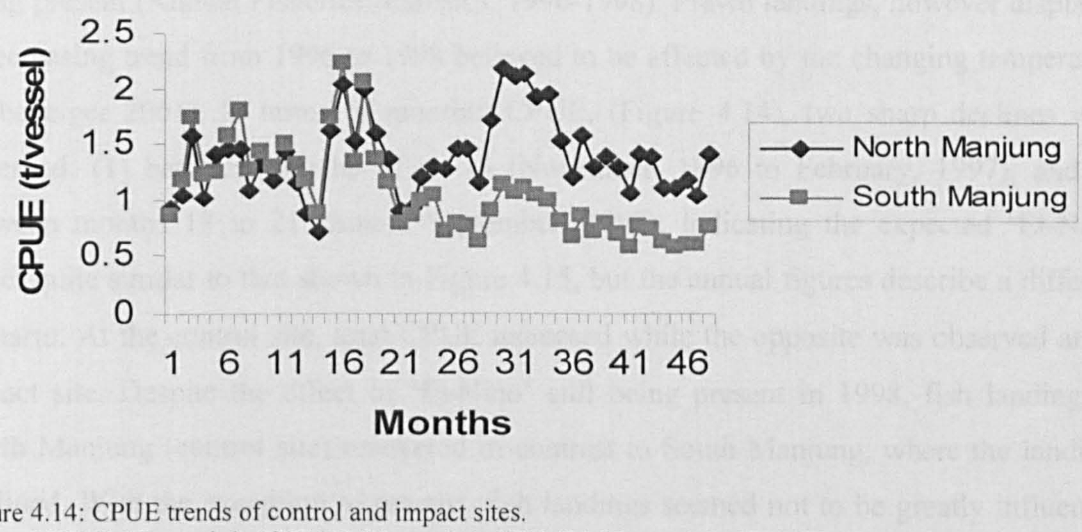


Figure 4.14: CPUE trends of control and impact sites.
Notes: 1996 (1-12 months), 1997 (13-24 months), 1998 (24-36 months), 1999 (37-48 months)

4.7.4 *Discussion*

An 'El-Nino' event, occurred in Malaysia between 1997 (Anon., 1997) and ended in 1998. It coincided with the start of the reclamation works and the abrupt fish decline the following year. This raises the question of whether 'El-Nino' was the culprit, thus, 'El-Nino' deserves discussion.

The main feature of the El-Nino was the occurrence of abnormally dry conditions over Malaysia and below average rain fall (MMS,2004). Many authors have discussed the harmful effect of El-Nino on fish (Anon.,1983; Jordan, 1985; Fiedler, *et al.* 1986; Hammann, *et al.* 1995; Yoklavich, *et al.* 1996) although Canon (1992) concluded that the 1992 El-Nino event didn't affect the pelagic species of northern Chile, and the low tuna catch seems not to be affected by this phenomena as well. However, the 1997 El-Nino had little effect on Malaysian fisheries as evident in the monthly landing data for west coast, Peninsular Malaysia published by the Department of Fisheries. The monthly time-series trend of fish landings (Figure 4.15) exhibited two sharp declines in 1997; (1) from months 13 to 14 (January - February, 1997), and (2) from months 19 to 21 (July - September, 1997) signifying an 'El-Nino' effect but not damaging since after each decline, it was followed by an increase in landings compensating the previous loss, thus resulting in minimal total loss. For example, fish landings (excluding prawns) were slightly reduced from 519,495 t in 1996 to 515,429 t in 1997, but then increased to 551,182 t in 1998 despite 'El-Nino' still being present (Annual Fisheries Statistics, 1996-1998). Prawn landings, however displayed a decreasing trend from 1996 to 1998 believed to be affected by the changing temperature (Lobegeiger 2001). In terms of monthly CPUE, (Figure 4.14), two sharp declines were observed: (1) between months 11 to 14 (November, 1996 to February, 1997); and (2) between months 18 to 21 (June - September, 1997), indicating the expected 'El-Nino' effect quite similar to that shown in Figure 4.15, but the annual figures describe a different scenario. At the control site, total CPUE increased while the opposite was observed at the impact site. Despite the effect of 'El-Nino' still being present in 1998, fish landings at North Manjung (control site) recovered in contrast to South Manjung, where the landings declined. With the exception of prawns, fish landings seemed not to be greatly influenced by the 'El-Nino', especially in 1998, where despite its presence, fish landings improved at both the local and regional scale. Thus the decline in fish landings at the impact site after impact were probably not be caused by 'El-Nino.'

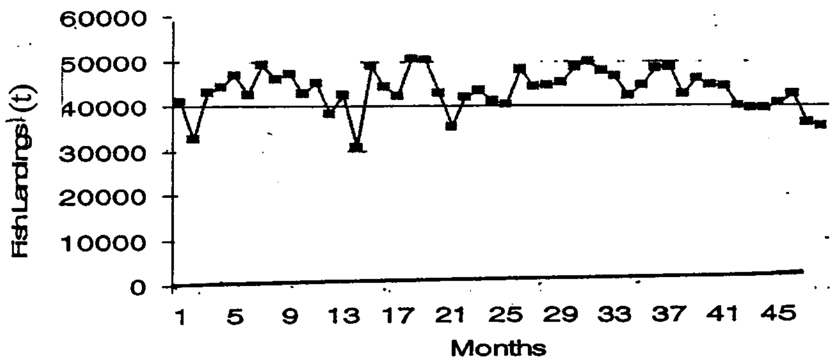


Figure 4.15: Fish Landings Trend in the West Coast of Peninsular Malaysia Between 1996 - 1999.
Notes: 1996 (1-12 months), 1997 (13-24 months), 1998 (24-36 months), 1999 (37-48 months)

Over-fishing is another factor that needs to be discussed. Could it be the main factor affecting fish landings in South Manjung rather than the presence of the project? The BACIP study employing North Manjung as control site and South Manjung as impact site showed that the change after the intervention was caused by the project since it was absent at the control site. However, beginning 2000, there was a substantial increase of fishing boats in South Manjung as well as in North Manjung giving raise to the question that the effect of over-fishing was dominant (Figure 4.16). The abrupt increase in fishing effort (number of boats and fishers) was also noticed in the State of Perak fisheries statistics (Annual Fisheries Statistics of Perak 2000 – 2003) indicating that the phenomena was widespread. According to the Fisheries Director of Perak and Head of FDOM (pers. comm.), economic recession as experienced by Malaysia had caused many jobless persons to resort to fishing.

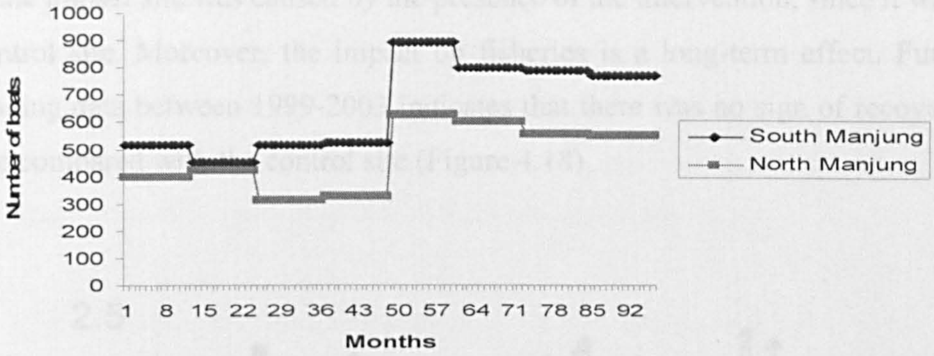


Figure 4.16: Number of fishing boats in South Manjung and North Manjung (1996-2003).
Notes: 1996 (1-12 months), 1997 (13-24 months), 1998 (24-36 months), 1999 (37-48 months), 2002 (49-60), 2001 (61-72), 2002 (73-84), 2003 (85-96).

The two years landings data (1996-1997) before the intervention reveals that higher number of boats in South Manjung compared to North Manjung resulted in higher amount of fish landed. However, after the intervention, the landings in South Manjung started to decline and seemed not to recover (Figure 4.17). This implies that, without intervention, higher number of boats (thus higher effort), may resulted in higher fish landings and the CPUE. The intervention had caused fish depletion and the increase in fishing effort further reduced the CPUE since fishers were competing for limited fish stocks.

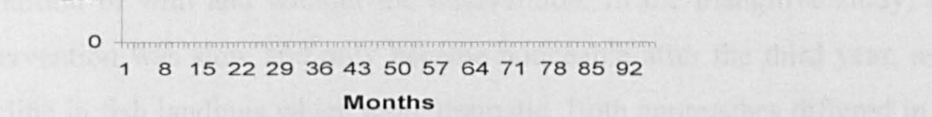


Figure 4.17: Fish landings of South Manjung and North Manjung (1996-2003).
Notes: 1996 (1-12 months), 1997 (13-24 months), 1998 (24-36 months), 1999 (37-48 months), 2002 (49-60), 2001 (61-72), 2002 (73-84), 2003 (85-96).

The reclamation project, later followed by the operation of the coal-fired power plant, no doubt caused a major impact on the fisheries resources. Unperturbed areas, such at the control site were not affected in contrast to the impacted area. The difference in fish landing trends at two sites (control and impact sites) after the month 24 showed two things: (1) El-Nino did not cause a significant effect on local fisheries; and (2) the decline in fish landings at the impact site was caused by the presence of the intervention, since it was absence at the control site. Moreover, the impact on fisheries is a long-term effect. Further analysis of landing data between 1999-2003 indicates that there was no sign of recovery at the impact site compared with the control site (Figure 4.18).

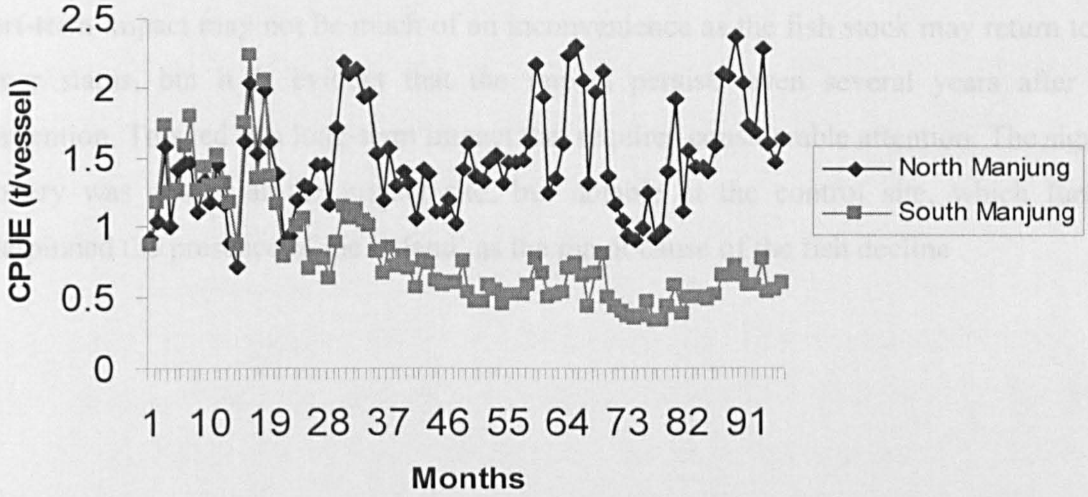


Figure 4.18: CPUE trends of control and impact sites.
Notes: 1996 (1-12 months), 1997 (13-24 months), 1998 (24-36 months), 1999 (37-48 months), 2002 (49-60), 2001 (61-72), 2002 (73-84), 2003 (85-96).

4.8 Conclusion

Two approaches were used to detect the source of intervention. Generally, both approaches were based on the premise that sites nearer to the source are affected most or comparing the condition of with and without the intervention. In the mangrove study, the effect of the intervention was slow and only became noticeable after the third year, as opposed to the decline in fish landings which more dramatic. Both approaches differed in results since the former was carried out without the before data, while in the latter, the before data were present and used. Nonetheless, both results suggest the problem is related to the 'island'.

Since fisheries production is dependant on mangroves, its degradation, although a slow process may impose a substantial impact on fish landings but due to lack of before data, it was difficult to show any correlation with the loss of diversity and fish stock losses. The after intervention data were unable to correlate with fish loss; for example, between 2002 and 2003, 80,025 mangrove individuals were estimated to be lost from Lekir but fish landings increased from 4,081 t to 5,636 t. The unavailability of 2004 fish landings data was also an obstacle to make any meaningful inference from the mangrove losses. Nonetheless, with the evidence that mangroves population continued to deteriorate, it is envisaged that fish stock may also affected in the future.

Short-term impact may not be much of an inconvenience as the fish stock may return to its former status, but it is evident that the impact persists even several years after the intervention. This led to a long-term impact that requires considerable attention. The sign of recovery was absent at the impact site, but notable at the control site, which further underpinned the presence of the 'island' as the major cause of the fish decline

CHAPTER 5: THE VALUATION OF MANGROVES:

Contingent Valuation Method (CVM)

5.1 Introduction

In Chapter 4, it was shown that the mangroves diversity had been altered by the presence of the 'island'. Stations nearer to the impact site were damaged more than ones situated further away. According to Choo (1996) and WWFM (2002), mangroves are important feeding and nursery grounds for many species of prawns and fish fry. Prawns are so dependent on mangroves that the size of its population (or annual catch statistics as a substitute for a population estimate) is determined by the area of contributing mangroves. A 20 % loss of mangroves could cause about 70,000 t of prawn loss valued at RM 300 millions (MOSTE, 2000). Ong (1995) and Rodehn (2002) also emphasized, that penaeid shrimps are one of the most important resource for coastal fisheries and they are often associated with mangroves. In State of Perak, although prawn landings are only 11.46% of the 2001 fish landings, their monetary value is about RM 191 millions or 35% of the total fish value (Info Perikanan Perak, 2001). The monetary loss in this sense could be substantial if mangroves are damaged.

If fisheries are considered, it appears that only fishers suffer from mangroves depletion. However, this is not always true as mangroves have other uses including timber, tourism and educational studies (Sasekumar and Lim, 1994) and it may serve as bird sanctuaries, wildlife protection, protection from strong storms, and land erosion. Mangroves provide many services and commodities to society (Mitsch and Gosselink, 2000). Some of these services and commodities are consumed directly and sold in the markets, such as fish, shellfish and timber, whereas others have no market value e.g. in recreational fishing, panoramic views, clean air and bird watching .

However, with the exception of fisheries and timbers, many mangroves uses are not tradable in markets and thus have not been represented by monetary value, but they have economic value. If someone is made better off by being able to enjoy for example fresh air at the beach, it has an economic value that will be reduced if the beach is degraded. In

1947, Ciriacy-Wantrup[1] wrote about the valuation of benefits of preventing soil erosion and proposed that one way of obtaining information on the demand for public goods would be to ask individuals directly how much they would be willing to pay (WTP) for it (Portney, 1994). If that person is asked his WTP for a certain amount of fee so that a cleaning program is underway, then the value he puts is the monetary value of the benefit he derived from the use of the beach.

In any proposed development, if mangroves are affected, they should be valued in monetary terms to inform the policy makers about the magnitude of the losses incurred. When mangroves are valued in that sense, their losses can be fully understood and judgment whether to approve the project will be better determined. It also has the purpose of aiding the impacted persons, project owners and court of laws in any legal disputes. Thus, in this study, the objective is to establish a monetary value for Lekir mangroves by asking people their WTP for a hypothetical project that will benefit those mangroves. A research method known as the Contingent Valuation method (CVM) is utilized to achieve the purpose.

5.2 Economic values

The environment holds different kind of economic value, depending on one's preference and taste. Constanza *et al.* (1997) refers this as valuation of ecosystem services that include ecosystem goods (such as food) and services (such as waste assimilation) and that their values may not be easily traceable through well functioning markets, or may not show up in markets at all. Several environmental economists have attempted to classify these values (Winpenny, 1991; Callan and Thomas, 2000 and Field, 1994) but in general they begin by distinguishing "use-value" from "non-use value" (Bateman and Turner, 1993). Use values are values related to some form of activity or expenditure (or money or time) (Adamowicz, 1995). It can be further differentiated into direct use, indirect use or option use value. Direct use values are relatively straightforward to measure, and usually involve the market value of production gains. Since environmental functions are rarely exchanged in markets,

[1] According to Portney (1994), the first published reference to the contingent valuation method apparently occurred in 1947, when Ciriacy-Wantrup wrote about the benefits of preventing soil erosion but he never put it into practice. It was not until 1963 when Bob Davis used the method to estimate the benefits of outdoor recreation opportunities in the Maine backwoods (Field, 1994).

measurement of indirect use values typically entail more complex techniques such as the change in productivity approach, travel cost method, and hedonic pricing method. Option value is the amount the person would be WTP to preserve the option of being able to experience a particular environment amenity in the future (Field, 1994). Non-use values can only be defined from surveys of people's preference about their WTP, for example the Contingent Valuation Method (Bann, 2002). On the other hand, "non-use" or "passive use values" are values that are not associated with any economic behavior (Adamowicz, 1995) and composed of bequest value and existence value. Bequest value is not a use value for the current individual valuer, but a potential future use value or non-use value for future generation while existence value is the value that people are WTP to some specific environmental amenities or scenic resources to keep them from being extinct or damaged (Turner *et al*, 1994). Direct use value, indirect use value and non-use (existence) value are summed up to represent the Total Economic Value (TEV) of the resource;

Total Economic Value (TEV) = Use Values (UV) + Non-Use Values (NUV),

where UV = Direct UV + Indirect UV + Option Values; NUV = Bequest Values + Existence Values.

The economic values of non-marketed goods, such as clean air, tranquility, recreational fishing areas, coral reef, beautiful scenery, are always inviting controversy since they are gauged by non-scientific approaches. While many researchers are supporters about the outcome of such exploration there are many other who are critics. Yet, alternatives to such valuation techniques are not forthcoming, leaving those interested for the answer to resort to the methodologies that are open to debate. Thus, these economic values are left for the people in authority to judge if they are worth considering or rejecting by reason of invalidity and unreliability. However, this study is optimistic that the method employed is gaining popularity and the acceptance by the authority is encouraging, for example, the State Government of Johor had collaborated with Danish Cooperation for Environment and Development (DANCED) in valuing the Benut mangroves (Bann, 1999).

5.3 Valuation approach

Turner *et al.* (1994) defined approaches to monetary evaluation into two groups, namely; the "demand curve approaches" (methods that value a commodity by means of a demand curve) and, "non-demand curve approaches" (methods not based on demand curve). CVM (Figure 5.1) is an expressed preference method that utilizes the demand curve approach.

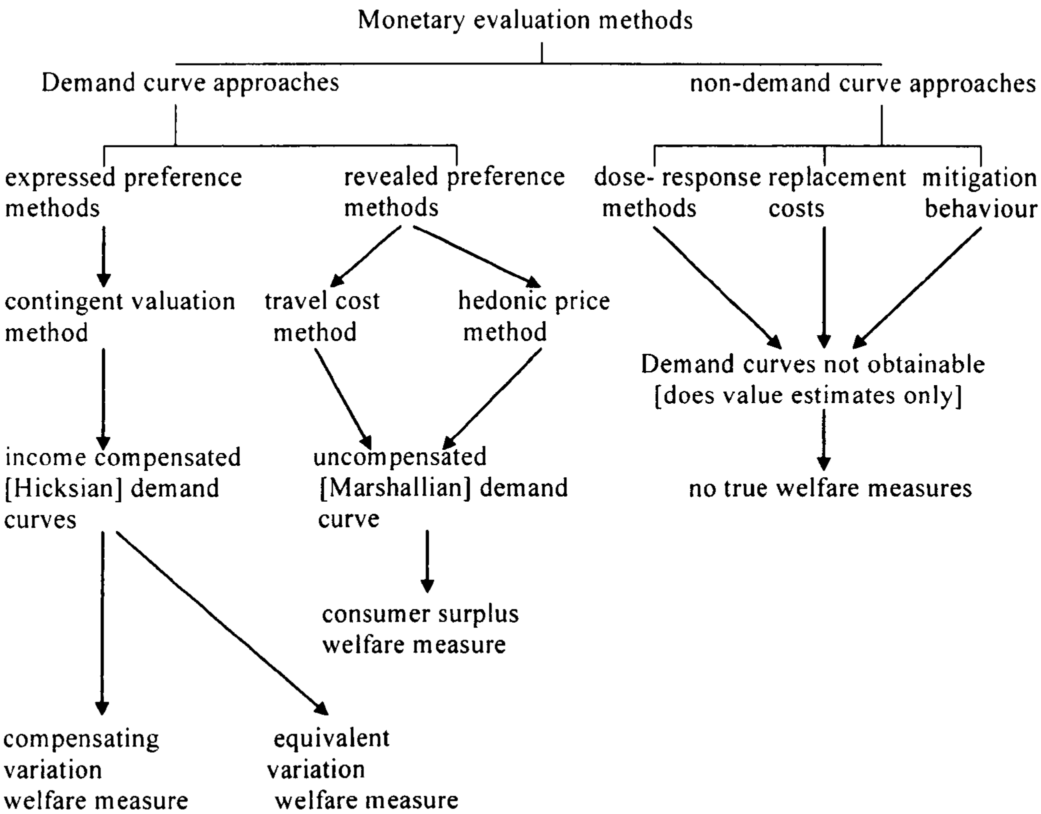


Figure 5.1: Monetary evaluation methods. Source: Turner *et al.* (1994)

This method uses survey technique (questionnaires) to elicit the willingness of respondents to pay for (generally) hypothetical projects or programme (Portney, 1994). The other demand curve approach is the "revealed preference method" that is based on models of actual market behaviour (Braden, *et al.* 1991). For example, the value of a wilderness area may be inferred by expenditures that recreationists incur to travel to the area and then the consumer surplus is estimated by relating expenditures to the number of visits.

Economic assessment of goods and services that are not traded in the market place, i.e. non-market goods, involves estimation of shadow prices – the price that would have been observed if market trading existed. Since consumer behavior relative to consumption of non-market goods cannot be observed directly, methods for inferring behavior, or asking consumers how they would behave under certain hypothesized or contingent conditions, have been developed to estimate shadow prices. Batie and Shabman (1982) suggested carefully structured land price analysis, travel cost, and contingent valuation, as alternative non-market wetland value estimation methods.

As illustrated by Turner *et al.* (1994), there are several methods of valuing the non-marketed goods and services to establish the shadow prices. However, for this study, a CVM is used against others since it can, in principle, provide useful information about the economic significance of lost passive-use values when ecosystems are degraded or destroyed by pollution and/or development (Batemen, *et al.* 1993). Other justifications for use of CVM are provided by Mitchell and Carson (1989) that inform a CVM is a standardized and widely used survey method for estimating WTP for use, option, existence, and bequest values and as put by Hanemann (1994), even without a market, there still exists a latent demand curve for non-market goods; contingent valuation represents a way to explore this out. CVM is a technique for providing estimates of the monetary value of public goods which have no market (Burgess, et al, 2000) and can be successfully applied to rural households within the developing country context (Shyamsundar and Kramer, 1996). In many respects it is easier to do high-quality contingent valuation surveys in developing countries than in industrialized countries (Whittington, 1998). From a judicial point of view, CVM is recommended for use in benefit-cost analysis performed by federal agencies (US Water Resources Council 1982), for valuing natural resource damages (US Department of Interior 1986) and has been upheld by the D. C. Court of Appeals (State of Ohio v. Department of the Interior, 880 F.2d 432 (D.C. Cir. 1989). According to Mitchell and Carson (1995), the increasing use of the CVM has been stimulated by three important events:

(i) The state of Alaska's contingent valuation survey which sought to measure the natural resource damage caused by the 1989 Exxon Valdez oil spill in Alaska (Carson, *et al.* 1992).

(ii) The Exxon Symposium where a series of papers, several based on empirical studies, were presented which were highly critical of contingent valuation methods and its use in natural resource damage assessment (Hausman, 1993).

(iii) The report submitted by the Blue Ribbon Panel (CV Panel) convened by the US National Oceanic and Atmospheric Administration (NOAA) to assess the reliability of the contingent valuation for use in assessing lost passive use values resulting from oil spills. The CV Panel, in their report , *inte alia,* concludes that contingent valuation studies can produce estimates reliable enough to be the starting point of a judicial process of damage assessment, including lost passive-use values (Arrow, *et al.* (1993)

The critical problem of administering CVM is to determine if the said value of WTP compromising the actual money is being paid. Individuals are tempted, for several reasons to state higher or lower value of WTP during the interview than their actual WTP. Wu and Huang (2001) performed a complete comparison of actual averting expenditure and stated willingness to pay measures, and found that the empirical results are consistent with the theoretical expectation for expenditure difference. Cost-based responses were found to partly explain inconsistent responses (Ryan and San Miguel, 2000). Their simple test of consistency in WTP, i.e. if commodity A is preferred to B, then individuals should be willing to pay more for A than B, produced thirty percent failure. Another problem is lack in realism since respondents are elicited to state their preferences based on hypothetical scenarios and making hypothetical payments. The importance of stressing the realism or policy relevance of a contingent valuation (CV) survey is commonly recognized by CV researchers (Cummings and Taylor, 1998).

Critics of the CV studies are numerous. Generally, the critics question whether meaningful benefit estimates can be made for environmental services and, if made, whether the estimates are acceptable guides to making environmental policy. Shabman and Stephenson (2000) concluded that at the debate over the "value of valuation" in water resources will not subside, because this debate is part of a wider intellectual dialogue regarding the role of analysts and quantification in the making of public policy. The CV Panel, in their attempt to improve reliability and validity of CV studies has identified a number of stringent guidelines, which this study will adopt, but with certain adjustments to suit local preferences.

Although controversial in many aspects, CVM is still being widely used because it remains the only valuation technique capable of capturing all benefits associated with good or service, be it use or non-use. The idea of placing a monetary value on non-marketable goods is beginning to gain momentum in Malaysia. Environmental valuations performed by Yeo (1998) calculated WTP for Pulau Payar Marine Park entry fee at RM 16.00, while Alias and Shazali (2000) concluded that the visitors of Pulau Manukan were WTP as much as RM 5.02 to visit the island. Bann (1999), calculated the value the Benut mangroves at RM 151,800, where 50 % of the local respondents surveyed had low educational level (primary school) and some 37 % earned below RM 500 per month (the poverty line of Malaysia was set at RM 420.00 per month[2]). Other environmental valuation surveys in Malaysia were also performed by Mourato and Day (1998), Dubourg (1998), Norlida and Jamal (2000) and Abas *et al* (2000).

Critics are also being naïve and suspicious of the competence of developing countries in performing the valuation techniques of non-marketed goods (Winpenny, 1991). While they are not totally wrong in their perception, the awareness of the use of environmental goods is long standing even in the poor countries of the world. Eco-tourism, for example, has grown in importance over the past decades and is now a major contributor to the economies of numerous developing countries, including Costa Rica, Belize, Ecuador, Kenya, Nepal, and Thailand (Lindberg and Huber, 1993). Moreover, Whittington (1998) suggested that many environmental and resource economists and policy analysts working in developing countries assumed that contingent valuation surveys are straightforward.

5.4 Theoretical background

In the CVM survey, a respondent is asked if he or she would pay a certain amount of money to help protect and restore the degrading mangroves of Mukim Lekir. The value they consented to pay, or generally known as the value they are WTP, can be defined first by examining a household utility function. Hanemann (1984) shows if there exists a representative consumer who has an indirect utility function, the level of the consumer's

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[2] In the Parliamentary debate dated 4 July 1995, the Minister of Agriculture pointed out that the poverty line of Malaysia was RM5, 040.00 per annum or RM420.00 per month (in http://agrolink.moa.my/parlimen/jwb_par.html)

utility depends on price (P), income (M), socio-characteristics (S) and the quality (Q). The respondent will pay if,

$$V\,(M - P, Q^{1}, S) > V(M - 0, Q^{0}, S)$$

The above equation shows that the respondent will answer yes if his utility derived from improved environmental quality (Q^1) and paying the price (P) is higher than not having improved environmental quality (Q^0) and not paying the price (P = 0). u is an unobservable component of the utility. If V is the observable component of the utility, the probability of the respondent saying yes is,

$$\text{Prob(Yes)} = \text{Prob}[V(M - P, Q^{1}, S) + u_1 > V(M - 0, Q^{0}, S) + u_0\,]$$

Since the dependent variable takes value only between 0 and 1, the logit model (or also known as the logistic model) is preferred over the ordinary regression model $Y_i = \alpha + \beta X_i + u_i$. The logistic model has the following functional form:

$$\ln\ [P_i/1 - P_i] = \alpha + \sum_{i=1}^{k}\ \beta_i \chi_i + u\,,$$

where P_i is the probability that the respondent i will say "yes" to the bid value, the α and $\beta's$ are coefficients to be estimated from the sample data and the $\chi's$ are the explanatory variables collected during the interviews. The logit model is estimated by regressing ln $[P_i/1 - P_i]$ against a constant α and χ. The rationale for this form can be seen by solving the equation P (by first exponentiating both sides). Then the probability of the respondent i saying "yes" is given by equation :

$$P_i(Yes) = \frac{1}{1 + \exp^{-(\alpha + \sum \beta\chi + u)}}$$

The population mean WTP is thus calculated from the inverse cumulative distribution function (CDF) over the WTP. The mean WTP for the sample is then calculated as the area under the estimated curve by integral $\int_i^k \frac{1}{1+\exp^{-(\alpha+\sum \beta\chi+\beta cadvalu)}} \delta cadvalu$, where the bid values (or denoted as cadvalu in the SPSS processing) are from i to k and the $\chi's$ are the means of the explanatory variables. The population mean WTP is then extrapolated to the reference population, in this case is the number of households of Mukim Lekir.

Assuming that the decision of voting 'yes', WTP, depends on many explanatory variables, the linear probability model of this study is given by;

$$WTP = \alpha + \beta_1 Cadvalu + \beta_2 Sex + \beta_3 Age + \beta_4 Race + \beta_5 Edulevel + \beta_6 Occupati + \beta_7 Distfrom + \beta_8 Income + \mu$$

where,

WTP = Log [$P_i/1\text{-}P_i$]

α = a constant

Cadvalu	=	Bid values
Sex	=	1 if male, 0 if female
Age	=	Age of each respondent
Race	=	1 if Malay, 0 otherwise
Edulevel	=	Number of years in school
Occupati	=	1 if fisher, 0 otherwise
Distfrom	=	a distant between respondent's house and Lekir Mangroves
Income	=	respondent's monthly income
μ	=	independently distributed random variable with 0 mean

Only households or heads of the family (the decision makers) were being sampled in this study. Gender segregation was not practiced as long as the respondent was the decision maker of the household. In the study by Teal and Loomis (2000), to determine whether a significant difference exists between females and males in term of their WTP for environmental programs dealing with the protection of wildlife and salmon, produced analyses that failed to reveal gender as a significant determinant of an individual's WTP, even when age, education, and income were accounted for. However, Brown and Taylor (2000) showed that gender differences exist in hypothetical valuation exercises, but not in real valuation exercises where the hypothetical bias is almost three times larger for males than for females. Quiggin (1998) in his study on the issue of whether willingness to pay (WTP) for the benefits generated by a public good should be elicited on an individual or on a household basis found out that, for general specifications of altruism, household WTP is less than the sum of household members' individual WTP.

5.5 Materials and methods

In the application of CVM, this study adopted five steps as suggested by Chesapeake Biological Laboratory (2002). In addition, this survey was also adhered to the views and suggestions provided by the CV Panel, whenever appropriate.

5.5.1 *Step I : Definition of valuation problems*

The mangroves along Mukim Lekir coastline are in danger of being degraded naturally or man-made. Perunding Utama (1997) pointed out in their EIA report, that some mangroves in Mukim Lekir were being reclaimed under various agricultural schemes while both erosion and accretion were causing some observable damage to the mangroves. The report further asserted that only areas in northern part of the reclaimed island in Phase 1 would experience erosion, while the rest of the Lekir coastline was not expected to change from its current status. This implies that the present mangrove deterioration as observed in some localities was not caused by the act of the reclamation itself. However, during the mangrove survey made by this study, inhabitants nearby the affected areas claimed to witness a large scale change on the coastline structures since the beginning of the reclamation project resulting in more damage to the mangroves. This has generated a conflict about the actual cause of the mangrove deterioration between the inhabitants and the project developer.

Although mangroves are capable of producing timber or other non-timber production, this activity was not found in the mangroves of Mukim Lekir. This was probably due to unsuitability of timbers for marketing purposes and uneconomic ventures for extracting non-timber materials from the mangroves. Furthermore, the said mangrove areas are State owned and permits to exploit resources was never issued by the authority. Perunding Utama (1997) identified 15 mangrove species present in Lekir while Tenaga Nasional (1997) noted only 11 species within a 3 km radius of the proposed power plant. On the terrestrial fauna, both surveys identified 113 and 101 vertebrate species including amphibians, reptiles, mammals and birds. Two mammals: *Nycticebus coucang* (Slow Loris) and *Manis javanica* (Pangolin) are protected under the Wildlife Act 1972 (Malaysia) while 13 others are partially protected. Only 15 avifauna species are not accorded by any legal status by the Act which means the majority of the species identified are endangered and hence protected by law.

The most affected party of society pertaining the uses and non-uses of these mangroves were the people of Mukim Lekir who were divided geographically by their proximity to the mangrove areas. This separation was done by assuming that those living within one km of the mangrove areas as coastal inhabitants while those further away as inland inhabitants (Figure 5.2).There were 2,232 houses or households in Mukim Lekir with the total number

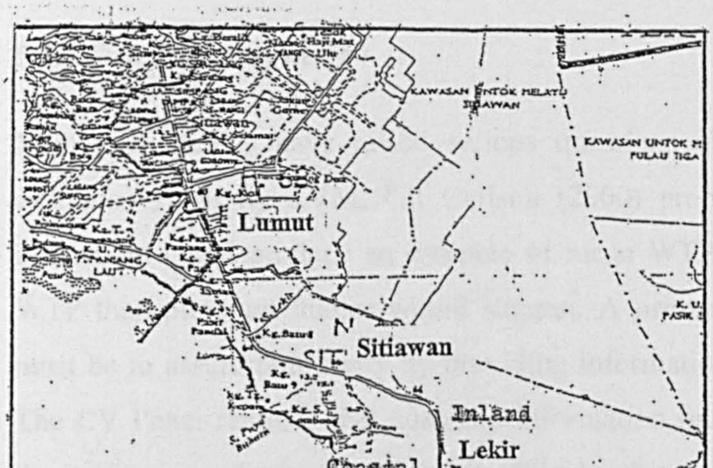

Figure 5.2: Separation between coastal and inland inhabitants of Mukim Lekir.

of 11,160 inhabitants assuming an average of five persons living in a house (Chapter 3). The inland area consisted of 1,476 houses while the coastal area had 756 houses. Fishers consisted 728 households the majority of which (464 fishers) lived within coastal area.

5.5.2 *Step 2: Questionnaire survey*

CV Panel prefer face-to-face interviews but does not single out the possibility of using telephone interviews because of its lower interviewing costs. However, this might not be appropriate in Mukim Lekir where only 69.1% of the households possess telephones (Perunding Utama, 1979). Mail questionnaires were not considered here because of its low response rate and problems in low-level-education communities.

Despite its high cost, face-to-face interviews allow the use of maps, text and graphics to communicate information on the mangroves of Lekir, and concepts such as biodiversity. It is much more appropriate when the respondents are mainly villagers with low education level. Considerable time and effort was allocated in this study to ensure their understanding of the mangrove's importance, biodiversity concepts and the meaning of WTP.

5.5.3 *Step 3: Survey design*

Numerous studies have raised serious questions about the validity and reliability of estimates given by CVM, but Carlson (2000) proposed that a carefully designed CV instrument could produce an estimate of mean WTP that is much closer to actual mean WTP than previous studies would suggest. A primary purpose of the contingent market must be to assure familiarity by providing information (Blomquist and Whitehead, 1998). The CV Panel reminds that adequate information must be provided to respondents about the environmental programme that is offered and it must be defined in a way that is relevant to damage assessment. Bann (1999) used several techniques such the use of maps, text and graphics to provide information on mangroves to local as well as foreign respondents.

There is no standard approach to the design of a contingent valuation survey. Nevertheless, virtually every application consists of several well-defined elements (Portney, 1994). CVM involves constructing a hypothetical market or referendum scenario in a survey. It consists of three key elements: (i) a *scenario* which presents the respondent with a clear description of the good he/she will be asked to value; (ii) a *policy* or project that will be undertaken to ensure that the respondent receives the good; and, (iii) a *payment vehicle* representing the mechanism through which respondents will be expected to pay for the policy or project.

In this study, description of good in question was elucidated verbally and simultaneously verified with maps, text and graphics. Figure 5.3 is an overview description of mangrove locations in the State of Perak. It generates a picture about mangrove existence to the respondent. Figure 5.4 brings the respondent closer to the existence of the mangroves as it shows them in his/her own backyard. Some recent photographs taken at various places at Lekir mangroves were also shown to the respondents (Plates 5.1-5.4). A series of information cards were shown and read to the respondent giving him/her information about mangrove biodiversity (Appendix 3 –Card A) and mangroves of Lekir (Appendix 3 –Card B).

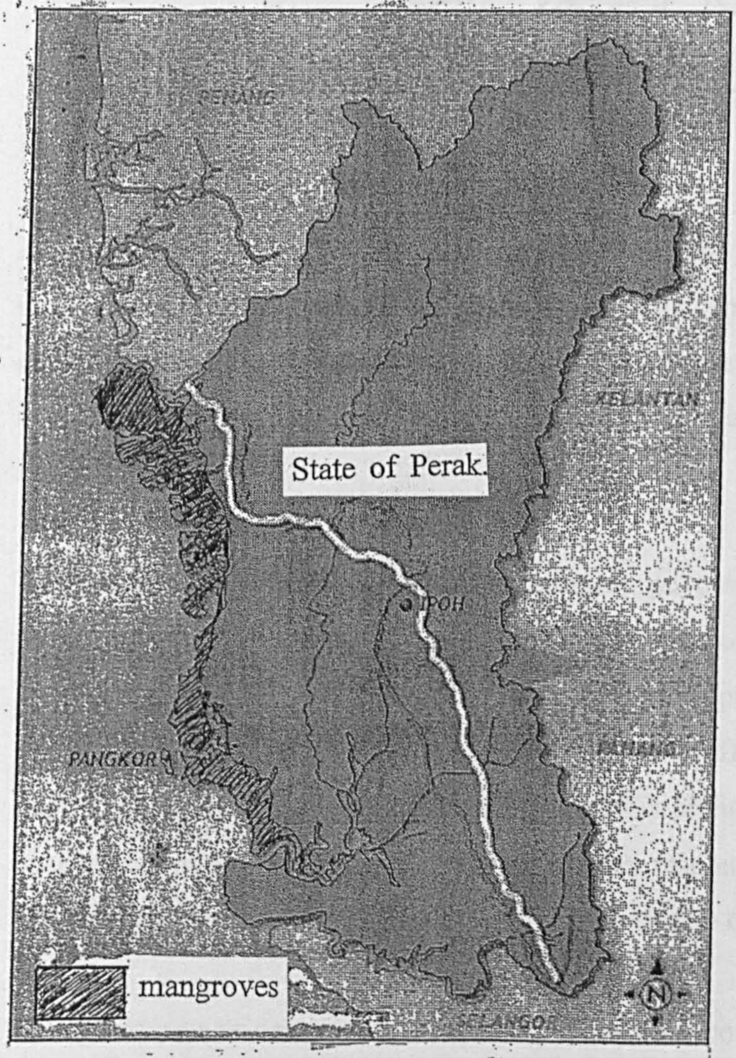

Figure 5.3: Mangroves of Perak

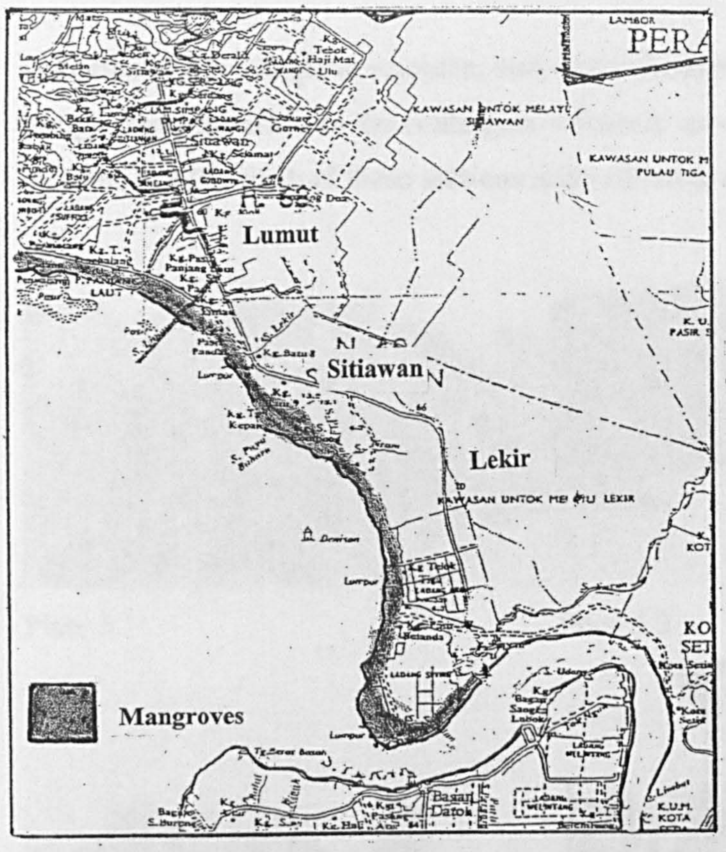

Figure 5.4: Mangroves of Mukim Lekir

A hypothetical policy or project scenario (Appendix 3 –Card C) giving the respondent usage benefits is illustrated. This contains two management scenarios A and B. The former explains the present state with no protection, while the latter explains the proposed management plan and the benefits that will be received by the respondent if it is implemented.

The payment vehicle proposed was a monthly payment to the Lekir's Mangroves Fund (LMF) which managed by the Government. The respondent was asked to contribute his/her WTP on a monthly basis to the fund with an optimistic assurance that, since the government manages it, the fund is legitimate and efficient in running the management plan. The respondent was also reminded of his/her ability to meet expenses of other private or public goods. To avoid overspending, the respondent was also informed of other expenditure possibilities that might be offered in future CV surveys or future referenda.

The questionnaire design was divided into 5 sections covering areas such as the purpose of the CV survey; attitudes towards the environment; current use of the mangrove area;

valuation of the mangrove resource; and, socio-economic characteristics (Appendix 3). The design was adapted from the contingent valuation survey on Benut mangroves, Johor State by Bann (1999). Each of these sections is described in detail below.

Plate 5.1

Plate 5.2

Plate 5.3

Plate 5.4

(a) *Section 1: The purpose of CV survey*

It is imperative that the interviewer when confronting a respondent gives a good first impression both in physical and moral perspectives. The interviewer was required to dress well in accordance with local culture, talk in moderate tone and posses several virtues such as tact, politeness, thoughtfulness, diplomacy and discreetness. The first task was to get a person to agree to participate in the interview by coaxing him/her into believing that the issues raised were relevant to him/her.

Instructions for interviewers were written down and attached to the front page of the questionnaire. As an introduction, the interviewer presented an appropriate salutation, addressing the potential respondent by his/her proper title and declaring his/her (the interviewer) name and the organization he/she was representing, and finally giving a brief explanation of the purpose of the survey. The respondent was informed that his/her answers to the questionnaire were confidential.

(b) ***Section 2: Attitudes towards the environment***

Bann (1999) pointed out that attitudes can be important determinants of WTP, and thus can be used in the interpretation of valuation responses. The objective of this section was to explore the respondent's personal views on environmental issues and his/her underlying motives for supporting the protection program of the mangroves. This section was also a preparatory to the WTP question, which was the fundamental quest of this survey. Each respondent was assessed of his/her attitudes and behaviour towards environmental problems, conservation and protection pertaining to mangroves through consistency in providing answers.

There were 3 questions attempting to extract the respondent's attitude, knowledge and commitment on of some the environmental problems. Question A.1 wished to know if the respondent was aware of any kind of problem that needed government attention most. The choices presented to him/her included other non-environmental problems. Question A.2 asked the respondent to state his/her most and second most important environmental problems. Question A.3 asked the respondent's opinion on certain environmental issues such as environmental protection, development, bequest, wildlife preservation, existence, productivity, and do-nothing options.

Question A.1 revealed the respondent's priority on the environmental issues. This starting point was crucial because it reflected the respondent's attitude throughout the survey. If he/she was inclined towards the environment, then the impetus was most likely to agree on anything that was environmental or otherwise. On the other hand, Question A.2. diverted the respondent to focus on the environmental issues by asking to choose the environmental problems that annoyed him/her. This second question attempted to put the respondent on the right tract of the survey again if the answer to the first question was inclined towards non-environmental issues. Question A.3 was to identify the respondent's level of environmental commitment. The last question in this section prepared the respondent to deal with next valuation questions.

(c) ***Section 3: Uses of the Lekir mangroves***

This section was intended to determine how important mangroves were to the respondent by asking various uses and services obtained from it. The questions posed to the respondent identified and classified him/her into user or non-user, and the possibility of being an option-user. The first question, B.1 asked the fundamental question, if he/she had heard of Lekir mangroves. If the answer was pessimistic then, question B.2 was no longer relevant because it asked the respondent if he/she ever visited the mangrove areas. Before going on to the next questions, the respondent was shown Figure 5.2 (the mangroves in state of Perak) and Figure 5.3 (the mangroves of Lekir) to help refreshes his/her mind about the existence of such mangroves. Question B.3 asked the respondent if he/she will be visiting the Lekir mangroves in the future. This question was to draw the possibility of the respondent to make use of the mangroves in the future by visiting it even though he/she might not be interested at present. Being a resident of nearby mangrove areas, the respondent was asked about his/her knowledge of the importance of mangroves to the people of Mukim Lekir in question B.4. The respondent was also shown Map 5.3 with the purpose of providing some ideas of its size relative to other types of vegetation. He /she had the option of saying 'I don't know' if mangrove activities were beyond his/her knowledge. Question B.5 was about major physical uses of the mangroves and intended to verify the respondent's knowledge on the variety of mangroves uses in general terms. Question B.6 was similar to question B.5 but more specifically on non-physical or environmental uses of the Lekir mangroves. Question B.7 was an open-ended question that asked the respondent to list down items that he/she extracted from the mangroves for personal or commercial uses. This question was intended to identify if he/she was a direct user of the mangroves. The concept of mangrove diversity and background information on the Lekir mangroves was then introduced to the respondent by showing and reading card A (information on mangrove biodiversity) and card B (background information on Lekir mangroves) along with some photographs showing the present state of mangroves and its relation to fishers and the power plant. The respondent was asked if he/she already knew about the information in question B.8. Question B.9 asked the respondent to state his/her opinion on the level of destruction on Lekir mangroves after been shown and read scenario A (about the damage of Lekir mangroves). Finally, question B.10 asked the respondent about the present condition of the mangroves and its chances of recovery.

The purpose of posing questions in this section was to gather information on the respondent's current use of, and benefits from, the mangroves. The respondent's future use was also revealed by asking a direct question if he/she intends to make a visit in the future. At the end of this section, the respondent's status as mangrove user was known, his/her awareness of the importance of the mangroves was enhanced, and the threats faced by the mangroves were appraised.

(d) ***Section 4: Valuation of mangroves resource- willingness to pay section***

Scenario B was shown and read to the respondent. In this scenario, the respondent was informed about some environmental changes that could happen if the proposed management plan was in action. It was then followed by a summary of the hypothetical market that introduced the payment vehicle (Appendix 3 –card D). The WTP section consists of three parts, namely; the payment vehicle, eliciting valuations and the follow-up questions.

Payment vehicle

The respondent was asked to state his/her WTP to protect the Lekir's mangroves that would result a change from the state of scenario A to the state of scenario B by contributing a monthly payment to the LMF that would be managed by the government.

Eliciting valuations

The value elicitation question was designed to draw out peoples' willingness to trade goods (or impacts) for money. There are several widely used elicitation methods but generally they come under three main formats; open-ended questions (OE), iterative bidding questions (IB) and dichotomous choice (DC) questions. Open-ended (OE) elicitation simply asks a respondent to state his/her maximum WTP on certain hypothetical scenario. The respondent is therefore free to state any amount (Brookshire, *et al.* 1983). In IB, the respondent is confronted with several rounds of discrete choice questions or bids, with the final question being an open-ended WTP question. Similarly to OE format, the respondent is ultimately free to state any final amount (Desvousges, *et al.* 1987). In the DC question, the respondents are asked, " Are you willing to pay £ X ?" with the bid level X being systematically varied across the sample (Cameron and James, 1987). A single-bounded dichotomous (SBD) choice is where the respondent is asked to state yes or no to a single

WTP amount or bid (Bishop and Heberlein, 1979), whereas in double-bounded dichotomous (DBD) choice, a respondent is further asked to state yes or no to the amount higher or lower than the amount previously decided (Hanemann, 1985). For example, in DBD format, if a respondent answered yes to a RM2 bid, then he/she is again asked to state his/her WTP at a higher amount of RM4. Conversely, the next bid is lowered if the first question produced a no answer. In practice, if a respondent indicates a willingness to pay the first offered amount, the new threshold is about double the first one. If the respondent is unwilling to pay the first offered amount, the second threshold is reduced to about half the original one (Cameron and Quiggin, 1994). Payment cards introduce the respondent with a visual aid containing a large number of monetary amounts. The respondent ticks the sums he/she is definitely willing to pay and puts crosses against those he/she is definitely not willing to pay.

The choice of elicitation format is of considerable importance: different elicitation formats typically produce different estimates. Some authors preferred the DBD format than others. Hanemann, *et al.* (1991) found that the DBD model shows statistically more efficient estimates than single-bound approach because the latter requires a larger sample to attain a given level of precision. Jordan and Ehnagheeb (1994) compared WTP estimates obtained from an actual survey using a checklist of questions regarding WTP for groundwater quality improvements with WTP estimates obtained from single-bounded referendum (SBR) and double-bounded referendum (DBR) questions and found that there was a loss of statistical efficiency of WTP estimates when moving from the checklist and DBR formats to the SBR format. Langford *et al.* (1998), on the other hand, pointed out that useful information can still be obtained from smaller OE studies.

The basis of choosing which formats prevail over others will largely be considered from the suggestion of the CV Panel and previous authorized CV surveys in Malaysia. The CV Panel recommends as the most desirable form of CV elicitation the use of a dichotomous question that asks respondents to vote for or against a particular level of taxation, as occurs with most real referenda, and if a DBD choice or some other question form is used to obtain more information per respondent, experiments should be developed to investigate biases that may be introduced. Several studies gave encouraging results on SBD, for example, Calia and Strazzera (2000) suggested the use of single rather than double bound model, provided a reliable pretest is conducted and the sample size is large. In Malaysia, a CV survey on mangroves of Benut, Johor State was carried out by the Johor State Forestry Department (in collaboration with DANCED/Darudec) in 1999 adopting two elicitation approaches; the payment ladder approach, and a referendum question followed by a DBD choice question (Bann, 1999). Other studies, however, employed the SBD choice to value the net economic values of recreational resources in Manukan Island, Sabah (Alias and Shazali,2000); to estimate the individual WTP for conservation of outdoor recreational places at the Damai District, Sarawak (Abas *et al*, 2000); to elicit the equivalent surplus to avoid degradation in the recreational quality of Taman Negara, Pahang (Norlida and Jamal, 2000) and to estimate the individual WTP for conservation of Payar Island, Kedah (Ayob,2002).

This study adopted the SBD choice, as commonly employed by CV researchers in Malaysia, which was in line with the suggestion of the CV Panel. Due to money and man-power constraints, only 30 % or 670 respondents of the total Mukim Lekir population were surveyed. This sample size was considered large compared with the 509 samples by Ayob *et al.* (2002) and 209 samples by Yeo (1998).

Since CVM is entirely based on a hypothetical rather than the real situation, it is always exposed to criticism. Previous experiments have suggested that the commonly used dichotomous choice contingent valuation method leads to hypothetical bias, i.e. overestimates the real willingness to pay (Blumenschein *et al.* 1998). In reality, people wish to be compensated of any man-made environmental disaster rather than made to pay to remedy it at values normally higher than their value of WTP. Because of such a human needs, Knetsch (1994) argued that based on present evidence, responses to contingent valuation questions are not likely to represent any measure of economic values. He further commented that the results of these valuation practices will , therefore, bias environmental policies and distort incentives. Perhaps the most severe critics come from Westra (2000), who argued that even if we could elicit a truly informed and 'free' choices, the method would remain flawed, as 1) all 'local' activity also has far-reaching environmental consequences, 2) majority decisions may support choices that adversely affect minorities, 3) even with full information, consenting to harms like significant alterations of our normal functioning or health, or genetic mutations, may not be morally acceptable. To overcome such enormous criticisms, the CV panel presents guidelines to which it believes any CV study should adhere if the study is to produce information useful in natural resource damage assessment. The guidelines are summarized in Table 5.1, and items ticked are deemed to have been adhered in this survey.

Table 5.1: NOAA guidelines: Guidelines adopted in Lekir Mangroves study

Personal interviews	x
Elicitation format: wtp measure	x
Dichotomous choice format	x
Adequate pre-testing	x
Careful pre-testing of photographs	x
Accurate scenario description	x
Conservative design	x
Deflection of warm glows	x
Representative sample	x
Reminder of undamaged substitutes	x
Reminder of budget constraints	x
No answer option	x
Yes/no follow-up questions	x
Cross-tabulations	x
Checks on understanding	x

In this section, the respondents were posed with the referendum format of question such as 'Are you willing to pay **X** RM per month to the LMF to manage and protect the Lekir mangroves?' The respondents were elicited to state their preferences by saying yes or no to the referendum. If the answer was no, he/she was asked to answer questions C.2 through C.4 specifically tailored for those respondents who stated zero WTP. Similarly, if the answer was yes, the respondent was asked to answer questions C.5 through C.7, which were designed for those stated positive WTP.

Follow-up questions

The respondent providing 'no-answer option' was posed with a question to explain his/her choice. The CV Panel suggested that respondents who choose the 'no-answer option' be asked non-directly to explain their choice. In question C.2, nine possible answers were offered to the respondent to choose only one that suited him/her. Answers of number (1) through number (5) are valid reasons for not participating in the contingent market, whereas the remaining answers are caused by the rejection of the market. A respondent preferring any of the answers number (6) to number (9) was considered as protest voter; i.e.

respondents who do not report genuine economic reasons for not wanting to pay anything to protect the mangroves, but reject the contingent market nonetheless (Bann, 1999). Protest voters were thus removed from the WTP analysis since it cannot be assumed that their WTP was truly zero. Question C.3 (including C.3a. and C.3.b) provided options to the respondent to contribute in non-monetary ways to the mangroves by allocating his/her spare time in doing volunteering job. Question C.4. was an open-ended question for respondents giving a no response to the referenda offered. It asks for the reason for voting no. Likewise, question C.5 asked for the reason if the respondent answered yes to the referenda thus committing positive WTP.

The CV Panel requires survey to include a variety of other questions that help to interpret the responses to the primary valuation question. Among the items that would be helpful in interpreting the responses were income (question D.8.), prior knowledge of the site (questions B.1., B.4., B.5., B.6., and B.8.), prior interest in the site (visitation rates) (questions B.2., and B.3.), attitudes toward the environment (questions A.1., A.2., and A.3.), attitudes toward big business (question A.3.), distance to the site (question D.6.), understanding of the task (questions B.8., and B.9.), belief in the scenarios (questions B.9., and B.10.) and ability/willingness to perform the task (question C.5.).

Socio-economic characteristics

The reasons for this section is to study how the socio-economic characteristics of the Mukim Lekir's population is related to their behaviour towards the environment, commitment to the protection of mangroves and the WTP patterns with respect to income, sex, age, educational level and employment status.

5.5.4 *Step 4 : Sampling method*

(a) *Sample type and size.*

Sampling type and size followed suggestions made by CV Panel. For single dichotomous question of the yes-no type, a total sample size of 1,000 respondents is favorable and if face-to-face interview is used, clustering and stratification must be taken into account. In the dichotomous valuation questions (e.g. hypothetical referenda), a random sub-samples is chosen and asked the amount they are WTP and using the econometric methods, the underlying population mean or median is estimated.

The decision of confirming the sampling size was made by considering the availability of money, manpower and time allocation. Although the CV Panel suggested 1,000 respondents as favorable, this study was compelled to limit the sample size to 648 samples or 29 % of the total population due to money-manpower-time constraints. Cluster sampling was disregarded, as the population concerned in this study was restricted only to Mukim Lekir where the sampling frame was at hand. Palys (1997) indicated cluster sampling should only be used when a sampling frame is unavailable, since it is ultimately not as good as the other sampling technique. Nevertheless, stratified sampling was implemented, as this study requires an equal and fair representation between fishers and non-fishers. The aim of stratification is to guarantee that the sample reflects the structure of the population, at least in terms of one or more important variables (Lynn, 1996). In addition, they were also stratified according to two locales; the inland and the coastal areas. The reasons for stratification are pertinent in considering the distance effect on WTP (Pate and Loomis, 1997) and different levels of acceptance to development (Breffle, *et al.* 1998). In a CV study to compare respondents' WTP of those living in urban areas and areas near petrochemical complexes in Taiwan, Liu and Chen (1996) obtained median WTP of those living near the petrochemical complexes is higher than those living further away. This implies that people living further away from disaster areas are less perturbed than those living near it. The locales segregation is thus imperative to provide better representation of the samples. The number of respondents sampled is shown in Table 5.2.

Table 5.2: The stratification of population in Mukim Lekir

Locales with Occupational Compositions	Population Size	% in Population	Sampling Fraction	N in sample	% in Sample
Coastal					
Fishers	464	61.38	0.29	135	61.36
Non-Fishers	292	38.62	0.29	85	38.64
Sub-Total	756	100	0.29	220	100
Inland					
Fishers	264	17.89	0.29	77	18.0
Non-Fishers	1212	82.11	0.29	351	82.0
Sub-Total	1476	100	0.29	428	100
TOTAL	2232	100	0.29	648	100

The population of Mukim Lekir was stratified into inland and coastal dwellers. The population census of both locales was obtained from the 1990 population survey by the Department of Statistic, State of Perak and cross-checked with the population data gathered by the Land Office of Manjung District (LOMD). Employment data for the population were collected from several sources; such as Town Council of Manjung for number of those working in private sectors and small business; LOMD for those in public sectors; Department of Human Resources, State of Perak for those in plantation sectors; Department of Fisheries, State of Perak and Manjung Fisheries Association for for fishers; and Department of Agriculture, State of Perak and Manjung Farmers Association for farmers. Other comparable data were obtained from the Economic Planning Unit, State of Perak which generally oversees the developmental progress of Perak. Employment data were the sampling frame of this study and sampled proportionally to their rate of occurrence in the population. The selection of samples from the sampling frame was done by quasi-random sampling or systematic random sampling (Wright, 1979; Neuman, 1997; and Chapter 3-paragraph 3.2.3).

Unreliable respondents were detected and eliminated in two stages. At stage 1, all returned questionnaires were examined to remove respondents who failed to cooperate satisfactorily in the interview exercise, providing unrealistic WTP values and showing inconsistency with environmental and attitude perception. At stage 2, those who either provided answer number 6, 7, 8, 9 or 10 in question C.2 was regarded as 'protest voter' and thus rejected as invalid. According to Bann (1999), protest voters are respondents that do not report genuine economic reasons for not wanting to pay anything for protecting the mangroves, but reject the contingent market nonetheless and they need to be removed from the WTP analysis since it cannot be assumed that their WTP is truly zero. Dziegielewska and Mendelsohn (2005) identified protest voters as those who believed that polluters (not respondents) should pay; taxes should not be used as a payment vehicle; and that the proposed policy would be ineffective at reducing pollution. The useable samples were analyzed pertaining to all sections of the questionnaires, except in WTP section, where the protest voters were excluded.

According to the CV Panel, high non-response rates would make the survey results unreliable. This study was expected to achieve a more than 50% sample response rate since it was carried out by face-to-face interviews. The effective final total response after the elimination of "protest zeros", "unrealistic high values", and other problematic responses was not expected to less than 50%. By comparison, studies such as a CV of the mangroves of Benut, Johor State, Malaysia, employed a 7% planned sampling size or 300 of a total 4,208 households (Bann, 1999). The effective final total response after eliminating some unwanted responses in the Benut CV study (rejection, non-qualified or no one at home) was, however, slightly higher, at 307 useable samples.

5.5.5 *Step 5: Survey implementation*

Before the survey was carried out, a pilot study was undertaken to resolve three major issues: (1) to test whether the questionnaire constructed would adequately be comprehended by the respondents, (2) what is the most appropriate payment vehicle; and (3) what are the number and level of bids (i.e. the value of each bid). A total of 66 respondents or about 10 % of the expected samples were stratified and randomly selected to participate in the pilot study. The respondents consisted of 14 fishers and nine none-fishers living in coatal area and, eight fishers and 35 non-fishers living in inland area. The development of the questionnaire was also examined by selected individuals in the focus group prior to the pilot study. Later, the focus group also examined the outcome of the other two issues, found by the pilot study.

(a) *Pretesting of CV questionnaire*

As required by the CV Panel, a pilot study to pre-test, was carried out. This was coupled with evidence from the final survey that respondents understood and accepted the main description and questioning reasonably well.

Focus groups are tools used by marketers, politicians and survey designers to understand how people react to unfamiliar products, policy speeches, or survey questions. It consists of a group of people from various disciplines, careers, and even some local people (a small sample of population under study) selected to undergo examination of the questionnaire. Its main purpose was to make the questionnaire comprehensible. However, the focus group method is undesirable by the CV panel since it is not supported by any systematic evidence. Kaplowitx and Hoehn (2001) found that focus groups and individual interviews are not substitutes and they yield different information about ecosystem services and resource uses.

Earlier, Chilton and Hutchinson (1999) concluded that focus groups should not automatically be taken as the only method to produce useful qualitative data to the CV process in general. Nonetheless, this study employed the focus groups method since it was felt that it helps to improve the questionnaire design into a more meaningful construct. Furthermore, it was followed by pretesting of the questionnaire to a small group of the sample population to ensure it was as successful as planned.

The focus groups selected were members of South Manjung Fishers Association's Board of Directors, government officers, fisheries officers and a few selected villagers of Mukim Lekir. Several sessions were held where at which, an open discussion was carried out to look for any deficiency of the questionnaire. When the questionnaire had gone through the scrutiny of the focus groups, it was pretested to 66 people living in Mukim Lekir.

(b) ***Determining appropriate payment vehicle***

Three possible payment vehicles were employed in the pilot study. They were: (1) monthly donation to a newly formed charity organization; (2) monthly fee paid to an organization formed by the government; and (3) payment via direct taxation. Samples of the wordings used to elicit WTP for each of the payment vehicle are as follows:

> "As such, suppose that in order to protect the mangroves, your household would be asked to pay a monthly donation to a charity organization which is going to be established to help protect the mangroves in Lekir".

> "As such, suppose that in order to protect the mangroves, your household would be asked to pay a monthly fee to a LEKIR MANGROVES FUND (LMF) which will be established by the government, to help protect the mangrove in Lekir".

> "As such, suppose that in order to protect the mangroves, your household would be asked to pay a tax to the government so that it can finance some projects to help protect the mangroves in Lekir".

(c) ***Determining the number and level of bids.***

Following Boyle and Bishop (1988), it was decided that, in the absence of any a priori expectations, the pilot survey should be undertaken using an OE approach and that bid levels for the CVM should be based upon those received in the OE pilot. Each respondent in the pilot study was then asked the three options of the payment vehicle. Those who stated a positive WTP were further asked the open-ended question to announce the amount of money that they would like to contribute to the vehicle of their choice. However, during this exercise, the respondents of these sub-samples were not asked to mention the amount of their WTP, but instead to write it down on a piece of paper, fold it and then insert into a provided box carried by the interviewer. The reason was to test for interviewer effects. According to the CV Panel, the presence of an interviewer can contribute to "social desirability" bias, since preserving the environment is widely viewed as something positive (except in the case of mail surveys). By so doing, their WTP in this fashion was analyzed to see whether some calibration should be introduced to compensate for the interviewer effect.

5.6 Results

5.6.1 *Background*

The biggest problem faced was about the acceptance of this survey by the respondents. After performing the pretesting exercises, the chosen sub-samples demonstrated a profound attitude and responsibility in responding to the CVM questions, thus providing impetus to test the affected population. Thirty or 45 % of respondents in the pilot study stated positive WTP and most of them (99 %) agreed to pay to the second payment vehicle, that is, a monthly fee to the LMF. The amount pledged by the respondents ranged from RM 1.00 to RM 5.00. Therefore it was decided by the focus group in light of this outcome to accept the second payment vehicle format and five bids of RM 1.00, RM 2.00, RM 3.00, RM 4.00 and RM 5.00.

The interview exercises started on 15 July 2003 with the objective of gathering 648 samples. Four trained interviewers (three were from the FDOM plus the researcher) were mobilized and set to work within the given period of 30-working day (excluding Saturday and Sunday) designed to finish on 25 August 2003. Each interviewer was assigned a quota of 162 interviews. Due to certain incompliance responses detected in the returned questionnaires, 15 were rejected and considered invalid. The incompliance response included refusal to answer most questions posed, provide unrealistic WTP values and inconsistency with environmental and attitude perception. Consequently, only 633 samples were analyzed, representing 28 % of the population (Table 5.3).

Table 5.3: The number of accepted samples

Locales	Planned Samples	N Sampled Interviewed	Number of Rejected Samples	Number of Valid Samples
Coastal				
1. Fishers	135	135	5	130
2. Non-Fishers	85	85	1	84
Inland				
1. Fishers	77	77	7	70
2. Non-Fishers	351	351	2	349
TOTAL	648	648	15	633

5.6.2 *General attitudes and behavior*

Of the 633 respondents surveyed, 54 % considered improving fish catches was the most important issue to be dealt with by the government whereas 29 % wanted more employment opportunity as their second most important issue (Table 5.4). No respondent cited the problem of protecting natural habitat and wildlife as their primary concern, although 16 % did choose the problem as secondary. Other issues did not really attract much attention indicating that the problem lies between improving fish catches and providing more employment opportunity.

Table 5.4: The ranking of social and environmental problems in Mukim Lekir

Problems	Most Important (%)	Second Most Important (%)
Increasing fisheries productivity	53.9	24.3
Increasing agricultural productivity	9.5	15.8
Reducing water pollution	21.5	14.8
Protecting natural habitats & wildlife	0.0	16.3
Providing more employment opportunity	15.2	28.8
TOTAL	100.0	100.0

However, 72 % of the responses made by the coastal population, thought that improving fish catches should be the most important issue to be addressed by the government and providing more employment opportunity was the second most important. The choice made by the coastal population was expected, as 61 % were fishers. In the non-fisher-dominated inland population, improving fish catches was also the most important issue, but to a lesser extend (44 %). Some concern was shown by non-fishers on this issue was probably due to indirect benefit they receive if fish catches increased.

Air pollution was regarded as the most worrying environmental problem by 43 % respondents, and it was further accentuated in their second choice indicating an underlying problem in the area. Conversely, 58 % of the respondents in the coastal population placed the destruction of fishing grounds as their most worrying environmental problem and 56 % gaved air pollution as their second choice. This behavior is expected, as fishers are more sensitive to fisheries problems. In the inland population, air pollution remained the main issue, declared by 56 % of the respondents, and water pollution was their second most worrying problem.

Question 3 was intended to unearth the perceived environmental values by providing a series of proposals. Each respondent was asked to rank the proposal from 'strongly agree' to 'strongly disagree' (Table 5.5). For proposal 1.0, most respondents agreed that protecting the environment was obligatory although they might incur some losses due to hampered development. The coastal population had a greater recognition of the intrinsic value; 70 % strongly agree to the proposal. Proposal 2.0 asked respondents to state their bequest value through environmental preservation so that it could be used by the next generation. Again, most respondents, especially fishers were very much aware of the importance of preserving for future generation. On proposal 3.0, respondents from the coastal population strongly opposed with 78 % disagreeing. Slightly half of the inland respondents agreed to the proposal, but in general, of 633 respondents surveyed, only 43 % agreed. It appears that the population is conservative of the environment and rejected the idea of damaging the environment for the for the benefit of providing more job opportunity. The disagreement was more prominent among fisher respondents probably because damaging the environment will adversely affect their livelihoods, and the promise of job opportunity was received with skepticism. The respondents' awareness of the need to conserve the mangroves was further revealed by Proposal 4.0. Most respondents agreed that birds, most species of which are endangered, should be protected, implying a very high existence value placed on them. However, Proposal 5.0 did not appeal much to the respondents. Nearly half disagreed (inclusive of those opted for 'no-opinion' option) reflecting their low non-use value of the mangroves. The low non-use value as declared by the respondents indicates that the mangroves are only for their use benefits, and this was reinforced by their gloomy behavior when Proposal 6.0 was suggested. More than half of respondents, including those who selected the 'no opinion' choice, disagreed to pay for mangroves protection for future use, revealing their low option value on the subject. Nonetheless, 75 % of respondents agreed to the Proposal 7.0 that requires them to pay to protect the mangroves for the betterment of fisheries activities. It shows that respondents were fully aware of the relationship between mangroves and fisheries, and protecting the mangroves is indirectly protecting the fisheries. To recapitulate to whole survey scene, the final Proposal 8.0 asked respondents if it is worth thinking about the loss of the mangroves whereas they might have other important issues to address. More than half of the respondents disagreed with the proposal, confirming the finding that the people of Mukim Lekir are concerned and aware of the need and importance of conserving the mangroves. The non-use values are summarized in Table 5.6 indicating the low option value and non-use value.

Table 5.5: Proposals of the uses of the mangroves

PROPOSALS	Population	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
(1.0) Everybody has the duty to protect the environment from development regardless of the cost *(intrinsic value overall duty to protect)*	Mukim Lekir Coastal Inland	36.7 70.1 19.6	50.9 29.9 61.6	3.2 0.0 4.8	9.3 0.0 14.1	0.0 0.0 0.0
(2.0) We should reduce our use of the environment now, so that our grand children may benefit from it (*Bequest value)*	Mukim Lekir Coastal Inland	48.6 78.6 33.9	38.6 11.7 51.8	0.0 0.0 0.0	9.6 0.0 14.3	3.2 9.7 0.0
(3.0) Malaysia needs to develop her forest, seas, and land to increase jobs and incomes, regardless of the environmental damage *(role of environmental assets in development)*	Mukim Lekir Coastal Inland	0.0 0.0 0.0	43.3 13.2 58.7	15.5 9.3 18.6	41.2 77.6 22.7	0.0 0.0 0.0
(4.0) Because birds depend on the mangroves, they should be protected regardless of the costs *(existence value)*	Mukim Lekir Coastal Inland	58.5 68.7 53.2	41.5 31.3 46.8	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0
(5.0) I should pay for the protection of the mangroves even though I do not visit them *(selfish use value motive)*	Mukim Lekir Coastal Inland	2.5 3.7 1.9	46.6 33.2 53.5	18.8 18.2 19.1	28.3 44.9 19.8	3.8 0.0 5.7
(6.0) Even I don't use the mangroves now, I am prepared to pay to protect them in case I want to use them in the future*(option value)*	Mukim Lekir Coastal Inland	3.0 0.0 4.5	40.0 40.7 39.6	40.0 33.2 43.4	15.8 26.2 10.5	1.3 0.0 1.9
(7.0) It is worth spending money to protect the mangroves because they help to protect fisheries activity in the area (indirect use motivations)	Mukim Lekir Coastal Inland	58.6 68.7 53.5	41.4 31.3 46.5	0.0 0.0 0.0	0.0 0.0 0.0	0.0 0.0 0.0
(8.0) We have more important things to think about than the loss of the mangroves *(putting issue in context)*	Mukim Lekir Coastal Inland	0.0 0.0 0.0	23.2 0.0 35.1	6.3 9.3 4.8	60.0 78.0 50.8	10.4 12.6 9.3

Table 5.6: Responses on use and non-use values.

Type of Value	% Respondents Who Recognize Non-Use Environmental Values
Indirect Use Value (Proposal 7.0)	100
Option Value (Proposal 6.0)	43
Bequest Value (Proposal 2.0)	87.2
Existence Value (Proposal 1.0 & 4.0)	87.6 / 100
Rejection of Non-Use Values (Proposal 5.0)	49.1

5.6.3 *Uses of Lekir mangroves*

The existence of Lekir mangroves were well known to the Mukim Lekir population (Table 5.7): 97 % had heard of the mangroves (Question 1) and 84 % had visited the area (Question 2). The 3 % of respondents that had never heard of the mangroves were revealed the ignorant nature of a small portion of the population. Option use or future use of the environment never appealed to the Mukim Lekir population and when asked if they intended visiting the mangroves in the future (Question 3), only 50 % of respondents said that they might visit the mangroves in the future.

Table 5.7: Knowledge on the existence of Lekir mangroves.
Figure in parenthesis is the number of respondents

	Population	YES (%)	NO (%)
Q. B.1: Have you ever heard of Lekir Mangroves area?	Mukim Lekir	97(614)1	3(19)
	Coastal	100(214)2	0(0)
	Inland	95.5(400)3	4.5(19)
Q. B.2: Have you ever visited Lekir Mangroves?	Mukim Lekir	81..2(514)	18.8(119)
	Coastal	100(214)	0(0)
	Inland	71.6(300)	28.4(119)
Q.B.3: Do you think you will be visiting Lekir Mangroves in the future?	Mukim Lekir	50.4(319)	49.6(314)
	Coastal	63.6(136)	36.4(78)
	Inland	43.7(183)	56.3(236)

Using Map 5.3 to illustrate graphically the size of the mangroves relative to other types of vegetations: of 633 respondents, 97 % thought that the mangroves were important to the people of Mukim Lekir (Question 4). Respondents of both the coastal and inland populations also recognized the importance of the mangroves when they concurred at 99 % and 96 % respectively (Table 5.8).

Table 5.8: The importance of mangroves in term of size.
Figure in parenthesis is the number of respondents

	Mukim Lekir Population (%)	Coastal Population (%)	Inland Population (%)
Very Important	29.1(184)	40.2(86)	23.4(98)
Important	44.1(279)	56.1(120)	37.9(159)
Somewhat Important	23.7(150)	3.7(8)	33.9(142)
Unimportant	3.2(20)	0(0)	4.8(20)
Very Unimportant	0(0)	0(0)	0(0)
I don't know	0(0)	0(0)	0(0)

Variable responses were received when confronted with suggested benefits likely to be derived from the mangroves (Question 5 and 6) (Table 5.9). Those that stated 'no' thought

Table 5.9: The familiarity of the respondents with the mangroves uses.
Figure in parenthesis is the number of respondents.

Physical uses	Population	Yes (%)	No (%)	Non-Physical/ environmental uses.	Population	Yes (%)	No (%)
Timber	Mukim Lekir Coastal Inland	15.5(98) 0(0) 23.4(98)	84.5(535) 100(214) 76.6(321)	Fish nursery ground	Mukim Lekir Coastal Inland	87.5(554) 100.0(214) 81.1(340)	12.5(79) 0(0) 18.9(79)
Poles	Mukim Lekir Coastal Inland	70.8(448) 67.3(144) 72.6(304)	29.2(185) 32.7(70) 27.4(115)	Bird sanctuary	Mukim Lekir Coastal Inland	93.8(594) 100(214) 90.7(380)	6.2(39) 0(0) 9.3(39)
Fuel wood and charcoal	Mukim Lekir Coastal Inland	46.0(291) 48.6(104) 44.6(187)	54.0(342) 51.4(110) 55.4(232)	Wild animal protection	Mukim Lekir Coastal Inland	78.2(495) 90.7(194) 71.8(301)	21.8(138) 9.3(20) 28.2(118)
Building dwellings	Mukim Lekir Coastal Inland	47.1(298) 61.7(132) 39.6(166)	52.9(335) 38.3(82) 60.4(253)	Eco-tourism	Mukim Lekir Coastal Inland	69.0(437) 82.2(176) 62.3(261)	31.0(196) 17.8(38) 37.7(158)
Medicines ingredients	Mukim Lekir Coastal Inland	35.7(226) 13.1(28) 47.3(198)	64.3(407) 86.9(186) 52.7(221)	Protection from strong wind and Storm	Mukim Lekir Coastal Inland	93.7(593) 100(214) 90.5(379)	6.3(40) 0(0) 9.5(40)
'sagu', 'nipa' and other edible products	Mukim Lekir Coastal Inland	57.5(364) 22.4(48) 75.4(316)	42.5(269) 77.6(166) 24.6(103)	Preventing erosion	Mukim Lekir Coastal Inland	31.6(200) 63.6(136) 15.3(64)	68.4(433) 36.4(78) 84.7(355)
Agriculture	Mukim Lekir Coastal Inland	74.6(472) 56.1(120) 84.0(352)	25.4(161) 43.9(94) 16.0(67)	Possibility of national park	Mukim Lekir Coastal Inland	42.2(267) 57.0(122) 34.6(145)	57.8(366) 43.0(92) 65.4(274)
Aquaculture	Mukim Lekir Coastal Inland	63.0(399) 72.9(156) 58.0(243)	37.0(234) 27.1(58) 42.0(176)	Possibility of forest/ mangroves reserve	Mukim Lekir Coastal Inland	65.1(407) 90.3(186) 52.7(221)	34.9(218) 9.7(20) 47.3(198)

that the suggested benefit was absent or irrelevant to the uses of mangroves. No respondents surveyed admitted that they extract anything from the mangroves for their own use or for trading (Question 7).

In preparation for the next vital question (Question 8), i.e. the WTP elicitation technique, three questions were prepared. Firstly, each respondent was introduced to the concept of mangrove biodiversity and the background information of the mangroves by reading him/her the information written on Cards A and B, respectively. Some magroves-related photographs were also shown to the respondent. It is found that knowledge pertaining biodiversity among the whole population is remarkably high; 64 % knew most of the information beforehand and a further 16 % had an absolute knowledge. Only 21 % admitted that their knowledge on biodiversity was limited. Respondents from the coastal population were more knowledgeable than those from the inland population. Only 9 % of the coastal population were very unaware of mangrove biodiversity in contrast to 24 % of the inland population (Table 5.10).

Table 5.10: Knowledge on biodiversity.
Figure in parenthesis is the number of respondents.

	Mukim Lekir Population (%)	Coastal Population (%)	Inland Population (%)
Yes, very new	20.9(132)	7.5(16)	27.7(116)
Only some of it is new	63.5(402)	74.3(159)	58.0(243)
I know all of this Already	15.6(99)	18.2(39)	14.3(60)

Before advancing to the next question, information on Card C and Scenario A was shown and read to the respondent. They were then asked about their feeling on the whole scenario. More than 90 % of the respondents expressed their unhappiness feeling (from very unhappy to a little unhappy, inclusively) about apparent destruction of the Lekir mangroves (Question 9) (Table 5.11). More than half of the respondents surveyed (Question 10) were optimistic about the ability of the mangroves to return to their original state in near future (Table 5.12).

Table 5.11: Feelings towards the present state of the mangroves.
Figure in parenthesis is the number of respondents.

	Mukim Lekir Population (%)	Coastal Population (%)	Inland Population (%)
Very Unhappy	10.3(65)	21.5(46)	4.5(19)
Unhappy	51.5(326)	43.0(92)	55.8(234)
A Little Bit Unhappy	30.6(194)	26.2(56)	32.9(138)
No Feeling	7(48)	9.3(20)	6.7(28)
Couldn't Care Less	0(0)	0(0)	0(0)

Table 5.12: The recovery likelihood of the mangroves.
Figure in parenthesis is the number of respondents.

	Mukim Lekir Population (%)	Coastal Population (%)	Inland Population (%)
Very, very bad. Unrecoverable.	0(0)	0(0)	0(0)
Very bad, but Recoverable in a long time.	12.2(77)	17.8(38)	9.3(39)
Bad, recoverable quite some time.	42.5(269)	39.3(84)	44.2(185)
Not so bad, recoverable soon.	29.7(188)	33.6(72)	27.7(116)
Not bad at all	15.6(99)	9.3(20)	18.9(79)
TOTAL	100(633)	100(214)	100(419)

5.6.4 *WTP section*

To ensure that each bid level had approximately equal sample sizes, interviewers gave successive respondents successive bid levels and ensured that this process continued without a break across interviews days (Bateman, *et al* 1993) To hold the number of valid respondents in each bid level equal, the interviewer skipped respondents giving the zero WTP answers (Question C.2 no. 6,7,8,9 and 10). The interviewers were encouraged to communicate and to trade among themselves to make sure of the equality of the sample sizes.

Eighty respondents were identified as protest voters (Table 5.13) and eliminated from the

Table 5.13: Valid non-participating and protest voters respondents.
Figure in parenthesis is the percentage of the total.

Valid Reasons For Not participating in the Contingent Market	
I have no spare income but would otherwise contribute	85 (20.4)
I feel that environmental protection of Lekir Mangroves is unimportant	96 (23.1)
I'd rather have the current situation than pay more	12 (2.9)
The user should pay	78 (18.8)
I believe that this improvement will take place without my contribution	65 (15.6)
Sub-total	336 (80.8)
Rejection of Contingent Market (protest voters)	
I don't believe the system would bring the changes you describe	24 (5.8)
It is the government's responsibility	40 (9.6)
I fail to understand the question	8 (1.9)
We cannot place a monetary value on bio-diversity	8 (1.9)
No-response	0 (0)
Sub-total	80 (19.2)
TOTAL	416(100)

WTP analysis. This reduced the number of valid respondents to 553 suitable for WTP analysis of which 336 were zero WTP respondents.

The zero WTP respondents were then asked to state their voluntarily non-monetary commitment on the mangroves (Questions C.3, C.3 [a] and C.3 [b]). All answered negatively indicating their absolute non-participation on the collective well-being of the community. Most stated time constraints as the main reason for failure to participate in the voluntary service for the mangroves (Question C.4).

The most common motive for those who agreed to pay the bid values, when asked of their reason (question C.5 – C.7[b]) was feeling responsibility to protect the environment (57 %).(Table 5.14). When asked to contribute to other funds managing distant mangroves, specifically the Matang mangroves (question C.6), 63 % agreed to pay the values of RM1.00 (80 %), RM2.00 (10 %) and RM5.00 (10 %). Those who would not contribute to other mangroves gave three reasons: (1) it is not my place, (2) the locals should be responsible and, (3) the mangroves are far away. Only 59 respondents of the total 217 respondents who agreed to pay were still willing to pay even if they moved put of the area (question C.7) with the same monetary amount as before (question C.7[a]). The other 158 respondents would not pay since they felt that the mangroves were no longer their responsibility and moreover, they did not think they would gain any benefit. (question C.7[b]).

Table 5.14: Reasons provided by respondents WTP.
Figure in parenthesis is the percentage.

Question	Reasons	Number of Respondents
C.5	Feeling responsibility to protect the environment	123 (56.73)
	Mangroves for future uses	14 (6.45)
	To contribute to the fund	7 (3.23)
	To help the government	29 (13.36)
	Rehabilitate mangroves	7 (3.23)
	I can afford it	22 (10.14)
	To protect wildlife	7 (3.23)
	To protect nursery ground of fish	8 (3.69)
	TOTAL	217(100)

In the principle of demand, a person consumes more good as its price declines and demand behavior is *vice versa,* as the price of the good increases. A similar behavior was observed when respondents were elicited to bid for the WTP at different values of RM 1.00, RM 2.00, RM 3.00, RM 4.00 and RM 5.00. In the cross tabulation (Table 5.15), less respondents were WTP at RM 5.00 compared with RM 1.00 and values between them denoting an inverse demand curve (Figure 5.5). Of the 553 samples examined, 217 or 39 % bid 'yes' with mean of RM 2.18, median of RM 2.00 and mode of RM 1.00.

Table 5.15: The Cross-tabulation of WTP and the bid values.
Figure in parentheses is the percentage of the total.

Card Value	Bid (Number of Respondents)		Total
	Yes	No	
RM 1.00	78 (14.1)	33 (6.0)	111 (20.1)
RM 2.00	75 (13.6)	36 (6.5)	111 (20.1)
RM 3.00	28 (5.1)	82 (14.8)	110 (19.9)
RM 4.00	19 (3.4)	91 (16.5)	110 (19.9)
RM 5.00	17 (3.1)	94 (17.0)	111 (20.1)
TOTAL	217 (39.3)	336 (60.8)	553 (100.0)

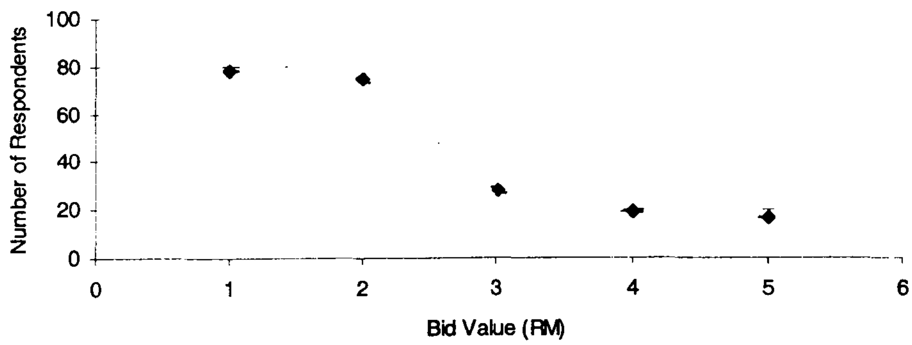

Figure 5.5: Demand curve of WTP

The Chi-square test was used to determine whether there was a statistically significant association between the two variables; bidding ('yes' or 'no') and the card values.(Table 5.16). There was a significant association between card value and bid in the population.

Table 5.16: The Chi-Square tests of bid verses card value.

	Value	*df*	Asymp. Sig. (2-sided)
Pearson Chi- Square	139.866[a]	4	.000
Likelihood Ratio	144.745	4	.000
Linear-by-Linear Association	119.085	1	.000
N of Valid Cases	553		

[a] 0 cells (.0%) have expected count less than 5.

The mean maximum WTP of a population can be obtained by computing the integral of $\int_{i}^{k} \frac{1}{1+\exp^{-(\alpha+\sum \beta\chi+\beta Cadvalue)}} \delta Cadvalue$ providing the area under the curve of equation.

Binomial (Binary) logistic regressing of WTP on all the explanatory variables and using the backward Wald-stepwise method to decide which variables to drop from the model, showed "*Age*", "*Sex*" and "*Occupati*" had no significant effect on the dependent variable (p>0.05) and were removed by the stepwise method (Table 5.17).

Table 5.17: Logit coefficients of the explanatory variables

	B	S.E.	Wald	df	Sig.	Exp(B)
RACE(1)	.867	.380	5.215	1	.022	2.380
EDULEVEL	1.267	.145	76.093	1	.000	3.549
DISTFROM	-.107	.046	5.364	1	.021	.898
INCOME	.006	.001	68.117	1	.000	1.06
CADVALU	-1.745	.193	81.475	1	.000	.175
Constant	-11.772	1.354	75.615	1	.000	.000

By fitting the logic coefficients into significant variable of the logit model, Log[$P_i/1-P_i$] = -11.772 - 1.746*Cadvalu* + 0.867*Race* + 1.267*Edulevel* - 0.107*Distfrom* + 0.006*Income* + μ was obtained. The mean maximum WTP was then calculated by finding the area under the curve $P_i = 1 / 1 + e^{-(\alpha + \Sigma\beta_i x_i)}$, where the means of *Race* = 0.63, Edulevel = *9.63*, *Distfrom* = 4.39 and *Income* = 1132.24 were inserted at their respective coefficients to produce $P_i = 1 / 1 + e^{-7.298 + 1.746Cadvalu}$. The integral of $\int 1 / 1 + e^{-7.298 + 1.746Cadvalu}\, dCadvalu$, where *Cadvalu* is RM1.00, RM2.00, Rm3.00, RM4.00 and RM5.00 is equivalent to 3.06 or RM3.06, i.e. the mean maximum WTP of the population. Considering the number of households in Mukim Lekir to be 2,232; then the total WTP for the population is the product of the number of the households by the mean WTP, which amounts to RM6,829.92 per month or RM 81,959.04 per annum.

5.6.5 *Demographic section*

Introduction

Since the targeted respondents were head of the households, it was not surprising that 91 % were male. In the stratification of the population in accordance to their occupational group, 31.6 % fishers and 68.4 % non-fishers were randomly selected. Most (51 %) respondents were between 41 to 50 years old and 37.4 % below the age of 40 years and earning between RM 600 to RM 3,000. A small number were above 50 years old. Malay dominated the survey representing 59 % of the total respondents, Chinese were 37 % and 4 % Indian. The race composition of the respondents reflected the races composition of the population (according to Manjung District Office [2003], - Malay 50 %, Chinese 33 %, Indian 14 % and others 3 %). Only 15 % of the respondents surveyed did not continue studying after completing the primary school level, while 45 % attained secondary level and the rest completed up to high school level. None of the respondents attained a university degree. Of all respondents surveyed, 72 % lived in houses less than 5 km from the mangroves area with the nearest inhabitants about 0.3 km and the furthest about 15 km away. The average number of persons living in a house was 4.3 persons whereas MDO in 2000 estimated it was 4.7 persons.

Cross-tabulation between fishers and non-fishers

(a) Sex

Female fishers were assumed low in number. According to FDOM, in 2002, there were five female fishers in Mukim Lekir or 1 % of the total fishers. During the previous socio-economic study (Chapter 3), none was randomly selected and only two fisher respondents interviewed in this survey were female indicating their low proportion in fisher population (Table 5.18). The female role as head or decision maker of household was more notably in the non-fishers sector, where they represented 13 % of the respondents. All non-fisher females interviewed were considered head of households since they were also wage earners and capable of making decisions.

Table 5.18: Sex and occupation cross-tabulation
Figure in parenthesis is the percentage.

SEX	OCCUPATION		TOTAL
	Fisher	Non-fisher	
male	198 (99.0)	376 (86.8)	574 (90.7)
female	2 (1.0)	57 (13.2)	59 (9.3)
Total	200 (100)	433 (100)	633 (100)

(b) Race

In Mukim Lekir, there were 256 Malay fishers or 76 % of the total fishers. Chinese and Indian fishers both made up the remaining portion. Eighty-five percent of fishers interviewed were Malay indicating a representative sample with respect to racial composition (Table 5.19). This characteristic was also palpable within the non-fishers sector where the racial composition of the respondents was 47 % Malay and 53 % non-Malay, which corresponded to the race composition statistics produced by MDO, in which Malays represented by 50 %, and non-Malay by 50 %. Race composition seems to hold without perceptible change over the years.

Table 5.19: Race and occupation cross-tabulation.
Figure in parenthesis is the percentage.

RACE	OCCUPATION		TOTAL
	Fisher	Non-fisher	
Malay	169 (84.5)	205 (47.3)	374 (59.1)
Chinese	22 (11.0)	209 (48.3)	231 (36.5)
Indian	9 (4.5)	19 (4.4)	28 (4.4)
Total	200 (100)	433 (100)	633 (100)

(c) Age

Within the fisher sector, those who were more than 50 years old accounted for about 25 % of the respondents compared with only 8 % within the non-fisher sector (Table 5.20). The

Table 5.20: Age-group and occupation cross-tabulation.
Figure in parenthesis is the percentage.

AGE-GROUP (Years)	OCCUPATION		TOTAL
	Fisher	Non-fisher	
26-40	44 (22.0)	193(44.6)	237(37.4)
41-50	106 (53.0)	215 (49.7)	321 (50.7)
51-60	22 (11.0)	21 (4.8)	43 (6.8)
61 through highest	28 (14.0)	4(9.0)	32 (5.1)
Total	200 (100)	433 (100)	633 (100)

majority of respondents were below the age of 50 years old (88 % of the total respondents). The percentage of non-fishers in the younger age group, between 26 years to 40 years old, was double that of fishers.

(d) Income

Generally, fishers earned less than non-fishers. Of the 200 fisher respondents, 153 (77 %) earned less than RM 1,000.00 per month. Conversely, non-fishers earn less than RM 1,000.00 per month made up of only 60 % of all non-fishers respondents. However, their income averages were similar; RM 1,058.29 (sd=RM286.43) earned by the fishers and RM 1,250.51 (sd=RM599.77) earned by the non-fishers. The lowest income received was RM 600.00 and the highest RM 3,000.00 (Table 5.21).

Table 5.21: Income-group and occupation cross-tabulation.
Figure in parenthesis is the percentage'

INCOME-GROUP (RM)	OCCUPATION		TOTAL
	Fisher	Non-fisher	
600-1000	153 (76.5)	261(60.3)	414(65.4)
1001-1500	42(21.0)	77 (17.8)	119 (18.8)
1501-2000	4 (2.0)	76 (17.6)	80 (12.6)
2001-3000	1 (0.5)	19(4.4)	20 (3.2)
Total	200 (100)	433 (100)	633 (100)

Distant from the mangroves

There were 756 houses situated within one kilometer or less away from the mangroves, while 1,476 houses were situated more than one kilometer away. The former were deemed termed as the coastal area and the latter as the inland area. Most of the coastal inhabitants were fishers (61 %) and of the total fishers in Mukim Lekir, 130 fishers (64 %) lived in the coastal area. Conversely, 72 % of non-fishers lived in the inland area (Table 5.22).

Table 5.22: House distances and occupation cross-tabulation.
Figure in parenthesis is the percentage'

HOUSE DISTANT (km)	OCCUPATION		TOTAL
	Fisher	Non-fisher	
Lowest through 0.5	38(19.0)	41(9.5)	79(12.5)
0.6-1	92(46.0)	43 (9.9)	135 (21.3)
1.1-5	63 (31.5)	178 (41.1)	241 (38.1)
5.1-10	6 (3.0)	133(30.7)	139 (22.0)
10.1 through highest	1(0.5)	38 (8.8)	39(6.2)
Total	200 (100)	433 (100)	633 (100)

Education level

In the previous socio-economic survey (Chapter 3), 65 % of the fisher respondents never continued their study after completing the primary school level. In this survey, only 33 % were primary school leavers while the majority of the fishers attained either the LCE or the MCE (Table 5.23). Education attainment among non-fishers were much higher than in the previous survey, where 96 % continued their studies after the primary school level. There were 57 non-fishers having high school certificates (HSC or Diploma). The probable explanation of such shift in the education level was related to the change in unemployment rate in other working sectors. For instance, the unemployment rate in 2001 was 3.6 %, an increase of 0.5 % from the previous year (Statistical Dept.,Malaysia, 2003). In 2002, the unemployment rate further increased to 3.8 % (CIA, 2003) and reached 4.0 % in 2003

(BNM, 2003). The increase in unemployment rate resulted some school leavers entering the open access fishing sector. Lack of job opportunity in other working sectors also resulted in school leavers accepting jobs that offer lower pay than their qualifications.

Table 5.23: Education level and occupation cross-tabulation.
Figure in parenthesis is the percentage'

EDUCATION LEVEL (number of years in school)	OCCUPATION		TOTAL
	Fisher	Non-fisher	
1	66(33.0)	26(6.0)	92(14.5)
2-4	88(44.0)	194 (44.8)	282 (44.5)
4.1-5	43 (21.5)	156 (36.0)	199 (31.4)
6-7	3 (1.5)	57(13.2)	60 (9.5)
Total	200 (100)	433 (100)	633 (100)

5.6.6 *Respondent's view on the whole survey scenario*

The final question (question D.9) required a respondent to state his/her general view on the survey itself. Assuming those who preferred to provide a 'boring' answer as negative respondents, this survey successfully elicited 86.2 % of positive responses (Table 5.24). Options such as 'interesting', 'interesting but difficult to understand' and 'provided me with new knowledge' were regarded as positively reflecting respondent's attitude towards the survey and indirectly approving it as a method of environmental valuation.

Table 5.24: Respondents general overview of the whole issues

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	interesting	137	21.6	21.6	21.6
	boring	87	13.7	13.7	35.4
	interesting but difficult to understand	263	41.5	41.5	76.9
	provide me with new knowledge	146	23.1	23.1	100.0
	Total	633	100.0	100.0	

5.7 Discussion

Is the contingent market an accepted approach to mangroves valuation among the rural population? This question can be answered from two perspectives; Firstly, the idea of having to pay a certain amount of money for the betterment or improvement of something for the collective benefit of the society is already a norm. For instance, within the Muslim society, the Friday's prayer public donation is used by the mosque's caretakers to cover the maintenance costs of the mosque itself, to provide allowances for services of the religious teachers to children of the village and financing other religious activities participated by members of the community. Professor Zaini Ujang in his speech on environmental degradation issues advised people to pay their bills for waste cleaning up costs as called for by Islam. He interpreted a verse from Al-Quran that reads "Mischief has appeared on land and sea because of the hands of men have earned, that (God) may give them a taste of some of their deeds: in order that they may turn back (from evil)" (Translated by Abdullah Yusuf Ali, 2004), to mean that the pollution and the destruction of environment is in fact caused by human being and therefore they shall be responsible to restore it for the benefit of all 'ummah' (mankind) or face the wrath of the god. Within the Buddhism community, environmental protection is also an important principle of life as emphasized by Quang (1996) who called for all religions, all strata of the society and all nations to come together, jointly participate in the protection of the environment for all living species, based on the harmonious model which Buddhism advocates. Being more religious than urban dwellers[3], rural inhabitants are expected to readily accept the idea of paying from the religious perspective. However, whether religion influences the individual WTP or the magnitude of the amount paid to the fund has not been covered by this study. Secondly, environmental awareness and attitudes was generally high. The respondents surveyed were concern about declining fish catches, air pollution and the destruction of fishing grounds. The majority agreed and strongly agreed to the questions pertaining to environment, birds and fisheries resource protection; and disagreed or strongly disagree on questions pertaining to environmental degradation for other economic purposes. They were more prepared to pay

[3] An article "Rural/Urban Versus Regional Differences in Religiosity" by Paul Chalfant and Peter Hiller examined three aspects of religiosity : rituals, experience, and ideology. They found higher levels of religiosity in the South and Midwest than East and West, and somewhat higher levels among rural residents than urban residents. Moreover, many researchers and practitioners long have assumed that rural residents were more religiously inclined (Cited from "Urban and Rural Religion Compared" in www.ndsu.nodak.edu/rsse/html/religion.html dated 9 November 2003.

only if protecting the mangroves indirectly protects the fisheries resources. Kotchen and Reiling (2000) found that the respondents with stronger pro-environmental attitudes were more likely to provide legitimate yes/no responses, while those with weaker attitudes are more likely to protest hypothetical CV scenarios.

Did the respondents perceive mangroves as having monetary value? Virtually all respondents (97 %), said they knew about Lekir mangroves. Some 81 % had visited the areas and half of all respondents considered visiting the Lekir mangroves in the future. The size or scope of the mangrove areas was sufficiently large to attract some significant attention from the population. Most agreed that the Lekir mangroves were important compared with other types of vegetation. This agrees with Carson and Cameron (1995) who rejected the hypothesis that respondents are insensitive to the scope of the good being valued. The respondents were also tested on their knowledge of the many uses of mangroves. They were aware of the scarcity or the unpopular physical uses of the mangroves but the majority agreed the diverse environmental or non-physical usage of the mangroves. Coastal respondents scored highest on all attributes of non-physical usage of the mangroves. Acknowledgment of the possible uses of the mangroves by the respondents, whether they were physical or non-physical, implies their recognition of some economic values on the environmental goods. For example, providing a nursery ground for fish was perceived as an enhancement of fish catch.

What were the factors that drive them to pay? In preparation for the respondents to answer the WTP questions, they were exposed and informed about the concept of biodiversity and then asked about their previous knowledge on the matter. In the next two questions, they were asked to state their feeling on the degradation and their optimism on the recovery of the mangroves. Their overall knowledge on the biodiversity was high, as more than half, especially among the coastal respondents, said that they already knew most of the information given. Their sentiment on the degradation of the mangroves was also high, as 93 % of the respondents were 'very unhappy' to 'a little unhappy' but, optimistic about the recovery of the mangroves. It is not worth spending money on things that provide uncertain success. The biodiversity knowledge, the sentiment and the optimism were all together influencing factors that drive the respondents to provide positive WTP answers.

Despite more than half of the respondents having good environmental awareness and attitudes, consenting to certain monetary values of mangroves, being unhappy about how mangroves were being treated but yet optimistic about its recovery; only 34 % were WTP to the LMF? Increased awareness of factors influencing the environment suggests it is reasonable to assume that salient environmental attitudes exist and influence behavior (Luzar and Cosse, 1998). Kline and Wichelns (1998) noted that public preferences for environmental policies often vary among individual citizens according to their socio-economic characteristics and attitudes towards environmental programme. If pro-environmental attitudes resulted in higher probabilities of responding 'yes', as contemplated by the study of Kotchen and Reiling (2000), then it contradicts with the responding behavior of the Mukim Lekir respondents or perhaps some of them were actually having difficulties to state in monetary terms when posed with the referendum. Goodman *et al.* (1998) in their CV survey, designed to measure non-use values for the natural coastal environment, suggested that public perceptions of conservation quality are multidimensional, and that it may be difficult for some individuals to express their preferences for the conservation value of natural resources in monetary terms. Although there was strong public support in the protection and the preservation of the Lekir mangroves, only 43 % of all fisher respondents and 30 % of all non-fisher respondents agreed to pay for the protection and the preservation of the mangroves. On the closer look at the income data, 68 % of those opting for zero WTP earned less than RM900.00 compared with only 17 % of those opting for positive WTP. Werner (1999) pointed out that covariates such as income are more significant in determining the positive portion of the distribution of willingness to pay.

The final question posed to the respondents was intended to extract their views on the overall survey scenario. Respondents received the survey positively, with only 14 % saying the survey was "boring". Thus, it demonstrated the usefulness of the survey in disseminating new information on environment, biodiversity and mangrove valuation by contingent market methods. There were some educational elements in the survey that indirectly improved the respondents awareness and attitudes on the protection and the preservation of the mangroves.

In general, the Mukim Lekir population was willing to pay RM 6,829.92/month for the betterment of the mangroves. If they are being deprived from the uses of the mangroves, then the value is the loss benefits to the society. In replace of the loss benefits, the society could be compensated by other means of benefits such as recreational parks built by the project owners. The value to build and maintaining such parks should reflect the monetary value of the loss benefits of the mangroves. This could be a just solution for either party whereby CVM plays an important role in determining the mangrove's value.

CHAPTER 6: THE VALUATION OF FISHERY LOSSES

6.1 Introduction

This chapter deals with the valuation of tangible goods that were lost as a result of the introduction of the intervention. Intangible goods, such as benefit loss of mangroves usage in Lekir was quantified by research method known as CVM (Chapter 5).When both values are added up together, it provides a complete economic losses incurred by the community. In economic terms, this is known as external costs (Field, 1994; Stiglitz and Driffill, 2000).

In the process of polluting the environment, polluters impose spillover costs on others (Sharp *et al,* 1994). Take the example of land reclamation project that dumps sand into a coastal area large enough to degrade marine environment resulting the destruction of rich fishing and nursery grounds and possibly the nearby mangroves area. Since fishers are dependent on fish to earn a living, they are obviously the most affected community. The low catches have resulted that their income being reduced. However, fish are also consumed by non-fishers that their scarcity has led the increase in market price which caused them to pay more than the price that was offered before the project. The description of the spillover costs on others is best demonstrated by the well-known economic theory of demand and supply (Lumsden *et al,*1974; Lipsey and Chrystal, 1995; Bergstrom and Miller, 1997; and Ferguson, 2002).

Segments of society claiming losses could be numerous. The construction of the power plant may cause air and noise pollutions affecting the health of people living nearby. They may have to pay additional medical expenses and their productivity may also be affected causing further losses to organization where they work. Other losses could also be observed incurred by hoteliers for reduced guests, fish traders for decreased revenues, fish processors for short of supply, restaurants for decreasing customers, property owners for decreased values and many others. It is a mammoth task if all losses were to be considered in this study. Therefore, this study limits its scope to the measurement of direct use value of the environment, that is, fishers and consumers who depended on the availability of fish, and cockles farmers who had lost their areas giving way to the 'island'. Government losses are included in this study since it is regarded as a direct impact of the 'island' on fisheries productivity which had perturbed the achievement of its objectives.

When fishers caught lesser fish than what they used to get without the intervention, the difference is regarded as a loss. Since fishers are producers, their losses can be explained in terms of reduced producers' surplus. Consumers who purchased fish for consumption had to pay more than before, regarded it as a loss as well since their consumer surplus had reduced. Cockle farmers used to harvest a substantial amount of cockles had to abandon their farms thus losing future incomes and finally when government had failed to achieve its objectives, the money spent on certain programs or projects was wasted Thus, the objectives of this study are, (1) to measure all losses incurred by fish producers and consumers as a result of change in fish landings, (2) to measure losses incurred by cockle farmers as they were unable to continue operating, and (3) to measure government losses.

The benefits gained or lost is practicable to be assessed by comparing the differences between before and after the start of the intervention. This study chooses the periods six years before (1992-1997) and six years after (1998-2003) the commencement of the project. In addition, forecasting technique was used to construct fish landing data which represented the amount that was forecasted to be landed in the absence of perturbation. Comparing forecasted data with the actual fish landed; consumer and producer surpluses and government losses were calculated.

6.2 Organization of this chapter

This chapter consists of four sections. Section 1 deals with losses incurred by fishers and fish consumers as a result of change in fish landings. Section 2 estimates the losses incurred by the cockle farmers who had to abandon their farms conceding to the project and section 3 gauges government losses. Finally, section 4 describes how forecasted data were constructed and used to determine forecasted losses.

6.3 Section 1: Producer and consumer surpluses.

6.3.1 . Introduction

Since fish are marketable goods, the market price method is used to estimate the economic value of ecosystem products or services that are bought and sold in commercial markets (Ecosystem Valuation, 2002). It values changes in either the quantity or quality of a good or service. The standard method for measuring the use value of resources traded in marketplace is the estimation of consumer surplus and producer surplus in market price and quantity data (Ecosystem Valuation, 2002). The definition of consumer surplus, as given by Marshall (1920) is: the maximum sum of money a consumer would be willing to pay (WTP) for a given amount of the good, less the amount he actually pays. Producer surplus and consumer surplus are the only practical means so far devised by economists for measuring welfare changes (Ellis, 1992). By comparing these measures before and after a market disturbance, it is possible to quantify how society has been affected (Callan and Thomas, 2000).

Although demand and supply curves emphasize the relationship between the price of a product and the quantity demanded or supplied, price is not the only factor that determines how much of a product consumers will buy or producers will sell (Rohlf, 2002). Berg, *et al.* (2003) pointed out three factors; the price of related goods, the income of consumers (buyers), and consumer tastes or preference that affect the demand curve and other three factors; technology available to producers, the cost of inputs (labor, machines, fuel and raw materials), and government regulation that affect the supply curve. With regards to the limits of this study, it was assumed the condition of *ceteris paribus*, other things equal at all the time. It means, other things were held constant that they did not affect the curves except the price.

6.3.2 *Materials and methods*

Econometrics was used to quantify economic relationship of the demand and supply data following a number of steps as suggested by Studenmund (1997). The steps proposed are (1) specifying the models or relationships to be studied, (2) collecting the data needed to quantify the models, and (3) quantifying the models with the data.

Specifying the models

Demand and supply curves follow the equation $Y = \alpha + \beta X + \mu$, where Y is the price of a unit commodity. X is the quantity demanded or supplied, α is a constant or interceptor on the Y-axis, β is the slope coefficient of the curve and μ is the error term. Depending on the empirical sign of β, the demand curve hypothetically has a negative sign whereas the supply curve is positive. The signs of the slope advocate the demand and supply economic theory; that a negative slope means an inverse relationship between demand price and the quantity demanded and a positive slope means a direct relationship between supply price and the quantity supplied assuming everything else held constant, *ceteris paribus.*

Figure 1.0 illustrates that before the coming of the polluters, fishers sold their catches at the equilibrium price P_1 by producing Q_2 amount of fish. By law of supply, P_1 is also the cost of producing the Q_2. Curve S_1S_1 and DD are supply and demand curves respectively. When the amount of fish caught is reduced as the consequences of the pollution, the supply curve moves upward as fishers incurred additional operation costs to produce fish and have to reduce the amount caught at Q_2. The law of the supply informed that as long as additional production of the commodity increases the profit of the producer, he will be interested in expanding the production but eventually a point is reached at which one additional unit supplied would increase the costs of production by an amount equal to its price, and the incentive to increase production disappears. The supply curve S_1S_1 then shifts upward to S_2S_2 and consumer is paying higher price than before at P_2. To produce Q_2 before the project, the cost incurred by fishers is P_o but is increased to P_2 as additional operation cost to produce same amount of fish. Thus, the effect of the project is that consumer has to pay more than before, that is, an extra $P_2 - P_1$ and fishers earn P_o which is less than P_1 after paying additional cost $P_2 - P_o$ of catching fish. Fishers will not attempt to increase the production more than Q_1 as at this point, the price of a unit additional amount of fish supplied will equal the costs of producing it.

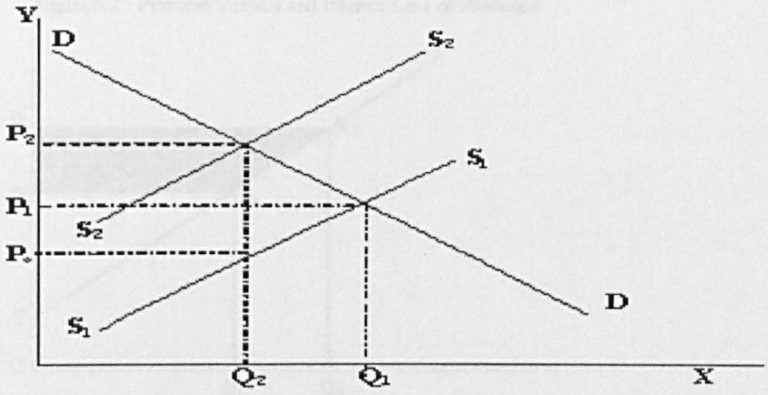

Figure 6.1: Supply and demand curves

Consumer surplus (CS) is given by the area under the demand curve DD but above the price level (Figure 6.2). At price P_1, the area is denoted by equation CS = ½ [$P_3 - P_1$] [Q_1], or represented by the area $P_1P_3A_1$, where P_3 is the maximum price that a consumer is WTP. It illustrates that if fish price is increased to P_2, the CS would be smaller (area $P_2P_3A_2$). Thus, the consumer loss is given by the area $P_1P_2A_2A_1$. Conversely, the producer surplus (PS) is the revenue obtained from a good sold which is represented by an area above the supply curve but below the price level (Figure 6.3). For example, at P_1, PS = ½ [$P_1 - P_o$] [Q_1] or represented by the area $P_oP_1A_1$, where P_o is the minimum price a producer is willing to sell the commodity. An increase of price to P_2 would be an advantage to the producer as he/she would gain more as denoted larger area of $P_oP_2A_2$. Thus, as a result of price increase, the producer gain would be the area $P_1P_2A_2A_1$.

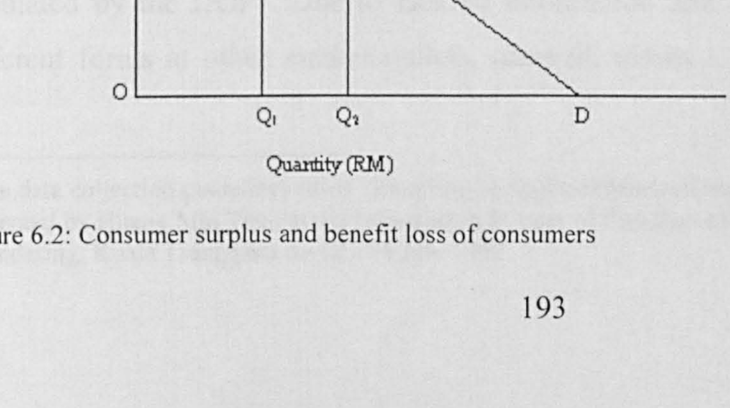

Figure 6.2: Consumer surplus and benefit loss of consumers

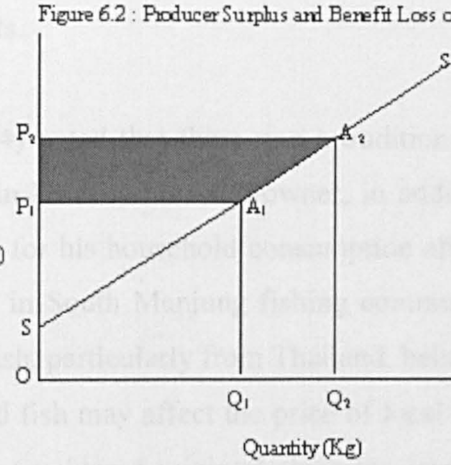

Figure 6.3: Producer surplus and benefit loss of producers

Econometricians use regression analysis to make quantitative estimates of economic relations that previously have been completely theoretical in nature (Studenmund, 1997). Time series demand and supply data, were used to estimate the value of α and β. SPSS software was used to regress the collected data but few authors had provided a good descriptions of the regression techniques which are beyond the scope of this study (Gujarati, 1995; Studenmund, 1997; Pindyck and Rubinfeld, 1998; Dougherty, 2002 and Ramanathan, 2002).

Data collection

Demand and supply curves for fish were constructed using data extracted from the Annual Fisheries Statistics (AFS) published by DOF for the period between 1992 and 2003 with the exception of fish landings and prices of South Manjung where they were obtained raw from unpublished statistical reports of FDOM recorded on the official forms number SMPP 1/8_Pin.1/96 and SMPP 4/86 respectively. Fish landings and ex-vessel prices were collected at the landing sites, and retail prices were obtained at fish markets. Fisheries Assistants of the FDOM collected data on a monthly basis following the guidelines as stipulated by the DOF[1]. Due to lack of information and data on fish that were sold in different forms at other market outlets, (canned, reduced, cured, etc.) this study limited

[1] The data collection guidelines titled 'Sampling Methods of Marine Data collection- A Review' were presented by Huang Min Tuoo at the Information System of Fisheries Management Seminar held at IPM Chendering, Kuala Trengganu on 12 - 15 July 1999.

itself to the study of demand and supply of fish that were transacted at landing points and fish markets.

Ishak (1994) noted that there was a tradition of sharing whereby each crew member was allocated, in kind by the boat-owner, in addition to normal wages, about 5 kg of fish or 'ikan lauk' for his household consumption after each fishing trip but this practice was not observable in South Manjung fishing community. Ishak (1994) also noted that there was imported fish, particularly from Thailand, being sold in the local fish markets. The presence of imported fish may affect the price of local fish, particularly of the same species, but the effect was considered minimal since the imported fish were sold frozen, contrary to the local fish that were sold fresh or chilled, thus they were priced independently. The marketing of frozen fish was still small, reflecting consumer preference for fresh fish (Ishak, 1994). With respect to the dissemination and pricing of fish, four assumptions were then made: (1) all fish landed were sold to the wholesalers who in turn disposed of them as alive, fresh or chilled, frozen, canned, cured, reduced or others; (2) all fresh or chilled fish were sold in the fish markets of South Manjung; (3) pricing mechanism between imported fish which were sold frozen and the local fish were independent, as were their demand and supply curves; and (4) the consumer benefits derived from fish other than those sold in fish markets was unknown or non-existence.

According to Wang (pers. comm.), the establishment of a precise number of traditional fishers operating in South Manjung is difficult to accomplish since quite a number of them did not bother to register with the FDOM[2] or become FASM[3]'s members. An indirect method of estimating their number was carried out; firstly, by enumerating the total number of fishing vessels present at each base, and secondly, by doubling the number since on the average, each traditional fishing vessel was manned by two crew (FAO, 2001). The total fishing vessels gauged in this manner include those without licenses. (Table 6.1).

[2]Fishers registration with the DFOM is not compulsory under the law but highly recommended by the department. Moreover, one of the important prerequisites as stipulated by the DOF in annual licensing renewal is that vessel owners must be registered fishers. While the number of licensed vessel owners is being properly recorded, the number of other fishers or crews remains indeterminate.
[3] FASM stands for Fisheries Association of South Manjung. Membership of this association is again not compulsory under the law. However, a membership certification from FASM is a prerequisite for any fisher wishes to register with the FDOM. Again, the membership list of the FASM may not include other fishers or crews.

Table 6.1: Annual Number of Traditional Vessels and Fishers in South Manjung.

Year	No. of All Vessels	No. of All Fishers
1992	500	1,000
1993	525	1,050
1994	483	966
1995	511	1,022
1996	515	1,030
1997	455	910
1998	515	1,030
1999	529	1,058
2000	898	1,796
2001	802	1,604
2002	792	1,584
2003	770	1,540

(a) Fishing costs

Unfortunately, there are no annual data on operational fishing costs or the variable costs. Although DOF (1987), Mahmood, *et al.* (1989) and DOF (1990) surveyed fishing expenditure in Peninsular Malaysia, their findings are no longer relevant to the present needs. However, a socio-economic survey conducted by FDAM in 1995 engaging fishers of Peninsular Malaysia concluded that the traditional fishers spent an average of RM40.60 per fishing trip (LKIM,1998). Another operational cost evaluation was undertaken by this study in 2002 (Chapter 3) where the average cost accrued by both fishers using canoes and boats was RM77.50 per fishing trip. Considering the former survey was completed before the projects started up, while the latter was after the projects development, due to data constraints, this study adopted RM40.60 as operating cost of base year 1995 for the enumeration of operating cost of year 1992 through 1997 and RM77.50 as operating cost of base year 2002 for the enumeration of operating cost of year 1998 through 2003.

For a traditional fisher, his expenditures per fishing trip was mainly fuel cost representing 70% of the total variable costs, while others such as food and ice make up the remainder. As such, the use of Consumer Price Index (CPI) to estimate the fisher's annual variable costs based on known value in a particular year is appropriate. However, because consumers spend greater percentages of their incomes on certain index items - more, say, on food and beverages than on apparel and upkeep - merely averaging all the indexes at face value to arrive at the all-items index would be misleading (Rohlf, 2002). Therefore, in attempt to place more emphasis on the concerned variable costs, the CPI or appropriately denoted as CPI-FF in this study, consisted of price index for food (PI-Food) as published by the Department of Statistics Malaysia and price index for fuel[4](PI-Fuel) as was adopted to deflate or inflate the monetary value of the operating cost of the particular year. Thus, the weightings for PI-Fuel and PI-Food are 70% and 30% respectively following the proportion of expenditure by the fishers and CPI-FF is derived by computing the summation of PI-Fuel * 0.70 + PI-Food * 0.30. The use of CPI for a similar purpose was described by FAO (October 2001) to inflate the 1997 fishing operating costs based on 1995 survey costs. Other CPI uses are to adjust wages, social security benefits, and tax brackets to correct for inflation (Mabry and Ulbrich, 1994).

(b) Fish price

The annual landing data preferred was the total amount of fishes caught by traditional fishers of South Manjung. It consisted mainly of fin fishes, prawns, shell-fishes and a negligible amount of trash fishes. Since the fisheries are multi-species and the prices fluctuate, fish prices were averaged annually following the grading system as stipulated by the DOF. Grade I group, the most highly priced fishes, were Chinese pomfret, silver pomfret, black pomfret, small pomfret, threadfin, Spanish mackerel, wolf herring, grouper and mangrove snapper; followed by less expensive Grade II fishes, such as longtail shad, shads/slender shads, red snapper, sweetlip, horse mackerel, and giant sea perch; and finally the least expensive, Grade III fishes represented by other fish species not included in Grade I or in Grade II, anchovies, squids, crabs and jellyfish. Prawns, manure fish (sometimes termed as by-catch or trash fish) and shellfish each made up its own price grouping. In calculating the average fish price, several groups or species had to be ignored because, (1) species were not commonly caught by the traditional gears (trash fish, Grade III fishes such as anchovies, squids, crabs and jellyfish), and (2) the low priced shellfish that may distort the true average price if it was to be included in the average. Thus the annual fish price was averaged by the following equation, $P_t = \Delta P_{Grade\ I(t)} + \Delta P_{Grade\ II(t)} + \Delta P_{Grade\ III(t)} + \Delta P_{Prawns(t)}$

[4] Price index numbers measure relative price changes from one time period to another. For example, to calculate a price index for a particular year, a base period is first chosen. Let the base year be $Year_o$ with price of a good X be P_0. Then the price index of $Year_1$ with the change of price of good X, P_1 , is given by equation Price Index = P_1 in $Year_1$ / P_o in $Year_o$ * 100. It is the Price Index of good X. The Consumer Price Index (CPI) on the other hand, measures a basket of goods used by consumers with each category of goods in the basket is weighted in accordance to the proportion that average family spends. For example if the price index of goods having six categories C_i where i = 1,2,3…,n=6 is P_i and weighted to be W_i%, then the CPI of that basket of goods is given by CPI = $PI_1*W_1\% + PI_2*W_2\% + PI_3*W_3\%$ …, n=6.

÷ 4 where t is year 1992..., n=2003 and ΔP is the average fish price of Grade I, II, III and Prawns. As stated earlier, the Grade III fishes do not include anchovies, squids, crabs and jellyfish in the estimation of averaged price.

Quantifying the models

As the value of Y (price of a unit commodity) and X (quantity demanded or supplied) was obtained for each year, the demand and supply curves which follow the equation $Y = \alpha + \beta X + \mu$, were constructed. On the demand curve, the value α obtained was the maximum price a consumer is WTP (P_3) while on the supply curve, the value α was the minimum price a producer is willing to sell (P_o). By inserting all parameters obtained into the equations CS = ½ [P_3 – P_1] [Q_1] and PS = ½ [P_1 – P_o] [Q_1], the consumer surplus and the producer surplus was estimated respectively.

6.3.3 *Results*

Table 6.2 illustrates the estimated operating cost of each year taking into the account the CPI-FFs and the surveyed operating costs of year 1995 and year 2002. This study had also determined the average fishing trips per month to be 20 days or 240 days per year and be used throughout the years in question. The Ratio Method; $I_2/I_1 = P_2/P_1$ or the Price

Table 6.2: Adjusted variable costs using the CPI

Year	Price Index for Food* (PI-Food)	Price Index for Fuel (PI-Fuel)	CPI-FF	Adjusted Variable Cost per day (RM)
1992	77.1	94.2	88.07	39.87
1993	79.9	94.2	89.91	40.70
1994	82.8	91.4	88.82	40.21
1995	85.7	91.4	89.69	**40.60**
1996	88.7	91.7	90.80	41.10
1997	91.0	91.7	91.49	41.41
1998	95.8	91.7	92.93	66.37
1999	98.5	91.7	93.74	66.94
2000	100.0	100.0	100.0	71.42
2001	101.4	108.3	106.23	75.86
2002	103.2	110.8	108.52	**77.50**
2003	105.1	112.5	110.28	78.76

Note: * From Ministry of Domestic Trade and Consumer Affairs Malaysia in www.kpdnhep.gov.my/index.php?ch=20&pg=98&ac=170 dated 22 May 2004. Base year 2000=100.

Adjustment Formula; $P_2 = I_2/I_1 * P_1$ was used to estimate the cost in year of question (U.S. DOD, 2004). For example, in 1995 (CPI-FF=89.69), the fishing costs was calculated at RM 40.60 per fishing trip. In Price Adjustment Formula, P_2 is the cost to be estimated, I_2 is the index for the period of which cost is to be estimated, I_1 is the index for the period of known cost that is, in this case equal to 89.69 and P_1 is the known cost which is equal to RM 40.60. Therefore, to estimate cost in 1994 at CPI-FF = 88.82 ; P_2 = 88.82/89.69 * RM 40.60 = RM 40.21.

The annual data on fish landings and the average ex-vessel prices are illustrated in Table 6.3 below.

Table 6.3 : Annual fish landings, average ex-vessel prices and average operational costs of traditional fishing in South Manjung.

Year	Total Fish Landing* (kg)	Average Ex-Vessel Price** (RM/kg)
1992	4,559,650.0	4.0
1993	4,105,000.0	3.62
1994	6,998,460.0	4.8
1995	7,216,680.0	5.1
1996	8,462,560.0	5.0
1997	7,109,070.0	4.77
1998	5,481,180.0	4.43
1999	4,395,940.0	4.1
2000	6,003,620.0	4.7
2001	5,518,590.0	4.43
2002	4,081,100.0	4.0
2003	5,636,210.00	3.9

Source: * AFS DOF Malaysia, ** FDOM

Fishes in the markets were sold fresh or chilled thus eliminating the amount of fishes disposed by other means such as frozen, canning, curing and reduction which were sold in other market outlets. Therefore, the actual total amount of fish sold in South Manjung markets is shown in Table 6.4.

Table 6.4 : The actual amount of fish sold in the markets

Year	Total Fish Landing* (kg)	Fish Disposition Fraction** (Fresh and Chilled)	Total Fish Sold In Markets (kg)	Average Retail Price*** (RM/kg)
1992	4,559,650.0	0.66	3,009,369	6.05
1993	4,105,000.0	0.39	1,600,950	8.25
1994	6,998,460.0	0.53	3,709,184	5.0
1995	7,216,680.0	0.58	4,185,674	5.30
1996	8,462,560.0	0.55	4,654,408	5.20
1997	7,109,070.0	0.56	3,981,079	5.50
1998	5,481,180.0	0.54	2,959,837	4.87
1999	4,395,940.0	0.49	2,154,011	5.89
2000	6,003,620.0	0.50	3,001,810	6.27
2001	5,518,590.0	0.19	1,048,532	7.12
2002	4,081,100.0	0.15	612,165	8.20
2003	5,636,210.0	0.22	1,239,966	7.30

Source: * AFS DOF Malaysia, ** AFS DOF Perak, *** FDOM

The demand scatter diagram (or scattergram) of retail price per kg against the quantity demanded over a 11-year period is shown in Figure 6.4. Since the scattergram exhibits a strong association between the two variables (Jedamus *et al.* 1976), it is assumed that the curve is characterized by a linear demand function. However, Miller *et al.* (2002) suggested that the scattergram alone is not a confirmatory statistical procedure. The scattergram allows the researcher to check visually the validity of a general linear confirmatory procedure that is being used (such as correlation or regression). To determine whether there is a genuine relationship or not, Pearson's product-moment correlation coefficient parametric test was applied to retail price against the quantity fish demanded ($r = -0.734$, $P = 0.024$). The negative relationship was significant at the 5% level indicating the nature of demand function, such that as price of fish increases, the less is being demanded.

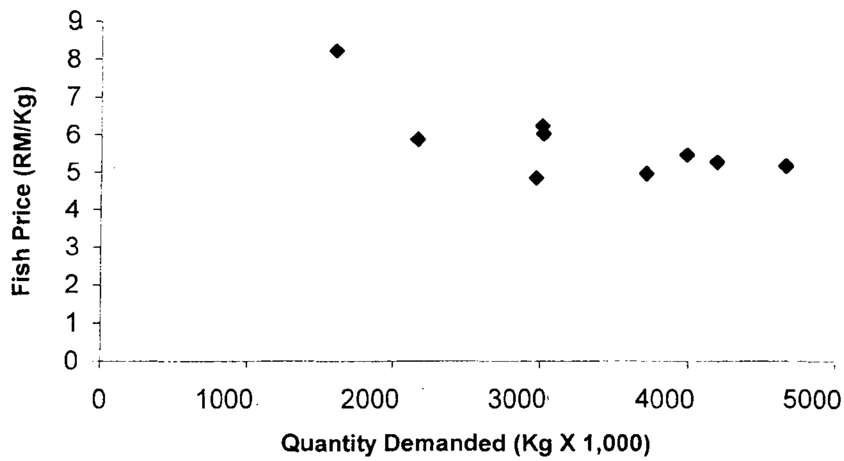

Figure 6.4: The scattergram of fish price (retail) against quantity demanded

The relationship between price (P_t) and quantity demand (Q_t) of fish was $P_t = 8.318 - 7.70E - 07Q_t$. The consumers' surplus of a particular year was represented by the area under the curve but above the retail price; that is, consumers' surplus, $CS_t = \frac{1}{2}$ [8.318 - P_t] [Q_t]. The net consumers' surplus is thus given by NCS = $\sum CS_t$ which fot the years 1992 to year 1997 was RM 28,802,337 and between 1998 and 2003 was RM 12,086,913 (Table 6.5), indicating a loss of RM 16,715,424 as a result of change of environment (land reclamation) after 1997.

Table 6.5: The difference of consumer surplus before and after perturbation

Year (i)	Retail Price- RM (P_t)	Quantity Demanded- kg (Q_t)	Consumer Surplus- RM (CS_t)
1992	6.05	3,009,369	3,412,624
1993	8.25	1,600,950	54,432
1994	5.0	3,709,184	6,153,536
1995	5.30	4,185,674	6,316,182
1996	5.20	4,654,408	7,256,222
1997	5.50	3,981,079	5,609,340
Total			$\sum CS_t$ = 28,802,337
1998	4.87	2,959,837	5,102,759
1999	5.89	2,154,011	2,614,969
2000	6.27	3,001,810	3,073,853
2001	7.12	1,048,532	628,070
2002	8.20	612,165	36,117
2003	7.30	1,239,966	631,142
Total			$\sum CS_t$ =12,086,913

The supply scattergram over 11 year period between ex-vessel price per kg and the quantity supplied is shown in Figure 6.5. The relationship between supply is designated by $P_t = 2.71 + 2.989*10^{-7}Q_t$, where P_t is the ex-vessel price, Q_t is the quantity supplied and t is year 1992..., n = 2003. The producers' surplus is the area below the ex-vessel price but above the supply function curve. Thus, the producers' surplus is given by $PS_t = ½ [P_t - 2.71] [Q_t]$, where P_t is the ex-vessel price, Q_t is the quantity sold and t is year 1992 ..., n = 2003. The net producers' surplus, NPS = $\sum PS_t$. For the years 1998 -2003 was lower than that in years 1992-1997 indicating a loss of RM 13,283,609.10 to the fishers (Table 6.6).

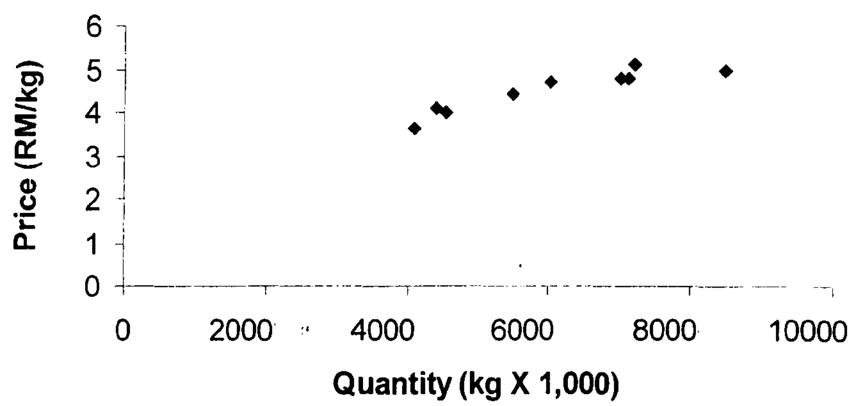

Figure 6.5: The Scattergram of fish price (ex-vessel) against quantity supplied

Table 6.6: The Difference of producer surplus before and after perturbation

Year	Quantity (kg) (Q_t)	Ex-vessel Price (RM) (P_t)	Producer Surplus (RM), $PS_t = ½ [P_t - 2.71] [Q_t]$
1992	4,559,650	4.0	2,940,974
1993	4,105,000	3.62	1,867,775
1994	6,998,460	4.8	7,313,391
1995	7,216,680	5.1	8,623,933
1996	8,462,560	5.0	9,689,631
1997	7,109,070	4.77	7,322,342
			$\sum PS_t$ = 37,758,046
1998	5,481,180	4.43	4,713,815
1999	4,395,940	4.1	3,055,178
2000	6,003,620	4.7	5,973,602
2001	5,518,590	4.43	4,745,987
2002	4,081,100	4.0	2,632,310
2003	5,636,210	3.9	3,353,544.
			$\sum PS_t$ = 24,474,436

Producers' surplus can also be estimated by the accounting method. The net profit of fishers is the difference between total revenue and the total variable cost. The total revenue is the amount fishers get by selling their fish at a given price. This net profit is the producers' surplus and is given by $PS_t = TR_t - TVC_t$, where TR is the total revenue, TVC is the total variable cost and t is the year 1992, 1993, 1994 ..., n = 2003. The TVC of a particular year is given by TVC_t = operating cost per fishing trip * 20 fishing days * 12 months * number of fishing vessels. For example, in 1992, there were 500 fishing vessels, each spending an average RM 39.87 for every fishing trip. Therefore, TVC_{1992} = RM 39.87 * 20 * 12 * 500 = RM 4,784,400. NPS for the years 1992 - 1997 was RM 150,564,580 compared with RM 57,292,913 between 1998 - 2003, indicating a loss of RM 93,271,667 as a result of the projects. (Table 6.7).

Table 6.7: Accounting method: The difference of producer surplus before and after perturbation

Year/No.of Vessels (i)	Total Revenue (TR_i) RM	Total Variable Cost (TVC_i) RM	Producers' Surplus (PS_i) $TR_i - TVC_i$ RM
1992/500	18,238,600	4,784,400	13,454,200
1993/525	14,860,100	5,128,200	9,731,900
1994/483	33,592,608	4,661,143	28,931,465
1995/511	36,805,068	4,979,184	31,825,884
1996/515	42,312,800	5,079,960	37,232,840
1997/455	33,910,263	4,521,972	29,388,291
$\sum PS_i$			150,564,580
1998/515	24,281,627	8,203,332	16,078,295
1999/529	18,023,354	8,498,702	9,524,651
2000/898	28,217,014	15,392,438	12,824,576
2001/802	24,447,353	14,601,533	9,845,820
2002/792	16,324,400	14,731,200	1,593,200
2003/770	21,981,219	14,554,848	7,426,371
$\sum PS_i$			57,292,913

6.4 Section 2 : Cockles farmers losses

6.4.1 *Introduction*

In the Third Malaysian Plan (1991 – 1995), the aquaculture sub-sector recorded a 20.5 % annual growth rate which was higher than the target growth rate of 12 % (Ministry of Agriculture, 2003). It continues to receive favorable attention from the government when a proposal was made in the Third National Agricultural Policy (1998 - 2010) to encourage aquaculture through large-scale open marine-cage culture (Ministry of Agriculture, 2003). The importance of aquaculture as a mean of food production to complement the already deteriorating marine fish landings was again emphasized by Ahyaudin Ali in his professorial appointment speech when he said that aquaculture remains the 'jewel' of the fisheries sector of the nation (USM, 2003).

In terms of aquaculture production, cockle (blood cockle, *Anadara granosa*) culture plays a very important role in contributing marine food to society. Despite the government's effort to promote and enhance aquaculture production in other areas, cockle culture remains a major aquaculture production in the country. In 1995, Malaysia was the highest mollusc producer with annual production of 100,000 t, where the major species were blood cockle (*Anadara granosa*), brown mussel (*Mytilus viridis*) and green mussel (*M. smaragdinus*) (FAO, 2003). The culture of cockles in mangrove mud flats in Peninsular Malaysia is the most important brackishwater culture in terms of production, and contributes to over 90% of the mariculture production (Choo and Raihan, 2003). However, the future of cockles culture in the country is being endangered by human activities along the coastline. Hashimi Ismail (WWF press release, 19 Januari 2001) warned that the breeding grounds of the cockles in Perak are being threatened by the removal of mangroves, coastal reclamation, environmental degradation and pollution.

Table 6.8 illustrates cockle production since 1992 to 2001 in the State of Perak, compared with other aquaculture productions. Its contribution is the highest in quantity throughout the years and only second to the marine pond production in terms of revenue. Before the intervention, for the period between 1992 and 1997, 490.32 ha of coastal land were used to culture cockles operated by three farm owners but at the beginning of 1998, the activities stopped altogether. The main reason was that the Land Office of Manjung refused to renew the TOL [5] permits to the farmers, without giving any reason to them. Unofficially, according to Wang (pers. comm.) the termination of the licenses was to make way for the land reclamation project. This was further verified by face-to-face interviews with five of the former farmers of the concerned cockle farms.

[5] Temporary Occupational License (TOL) issued by Land Office. This license has to be renewed annually at fee of RM 100/0.4 ha.

Table 6.8 : Annual Aquaculture Productions in Perak

Freshwater (t)						Marine(t)			TOTAL (t)
Year	Pond	Mining Pond	Cage	Pen-Culture	Concrete Pond	Pond	Cage	Cockles	
1992	402.47 (1.653)	604.53 (1.430)	14.03 (0.0468)	-	-	371.72 (6.690)	496.14 (4.511)	51018.25 (12.754)	52907.14 (26.988)
1993	831.11 (3.253)	762.53 (2.500)	31.52 (0.110)	-	-	619.20 (11.145)	1839.92 (22.552)	54919.17 (13.730))	59003.77 (41.750)
1994	748.67 (3.262)	1556.32 (5.168)	112.92 (0.662)	-	-	1226.15 (25.749)	1576.12 (25.658)	50880.90 (17.808)	56101.08 (78.306)
1995	919.88 (4.15)	1393.81 (4.65)	113.07 (0.62)	31.68 (0.14)	280..82 (1.05)	1433.84 (32.82)	1533.48 (25.03)	70256.73 (28.10)	75963.21 (96.56)
1996	1267.32 (5.56)	1903.06 (6.65)	87.74 (0.50)	206.51 (0.91)	246.03 (0.92)	1761.94 (38.39)	1791.89 (28.13)	45089.64 (27.05)	52354.13 (108.11)
1997	1741.31 (7.78)	2655.35 (10.29)	89.56 (0.60)	238.11 (1.01)	319.19 (1.28)	1969.26 (41.16)	1444.57 (21.22)	33899.24 (23.73)	42356.59 (107.07)
1998	2158.90 (9.09)	3357.64 (12.21)	61.61 (0.37)	133.82 (0.55)	267.23 (1.01)	2579.77 (71.89)	1386.91 (19.19)	54506.52 (43.60)	64452.40 (157.91)
1999	4607.64 (18.11)	5343.40 (18.51)	86.13 (0.43)	70.31 (0.28)	254.49 (0.94)	2032.65 (55.33)	698.72 (9.13)	56031.91 (44.83)	69125.25 (147.56)
2000	5403.78 (21.04)	5995.75 (20.93)	126.16 (0.57)	148.24 (0.57)	274.33 (1.05)	2685.25 (82.87)	525.26 (7.61)	43382.17 (34.71)	58540.94 (169.35)
2001	5380.84 (21.14)	4608.20 (15.22)	368.41 (1.55)	164.74 (0.63)	294.66 (1.13)	5459.21 (139.04)	708.40 (10.48)	51583.36 (41.27)	68567.82 (230.46)

Source : Fisheries Statstics of Perak 1992 - 2001

6.4.2 *Materials and methods*

Aquaculture, particularly cockle breeding was known to be badly affected by the land reclamation project. For this study, the lost benefits were calculated as monetary value of cockles that was supposed to be received by the farmers if the project had not been there in the first place. Again, the accounting method was used to gauge lost benefits.

The producer surplus in each year was calculated beginning with year 1991 to 1997 as in succeeding years, farming activities had ended. The producer surplus is given by $PS_t = TR_t - TVC_t$, where TR is the total revenue (quantity landed * ex-vessel price) and TVC is the total variable costs and $t = 1991 \ldots, n = 1997$.

Data collection

Data on aquaculture activities were gathered by the FDOM on a monthly basis. The only type of aquaculture activity that was directly affected by the reclamation project was cockle breeding farms. Bivalves such as clams and cockles appear to be the most sensitive since they are largely sedentary (Perunding Utama, 1997) .Table 6.9 shows the annual revenue of the cockle breeding farms since 1992. The ex-vessel price or the farm-gate price is the price received by the farmers at the landing sites. Cockle landings recorded in 1998 and thereafter were considered naturally occurring and therefore were not revenues to the farms. Since the quantity of cockles sold in the fish markets in Manjung was unknown due to unavailability of the data it restricted this study to finding farmer losses only.

Table 6.9: Annual cockle revenues of South Manjung

Year	Number of Farmers*	Total Farm Area (Hectares/Acres)	Cockles Landings (kg)	Average Ex-Vessel Price(RM/kg)	Revenues (RM)
1992	3	566.68/1,400.32	3266450	0.25	816612.5
1993	3	435.05/1,075.05	3148640	0.25	787160.0
1994	3	435.05/1,075.05	1619620	0.35	566867.0
1995	3	394.55/974.97	2142600	0.40	857040.0
1996	3	555.28/1,372.15	415200	0.60	249120.0
1997	3	555.27/1,372.15	72390	0.70	50673.0
1998	-	-	2940	0.68	1999.2
1999	-	-	11860	0.84	9962.4
2000	-	-	22700	0.80	18160.0
2001	-	-	53000	0.90	47,700.0
2002	-	-	-	-	-
2003	-	-	-	-	-

Source: Fisheries Statistics of Perak 1992 - 2002

* These are the number of registered farm owners. According to Wang (pers. comm.) only three TOL were issued by the land Office. The higher number of farmers as recorded by the fisheries statistics are actually number of people actively involved in the running of the cockle farms. Most of them are wage-earning workers thus are not considered as owner-operator farmers.

It is important to note that the cockle culture in Manjung had always under-produced compared with the production in other areas. Table 6.10 shows the rate of production per hectare in other districts in Perak. Noordin (1988) found that on average, cockle farms in Penang produced 70 t/ha at a spat stocking rate of 3.5 t/ha. The low yield in Manjung was probably due to the low stocking rate suggesting under utilization of the available culture areas. Moreover, it suggests that the cockle farmers of South Manjung did not adhere to the standard farm practices[6].

Table 6.10: Cockles Production in Metric Tonnes per Hectare in each District.

Year	Kerian	Larut and Matang	Hilir Perak	Manjung
1992	12.7	42.20	9.63	5.76
1993	21.29	23.66	35.35	7.24
1994	16.23	22.14	25.67	3.72
1995	27.50	27.14	17.41	5.43
1996	9.67	23.85	12.43	0.75
1997	9.11	17.46	11.04	0.13

Source : Annual Fisheries Statistics of Perak 1992 - 1997

Variable costs, the costs of running a farm on daily basis, were obtained by conducting a survey interview on 20 October 2003. Five randomly selected former cockle farmers of South Manjung were interviewed by posing open-ended questions following the cost-benefit analysis procedures by Noordin (1988) who surveyed a cockle culture project in Penang state. The guidelines for the estimation of the cost and benefit of the cockle farm on the average of 0.4 ha basis are given below:

<u>General Information</u>

Cockle spats stocking rate is 50 gunnysacks/ha. The weight of one gunnysack is estimated to be about 70 kg. This is the optimum stocking rate that generally will produce about 1,000 gunnysacks of adult cockle per hectare. The size of an adult cockle is 31.8 mm and it is the legal size that can be sold in the market (Fisheries Marine Regulation 1967 (Protection and Conservation of Cockles, species *anadara granosa*). In Penang, cockles took two years to reach marketable size. However, culture duration varies in accordance to the fertility of the sea-beds, pollutions and other environmental factors. In Perak, cockles took between 10 - 12 months to reach the marketable size.

1. <u>Fixed Cost</u>

A fixed cost of a cockle farm is the value of boat used in its operation. The size of the boat used is normally between 10 -15 GRT fitted with in-board diesel engine having horse-power between 60 - 120 h.p. Cockles collection is done by using a rake with sieve size more than 15 mm (Munprasit, *et al.* 1989). The value of this rake is normally absorbed in the boat's price. The number of boat in each farm varies depending on the production capacity of a farm.

2. <u>Variable Costs</u>

a. Stocking Rate per Acre

The cost of one kg of cockle spats is between RM 0.23 - RM 1.85. Therefore, the cost of a gunnysack of spats = 70 kg * the cost of spats per kg. Supposing the stocking rate is 50 gunnysacks /ha, then the cost of spats /ha is = 50 gunnysacks * cost of spats per gunnysack. However, the

[6] Bulletin no.28 authored by Noordin (1988) is the DOF publication and its cockles breeding guidelines are considered as standard farm practices.

stocking practice is not always observed. In Perak, all farmers do not abide the suggested stocking rate. This is clearly evidenced by their low production per acre.

b. Licenses
The fee of 'Temporary Occupational License' (TOL) land use paid
to Land Office = RM 250/ha per year.

Marine Aquaculture System (MAS) fee paid to the Department of Fisheries
= RM50.00 per year per farmer (regardless of farm size).

c. Administration
Each farm hires one or more workers to perform several duties. The most important duty of a worker is to look after the farm. Other duties are to collect the adult cockles and seeding spats at the sea-beds. The wages are paid monthly by means of cash. A farmer normally spends between RM 1,000.00 - RM 2,000.00 annually for other miscellaneous expenditures including fuel cost for the boats.

d. Depreciation of fixed cost
The variable cost of a fixed cost the total depreciation of the value of the boat. The depreciation rate is taken to be 10% per annum.

e. Total Variable Costs (TVC)
Total Variable Costs = Stocking Rate + TOL fee + MAS fee + Wages +
Miscellaneous + Depreciation costs.

3. Revenues
Total Revenues = Quantity of adult cockles harvested (kg) * ex-vessel price per kg.

4. Net Profit
Net Profit = Total Revenues - Total Variable Costs

All farmers interviewed did not keep their farm accounts properly and therefore most of the information was based on their memory and assumed to be in good faith. Each was asked, on an annual average, his practice and expenditures since 1992 until present. Although the information given was solely based on memory, they did provide some reliable information that appear to concur amongst each other. However, all of the farmers surveyed did not remember the amount of spats stocked each year, but assuming that each gunnysack of spats would produce 20 gunnysacks of adult cockles, then the amount of spats stocked in the previous year can be estimated. Table 6.11 shows the summary of the stocking rates and farm costs as declared by the farmers and the calculated averages. The prices of cockles spat, adult cockles, TOL fee and MAS fee were obtained from the fisheries statistics. Contrary to Noordin's two-year breeding duration, cockles farmers interviewed said that their cockles were harvested between 10 - 12 months of age, which is the maturity age given by SERI (2002).

Table 6.11: Cockle farming costs

Farmers Identification	Stocking Rate per hectare (kg)	No. of Workers	No. of Boats	Wage per Worker Per month (RM)	Miscellaneous Costs per month (RM)	Price of a Boat (RM)
Farmer 1	50:1	4	2	600	500	23,000
Farmer 2	50:1	3	3	600	1,000	24,000
Farmer 3	50:1	4	2	650	250	22,000
Farmer 4	50:1	4	2	600	500	25,000
Farmer 5	50:1	4	2	700	800	26,000
Average	50:1	3.8*	2.3*	630	610.00	24,000

Note: * These averages are rounded up to 4.0 and 2.0 respectively.

The marketing strategy of cockle farming is to ensure steady supply of cockles to the markets. In so doing, farmers could control the amount supplied, thus making sure the price offered by traders always exceeded the long-run average cost (Berg, *et al.* 2003). Knowing the amount of cockles harvested, then the spats stocked can be estimated by the equation $A_{ht} = \beta A_{st-1}$, where A_{ht} is the amount harvested at time t, say, year 1992, A_{st-1} is the amount of spats stocked in year t-1 (1991) and β is equal to 20. In this case, the amount of harvested adult cockles, A_{ht}, was known through the published annual fisheries statistics of Perak. The spats stocked for particular harvest year were thus estimated by $A_{st-1} = A_{ht} / \beta$ (Table 6.12).. For example, in 1992, the 3,266.45 t of adult cockles harvested originated from 163.32 t of spats stocked in year 1991.

Table 6.12: Annual estimated stocked spats

Year	Adult Cockles Harvested (kg)	Estimated Spats Stocked (kg)
1991	-	163,322
1992	3,266,450	157,432
1993	3,148,640	80,981
1994	1,619,620	107,130
1995	2,142,600	20,760
1996	415,200	3,619
1997	72,390	-
1998	2,940	-
1999	11,860	-
2000	22,700	-
2001	-	-
2002	-	-
2003	-	-

Although the suggested number of working boats required was one boat for each four-hectare of culture area (Wang, pers. Comm.), most of the farmers surveyed used only on the average two boats for a farm and with regard to number of workers, each of them on the average hired four workers only. The low number of man-power and boats reflects the low farming effort by reducing stocking rates and managing smaller amounts of cultured cockles. Generally, all farmers surveyed did not maximize their farms potential due to lack of capital. Towards the termination of their farms' TOL in 1996 and 1997, most farmers reduced the number of workers and boats to the minimum, i.e. one worker with a boat for each farm.

The TVC of running cockle farms for the previous years was estimated by the following methods:

(a) ***Fixed cost***

During the TVC survey in 2003, the price of a boat quoted by respondents was the price when they first bought the boat at the start of their farming project, an average RM 24,000 per boat. Since all respondents started farming more than 10 years ago, it was assumed that the price quoted began in 1988. Thus, the TVC of this fixed cost is the annual depreciation cost of the boat which is taken as 10 % of the remaining value of the boat, given by $D_t = P_{t-1} * 0.1$ and $P_t = P_{t-1} - D_t$ where D_t is the depreciation cost for particular year, P_t is the price of the boat at that particular year and P_{t-1} is the price of the boat of previous year. Year 1988 is the base year whereby P_{1988} = RM24, 000. For example, since P_{1988} = RM24, 000, then the depreciation cost of year 1989 is given by $D_{1989} = P_{1988} * 0.1$ = RM24, 000 * 0.1 = RM2, 400. Hence, the remaining value of the boat in year 1989, was $P_{1989} = P_{1988} - D_{1989}$ = RM24, 000 - RM2, 400 = RM21, 600. The depreciation cost of the subsequent year is thus calculated by equation $D_{1990} = P_{1989} * 0.1$ and $P_{1991} = P_{1990} - D_{1991}$. Table 6.13 shows the annual depreciation costs of boats used by the farmers. With the termination of TOL beginning 1998, all boats were either sold to fishers or converted to other purposes. Therefore, the depreciation costs ended in 1997.

Table 6.13: Annual boats depreciation cost

Year	Number of Farms	Number of Boats	Depreciation Cost Per Boat(A boat value In 1988 = RM24,000.00) (RM/boat)	Total Depreciation Costs (RM)
1988	3	6	0	0
1989	3	6	2,400.00	14,400.00
1990	3	6	2,160.00	12,960.00
1991	3	6	1,944.00	11,664.00
1992	3	6	1,749.60	10,497.60
1993	3	6	1,574.64	9,447.84
1994	3	6	1,889.57	11,337.84
1995	3	6	1,700.61	10,203.66
1996	3	3	1,530.55	5,591.65
1997	3	3	1,375.50	4,126.50

(b) *Variable costs*

The annual price of cockle spat purchased by the farmers was gauged from the Annual Fisheries Statistic of Perak years 1992 - 2003. The annual TOL and MAS fees were available from the record kept by the FDOM. While TOL fee paid was RM 250/ha annually to the Land Office, the MAS fee collected by FDOM was RM50.00 per owner per year regardless of the size of the farm. Table 6.14 shows the annual variable costs of cockle spat , TOL and MAS fees.

Table 6.14: The annual variable costs of cockles farming

Year	Number of farmers	Total Farm Area (Hectares)	The Amount of Cockle Spats (kg)	Cockles Spat Price (RM/kg)	Total Value of Cockles Spat (RM)	TOL Fee	MAS Fee
1991	-	-	163,322	0.60	97,993	-	-
1992	3	566.68	157,432	0.65	102,330	140,032	150
1993	3	435.05	80,981	0.23	18,625	107,505	150
1994	3	435.05	107,130	0.31	33,210	107,505	150
1995	3	394.55	20,760	0.8	16,608	97,497	150
1996	3	555.28	3,619	0.93	3,366	-	150
1997	3	555.27	147	1.85	271	-	-
1998	-	-	593	2.87	1701	-	-
1999	-	-	1,135	2.47	2,803	-	-
2000	-	-	-	3.54	-	-	-
2001	-	-	-	12	-	-	-
2002	-	-	-	6	-	-	-
2003	-	-	-	5	-	-	-

Noordin (1988) observed that worker's main activities in the farm were collecting, cleaning and packing the adult cockles in preparation for sale to the wholesalers or retailers. In the

2003 survey, they were also responsible for the security of the farm and other miscellaneous operation of the farm. A worker's monthly wage in 1997 was calculated on average at RM630 per month. Since there was no previous year's record on the wages of the workers, the CPI was used as the deflator of the wage assuming the wage rate followed the inflation rate. Thus, using the Price Adjustment Formula, $P_2 = I_2/I_1 * P_1$, where $I_1 = 91.0$ and P_1 = RM 630, P_2 was obtained by fitting the value of I_2, which is the CPI of the year in question. Table 6.15 shows annual total wages incurred by all farms.

Table 6.15: Annual total wages of cockles farming

Year	Number of Farms	Number of Workers	CPI*	Estimated Wage per worker (RM/Month)	Total Wages (RM/Year)
1991	3	12	73.6	509.54	73,373.54
1992	3	12	77.1	533.7	76,862.77
1993	3	12	79.9	553.15	79,654.15
1994	3	12	82.8	573.23	82,545.23
1995	3	12	85.7	593.31	85,436.31
1996	3	3	88.7	614.08	22,106.77
1997	3	3	91.0	630.00	22,680.00

*Source: Department of Statistics Malaysia in http://www.bnm.gov.my/files/publication/msb/2004/3/pdf/vi_12.pdf dated 12 June 2004.

6.4.3 *Results*

Since the quantity of cockles sold in fish markets in Manjung was unknown, the calculation of the consumers' surplus was abandoned and thus had to be assumed as having zero value. On the other hand, the producers' surplus was calculated from 1992 to 1997, but for the last two years, farmers had stopped stocking cockle spat since they were fore-warned by the Land Office to stop investing in future production, as an indication of the termination of the TOL permits. Farmers did not pay the TOL fees from 1996 and the MAS fees from 1997 (Wang, pers.comm.). They reduced the man-power requirement to the very minimum, i.e. a single person to watch over a farm using a boat. All unused boats were sold to fishers living nearby the areas. Only the accounting method was used to derive the producers surplus since with only four remaining observations, it was unlikely to produce good result (Studenmund, 1997). Table 6.16 shows the annual total variable costs.

Table 6.16: Annual total variable costs of cockles farming

Year	Depreciation Cost	Spats Cost	TOL fee	MAS fee	Wages	Misc. Cost	TOTAL
1991	11,664	97,993	140,032	150	73,373	3,000	326,213
1992	10,497	102,330	140,032	150	76,862	3,000	332,873
1993	9,447	18,625	107,505	150	79,654	3,000	218,382
1994	11,337	33,210	107,505	150	82,545	3,000	237,748
1995	10,203	16,608	97,497	150	85,436	3,000	212,895
1996	5,591	3,366	0.0	150	22,106	3,000	34,214
1997	4,126	0.0	0.0	0.0	22,680	3,000	29,806

The total PS over the six-year period before the projects was RM 1,965,146 (Table 6.17) or on average of RM 327,524 per year, implying about the same amount gained if there was no development project. Although the previous cockle production was relatively small compared with other districts, it had tremendous potential. Cockle culturists in Penang produced 400 gunnysacks or 28 t of adult cockles per acre of land. Assuming that the average 1,211 acres of farms in South Manjung are managed and operated to optimal farm practices, then they would be estimated to produce 33,908 t of adult cockles valued at RM 27,126,400, for a farm-gate price of RM 0.80 /kg.

Table 6.17: Annual producer purplus of cockle farming

Year	$Revenue_i$ (RM)	TVC_i (RM)	PS_i (RM)
1992	816,612	326,213	490,399
1993	787,160	332,873	454,286
1994	566,867	218,382	348,484
1995	857,040	237,748	619,291
1996	249,120	212,895	36,225
1997	50,673	34,214	16,458
Total	3,327,473	1,362,326	$\sum PS_i = 1,965,146$

6.5 Section 3: Government losses

6.5.1 *Introduction*

The costs incurred by fishers or farmers are the accounting costs or the financial costs or the private costs. All the cost terms used carry the same meaning that the producer, in this example, a fisher , calculates only his own costs of fishing out of his own pocket as oppose to the economic costs, that according to Callan and Thomas (2000:48), includes both the *explicit* or "out-of pocket" costs associated with production and all *implicit* costs based on the highest-valued alternative use of any economic resource. When a fisher goes out fishing, apart from his "out-of pocket" costs, the government also indirectly contributes to the fishing costs, in terms of fuel subsidy and the fisheries management costs, and in addition, fishers have to forgo earnings that can be obtained by working elsewhere. These costs, including the out-of pocket costs, are the opportunity costs which is defined as the value that could be used to produce other next best items had it not used the resource to produce the item in question (Field, 1994; Dobson, *et al.* 1998). In economic terms, the opportunity costs are the society costs that are included in the profit maximization scheme of a firm where Total profit = Total revenue (TR) - Total costs (TC). TR is simply the monetary value of the firm's sales, found as the product of market price (P) and the quantity of output sold (q) (TR = P*q). The TC include all economic costs associated with producing the output (Callan and Thomas, 2000).

The existence of the perturbation has been shown above to affect not only consumers and producers, but the government as well. Bio-economic modelling on the small pelagic fisheries of the west coast of Peninsular Malaysia by FAO(2001) using the BEAM 5 simulation model, the diesel fuel subsidy cost as endured by the government was calculated with an adjustment factor between 1.25 to 1.30 for various fishing gears as against the financial operating costs paid by the fishers. For example, if a drift-net fisher paid RM 100 for his fishing expenditure, then the economic operating costs would be RM 125, inclusive of fuel subsidy valued at RM 25. Apart from the fuel subsidy cost, the government also spent a substantial amount of money on the development of fisheries. FAO (2001) termed it as the fisheries management costs which include expenditure for fisheries research, administration costs and the costs of enforcement, and calculated these costs at RM 11.9 million per year. On the other hand, fishers opportunity labour costs, estimated at the average annual wage of a factory worker was valued at RM 4,704.00 per annum.

In other instances, government costs can also be regarded as a subsidy to a particular sector or industry since they correspond to the definition given by FAO Fisheries Glossary and Encyclopaedia Britannica (2001) that it is "a direct or indirect payment, economic concession, or privilege granted by a government to private firms, households, or other governmental units in order to promote a public objective". In more specific fisheries terms, FAO (2002) defined fisheries subsidies as government actions or inactions that are specific to the fisheries industry and that modifies - by increasing or decreasing - the potential profits by the industry in the short-, medium - or long-term. As an economic concept, therefore, a subsidy may be defined as "a government-directed, market-distorting intervention which decreases the cost of producing a specific good or service, or increase the price which may be charged for it (Barg, 1996). It is a form of government intervention - or lack of intervention - that affects the fisheries industry and that has an economic value. This economic value is interpreted as something having an impact on the profitability of the fisheries industry.

There are many forms of subsidies provided by government to the fisheries industry[7], but in this study only the most relevant are selected particularly those received by or imposed on the fishers of South Manjung. Following Westlund (2004), subsidies identification was carried out using the two-angle approach, that is, from the point of view of the providers and from the point of view of the recipients. Only two subsidy providers were identified; (1) the Department of Fisheries (DOF), and (2) Fisheries Development Authority of Malaysia (FDAM). Documents pertaining to fisheries development obtained from the district offices

[7] FAO (2002) classifies fisheries subsidies into four main categories, that is, (1) Direct financial transfer, (2) Services and indirect financial transfer, (3) Interventions with different short and long-term effects, and (4) Lack of intervention. Example of subsidies of category 1 are investment grants (e.g. to purchase vessels or for modernization), grants for safety equipment, vessel decommissioning programs, equity infusions, income guarantee schemes, disaster relief payments, price support, direct export incentives, etc. while profit-decreasing subsidies in this category would include, for example, various taxes and fees, and import/export duties. In category 2, subsidies may be in the forms of investment loans on favourable terms, loan guarantees, special insurance schemes for vessel and gear, provision of bait services, indirect export promotion support, inspection and certification for exports, specialized training, extension, ports and landing site facilities, payments to foreign governments to secure access to fishing grounds, government funded research and development programs, international cooperation and negotiations, fuel tax exemptions, investment tax credits, deferred tax programs, special income tax deductions, etc. Government's interventions on import quotas, direct foreign investment restrictions, environmental protection programs, gear regulations, chemicals and drugs regulations, fisheries management are subsidies under the third category and finally, the examples of category 4 subsidies are free access to fishing grounds, lack of pollution control, lack of management measures, non implementation of existing regulations, etc.

of DOF and FDAM located in Manjung were studied and some officers were interviewed on the subsidies allocation among fishers. The findings showed that bulk of the government allocations spent on the development of fisheries were channeled through the DOF, and the diesel subsidy, which was first introduced in Malaysia during the Budget Report 2002 speech in Parliament by the Minister of Finance on the 19 October 2001 (KPDNHEP,2004), was not meant for traditional fishers but rather to stimulate the deep-sea fishing industry. It appears that the fuel subsidy as suggested by FAO (2001), was in actual fact the already existing subsidy system provided for general public that had been practiced by the government since 1983 to lessen the economic burden of the population. Nonetheless, this fuel subsidy is assumed to meet the stipulated definition as its objective is to enhance the economic activities of the population.

It is not, however, the purpose of this study to question the appropriateness of the government's conduct in providing subsidies or its effect on the market systems rather to establish if the costs spent were subsidies thus merit costing calculation. According to Bernama (19 May 2004), subsidies are generally costs on public funds and such money could be directed to areas which could generate long-term GDP growth. If government expenditures or subsidies spent do not meet its objectives, then the costs become benefit loss to society.

6.5.2 *Materials and methods*

Unlike in fish or cockles evaluation, Government's losses demand a separate method of evaluation. The evaluation consists of three parts; (1) fuel subsidy costs, (2) fisheries management costs and (3) government expenditure costs of which was based on performance guidelines issued through the Treasury Circular No. 5 Year 1990.

Fuel subsidy costs

The retail price of the petroleum products[8] has been controlled through the Automatic Price mechanism (APM) since 1983 (Parliamentary debate, Question number 85, dated 26 June,2002). Through the APM, the government first determines a long-run retail price level based on market conditions and cost of production and crude oil, as well as dealers' commission. If the calculated market price is lower than the long-run price level as

[8] Petroleum products include unleaded petrol, leaded petrol and diesel.

determined by the government, a tax is imposed but if the calculated price is higher than the pre-determined price, oil companies are given a subsidy and tax exemption (PETRONAS Dagangan Berhad, 2004). In this study, the adjustment factor 1.25 as used by FAO (2001) to arrive at the economic operating (variable) cost of drift-netters was adopted. Table 6.18 shows the conversion of operating costs into the economic operating costs and the difference between them; the fuel costs as incurred by the government. The government fuel cost is measured between 1998 to 2003 as it was the period after perturbation.

Table 6.18: Fuel subsidy or government fuel cost

Year	Total Variable Cost (TVC) (RM)	Economic Total Variable Cost (ETVC) (RM)	Government fuel Cost (RM)
1998	8,203,332	10,254,165	2,050,833
1999	8,498,702	10,623,378	2,124,676
2000	15,392,438	19,240,547	3,848,110
2001	14,601,533	18,251,916	3,650,383
2002	14,731,200	18,414,000	3,682,800
2003	14,554,848	18,193,560	3,638,712
TOTAL			

Note: TVC * 1.25 = ETVC.

Fisheries management costs

Unlike fuel subsidy, which the purpose is to safeguard the welfare of the people (Mahathir, 21 September, 2000)[9], government expenditures in fisheries via the Department of Fisheries are more geared towards achieving the specific objectives of the government, i.e. maximization of income through the optimal utilization of resources in the sector which includes maximizing agriculture's contribution to national income and export earnings as well as maximizing income of producers (Third National Agricultural Policy,2004). Consequently, the Fisheries Department of Malaysia is given the full responsibility for the overall management, administration and development of fisheries throughout the nation. Its objectives thus include increasing the national fish production, managing the resources on a sustainable basis, developing a dynamic fisheries industry, increasing the income of fisheries operator and intensifying the development of fish-based industries (Department of Fisheries, 2004). At the macro level, the achievement of these objectives is depicted by Said (2000) pointing out the remarkable improvements in fish production in the last ten years. The achievement is also evident from the gradual shift from artisanal fishing to one

[9] Mahathir Mohammed, Prime Minister of Malaysia in Bernama dated 21 September 2000.

that is commercially oriented, and made possible by active participation of the private sector and the use of new technologies which has led to the rapid development of deep-sea fishing and commercial aquaculture contributing towards an increase in fish production. At the same time, through prudent management measures, the inshore fisheries are still the major contributor to fish production. However, a different scenario is observed if fisheries are assessed at the micro level, particularly in the Lekir waters. As demonstrated in Chapter 4, the presence of the 'island' had caused low fish catches and mangroves degradation which led to government's failure in achieving its objectives.

The objectives failure had caused wastage in government expenditures or in economic terms, opportunity costs to society, i.e. the money could be used in other feasible production systems that could benefit society, e.g. government did not use the money in fisheries, but on replacing an old primary school building.

Three most important aspects in fisheries objectives are *increasing, fish production* and *income*. The word fish operators is taken to mean both fishers and fish-farmers, and all of them are actively involved in the production of fish. To achieve these objectives, the government budget allocates annual funds to the DOF for the implementation of specified projects for the development of fisheries. These annual funds come in two packages; the operating fund and the developmental fund. The operating fund is used to run an office and paying other expenditures such as wages, emoluments, utilities, equipments etc. The developmental fund has one or several interrelated activities working together to achieve the purpose of the program. For example, if the purpose of a program is to 'increase the farmers' income from RM 150.00 to RM 200.00', then several activities deemed to assist towards accomplishing such purpose are formulated. The activities could be (1) to improve the irrigation system (2) providing agricultural subsidies and (3) fertilizer and seed aids.

Table 6.19 shows the annual government expenditures under the operating and developmental funds, generally, for the betterment of the fish operators welfare of the State of Perak. Since the precise expenditure allotted to particular groups or communities of fish operators is unavailable, and furthermore, this study is only interested on the wellbeing of fish operators in South Manjung, the expenditures spent is then viewed from the per capita allotment mechanism. If Y is the expenditures spent, X is the total number of fish operators of Perak, then the per capita allotment , $P = Y/X$. Therefore, if the number of fish operators in South Manjung is Z, then the expenditure allotment for that community will be $P * Z$. While values of Y are easily gauged from the Annual Fisheries Statistics of Perak (1992-2003), the values of X and Z are worked out by allowing for certain adjustment and assumptions. The problem is with the number of actual people actively involved in fishing since the published statistical reports do not account for unregistered fishers. Unlike fishers, the number of fish farmers is represented by the actual number of people working in the farming sector since they are easily enumerated. According to Wang (pers. comm.), all farmers are registered with the FDOM and their numbers, as published by the DOF, are accurate. The estimation of the number of fishers was then carried out first by identifying the number of vessels in operation, which is available in the statistics, and second by assuming that each vessel operating a particular type of gear will engage a maximum number of crews as suggested by the DOF. The total number of Perak's fishers are arrived at by multiplying the number of vessels in operation according to the types of gear used with the number of suggested crews (Table 6.20). A similar approach was also used in estimating the number of South Manjung's fishers (Table 6.21).

Table 6.19: Annual operating and developmental funds of DOF Perak between 1998 – 2003

Year	Operating (RM)	Development (RM)
1998	6,996,196	1,200,735
1999	3,996196	1,708,039
2000	4,264,747	3,215,022
2001	4,269,753	501,769
2002	4,467,330	1,810,251
2003	3,994,276	1,985,032

Source: Annual Fisheries Statistics of the State of Perak (1998-2003).

Table 6.20: Annual number of fishers of State of Perak

	Trawls	Fish Purse-seine	Anchovy Purse-seine	Other seines	Drift-nets	Portable traps	Hooks and Lines	Lift nets	Barrier nets	Push/ Scoop nets	Bivalve collecting	Misc	TOTAL Fishers
A	1697	44	14	489	1802	61	207	139	74	160	46	165	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(1992)	6788	528	168	978	3604	244	414	278	148	320	46	165	13,681
A	1581	39	12	430	1582	72	181	126	105	240	20	246	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(1993)	6324	468	144	860	3164	288	362	252	210	480	20	246	12,818
A	1577	42	11	416	1599	55	201	126	113	213	17	259	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(1994)	6308	504	132	832	3198	220	402	252	226	426	17	259	12,776
A	1626	43	10	396	1490	51	188	107	142	197	35	227	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(1995)	6504	516	120	792	2980	204	376	214	284	394	35	227	12,646
A	1621	44	10	387	1509	54	212	114	120	197	24	243	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(1996)	6484	528	120	74	3018	216	424	228	240	394	24	243	11,993
A	1404	45	8	337	1521	22	211	127	69	281	17	268	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(1997)	5616	540	96	674	3042	88	422	254	138	562	17	268	11,717
A	1289	50	9	322	1553	12	206	131	45	316	25	241	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(1998)	5156	600	108	644	3106	48	412	262	90	632	25	241	11,324
A	1368	51	8	329	1592	11	206	135	47	351	22	261	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(1999)	5472	612	96	658	3184	44	412	270	94	702	22	261	11,827
A	1378	51	9	334	1668	11	223	152	55	397	26	269	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(2000)	5512	612	108	668	3336	44	446	304	110	794	26	269	12,229
A	1491	58	8	344	1763	10	377	192	73	424	32	248	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(2001)	5964	696	96	688	3526	40	754	384	146	848	32	248	13,422
A	1465	58	8	324	1566	10	37	192	73	423	32	244	
B	4	12	12	2	2	4	2	2	2	2	1	1	
C(2002)	5860	696	96	648	3132	40	754	384	146	846	32	244	12,878
A	1476	56	7	334	1542	8	373	187	72	400	30	239	
B	4	12	12	2	2	4	2	2	2	2	1	1	12,777
C(2003)	5904	672	84	668	3084	32	746	374	144	800	30	239	

Note: A= Number of Vessels, B= Number of crews per vessel, C= total number of crews

Table 6.21: Annual number of fish operators of the State of Perak and South Manjung.

Year	Number of Fishers of Perak	Number of Fish Farmers of Perak	Number of Fish Operators of Perak	Number of Fishers of South Manjung	Number of Fish Farmers of South Manjung	Number of Fish Operators of South Manjung
1992	13681	2005	15686	1000	16	1016
1993	12818	2026	14844	1050	9	1059
1994	12776	1978	14754	966	9	975
1995	12646	1842	14488	1022	8	1030
1996	11993	2267	14260	1030	12	1042
1997	11717	2151	13868	910	12	922
1998	11324	2148	13472	1030	0	1030
1999	11827	2023	13850	1058	0	1058
2000	12229	1883	14112	1796	0	1796
2001	13422	1940	15362	1604	0	1604
2002	12878	1766	14644	1584	0	1584
2003	12777	1876	14653	1540	0	1540

Table 6.22 shows the annual expenditure allotment for South Manjung based on the number of fish operators. For example, in 1992, the total expenditure Y = RM 4,598,879 and the number of fish operators of Perak, X = 15,685 . Therefore, the per capita allotment of Perak is given by $P = Y/X$ = RM 4,598,879/15,685 = RM 293.18.. The total expenditures of Y spent for South Manjung is then given by multiplying the number of fish operators of South Manjung with the value of P, in this case, Y = 1,016 * RM 293.18 = RM 297,870.60.

Table 6.22: Annual expenditures spent for South Manjung

Year	Total Expenditures(RM)	Number of Fish Operators of Perak	Per Capita Allotment of Perak(RM)	Number of Fish Operators of South Manjung	Total Expenditures Spent for South manjung (RM)
1992	4598879	15686	293.18	1016	297870.6
1993	7009023	14844	472.18	1059	500038.6
1994	5421677	14754	367.47	975	358283.3
1995	3917095	14488	270.37	1030	278481.1
1996	4763990	14260	334.08	1042	348111.4
1997	4768831	13868	343.87	922	317048.1
1998	8196931	13472	608.44	1030	626693.2
1999	5704236	13850	411.86	1058	435747.9
2000	7479769	14112	530.03	1796	951933.9
2001	4771523	15362	310.61	1604	498218.4
2002	6277581.29	14644	428.68	1584	679029.1
2003	7095199.41	14653	484.21	1540	745683.4

The performance indicator is the production of goods compared with the amount of money spent. If a particular year is denoted by t_B, where t = 1992, 1993, 1994…n = 1997i.e. years before the projects, t_A is a year after the projects where t = 1998,1999, 2000…n = 2003, then the amount of money spent before the projects is given by $Exp._B = \sum[Exp._{tB}]$ and after the projects is $Exp._A = \sum[Exp._{tA}]$. Consequently, the production before and after is given by $P_B = \sum[P_{tB}]$ and $P_A = \sum[P_{tA}]$ respectively. Production can be in term of goods production, income, or services provided. The objective is to demonstrate if there is a government's performance difference between before and after the projects. Therefore, the government performance before and after the projects is assessed by measuring the difference between the total production and total expenditures before the projects, and then compare it with that after the projects.

Government's performance

To assess achievement of the government's objectives, the Ministry of Treasury Malaysia provided guidelines to relevant government agencies. The guidelines are formulated as an alternative to the usual cost - benefit analysis of the private firms that is unsuitable when measuring performance of public functions (Treasury Circular No.5 Year 1990). The government's performance is measured by three indicators with their respective indexes; they are effectiveness, efficiency, and quality and standard of services provided. Only the first two of the indicators are being considered here. The quality and standard of services provided would not be measured since it does not directly portray the achievement of the objectives. Moreover, data such as on the effectiveness of training provided, time taken for a complete cycle of licensing process, farming development, man-power efficiency are inadequately available as such a presentation of time-series performance is curtailed.

(a) ***Effectiveness***

A programme or an activity is said to achieve effectiveness if the end-result of such a programme or an activity is better than what was being expected by the policy maker. It does not take into account the cost of the programme or the activity but emphasize on the end-result alone. If X is the objective[10] of a programme or an activity as determined by the policy maker, and $X = 1,2,3\ldots n$, whereas the end-result is Y_t as measured at the end of a particular year t or at the end of specified program's duration, where $Y = 1,2,3\ldots n$, then the effectiveness index of year t, $E_t = Y_t/X$. If the comparison between years is desired, then the effectiveness index of previous year t-1, is given by E_{t-1}[11]. A programme or an activity is said to be more effective than previous year, if $E_t/E_{t-1} * 100 > 100\%$. However, since the interest here is to deduce the effectiveness of government's performance after the project compared with before, E_{AB} , then $E_{AB} = \sum[Y_{tA}]/\sum[Y_{tB}]$ where Y_{tA} is the end-result of a programme or activity a year after the projects and Y_{tB} is before the projects. The performance after the projects is said to be more effective than before if $E_{AB} = \sum[Y_{tA}]/\sum[Y_{tB}] * 100 > 100\%$ or ineffective if it is less than 100%.

[10] For example, the objective of a program is to achieve 2,300 farmers whose incomes will increase from level A to level B (Treasury Circular No.5 Year 1990).

[11] Sometimes a base year is chosen which is not necessary year t-1. The choice is again depending on the policy maker. Continuing with the example above, on completion of the program, instead 2,500 farmers had attained the level B incomes. Hence, $E_t = 1.087$. Assuming that $E_{t-1} = 1.064$, then the effectiveness of the program is given by $E_t/E_{t-1} = 1.022$ or 102.2%. Thus the program is said to be effective.

(b) *Efficiency*

Normally efficiency is measured by the ratio between the output and the input. The ratio determines the extent to which the resources are being utilized economically to produce the goods in question. Basically, efficiency is described in the following forms; production potential, man-power utilization and cost per unit production. Let Y_t be the production of year t, the expenditures spent to produce Y_t be C_t, the number of man-power needed to produce Y_t be M_t, and then the efficiency production potential index $EP_t = Y_t/C_t$, the efficiency man-power index $EM_t = Y_t/M_t$ and the efficiency cost per unit index $EC_t = C_t/Y_t$. The efficiency comparison between the present year t, and the previous year t-1, is given by EP_t / EP_{t-1} * 100, EM_t / EM_{t-1} * 100, and EC_t / EC_{t-1} * 100. The present year is said to be more efficient if its ratio to the previous year is more than 100% with the exception of EC_t, that the cost of producing a single unit of production is said to be efficient if it is less than the previous year. Hence, EC_t / EC_{t-1} * 100 < 100% is efficient.

Comparing the efficiency measures between before and after the projects is accomplished by making use; $EP_B = \sum Y_{tB} / \sum C_{tB}$, $EM_B = \sum Y_{tB} / \sum M_{tB}$ and $EC_B = \sum C_{tB} / \sum Y_{tB}$ for before and after (replacing A with B) measures. The production Y_t consists of two components, Y_{tf} where f denoting fish production and Y_{ti} where i is the incomes. Thus, a programme achieving EP_A / EP_B * 100 >100%, EM_A / EM_B * 100 > 100% and EC_A / EC_B * 100 < 100% is said to be efficient.

6.5.3 Results

Table 6.23 illustrates the data of fish production and income before and after the projects. Fish production and income was derived from the total fish landings and aquaculture production. If Y_f represents fish production and Y_i is the incomes of fish operators, then the effectiveness indexes, $E_{ABf} = \sum[Y_{tAf}]/\sum[Y_{tBf}]$ and $E_{ABi} = \sum[Y_{tAi}]/\sum[Y_{tBi}]$. Since $\sum[Y_{tAf}]$ = 31,116,640 kg, $\sum[Y_{tBf}]$ = 49,116,320, then E_{ABf} = 0.633 or 63.3%. Likewise, $\sum Y_{tAi}$ = RM 55,938,966, $\sum[Y_{tBi}]$ = RM 152,988,924, which brings the value of E_{ABi} = 0.366 or 36.6%.

Table 6.23: Fish production and Fishers' Income Before and After the Projects

Year (t)	Fish Production (Landings, KG)	Fish Production (Aquaculture, KG)	Producer Surplus (Landings, RM)	Producer Surplus (Aquaculture, RM)	Total Fish Production (Y, KG)	Total Producer Surplus (I, KG)
1992	4559650	3266450	13454200	490399.5	7826100	13944600
1993	4105000	3148640	9731900	454286.8	7253640	10186187
1994	6998460	1619620	28931465	348484.4	8618080	29279949
1995	7216680	2142600	31825884	619291.6	9359280	32445176
1996	8462560	415200	37232840	478115.60*	8877760	37710955.6
1997	7109070	72390	29388291	478115.60*	7181460	29866406.6
Total	38451420	10664900	150564580	2868694	49116320	153433274.2
1998	5481180	0	16078295	0	5481180	14724347
1999	4395940	0	9524651.6	0	4395940	9524652
2000	6003620	0	12824576	0	6003620	12824576
2001	5518590	0	9845820	0	5518590	9845820
2002	4081100	0	1593200	0	4081100	1593200
2003	5636210	0	7426371	0	5636210	7426371
Total	31116640	0	57292913.6	0	31116640	55938966

The efficiency measures of before and after perturbation (based on values in table 6.24) for the fish production are EP_A / EP_B = 33.78%, EM_A / EM_B = 62.74% and EC_A / EC_B = 325% whereas for incomes, EP_A / EP_B =19.45%, EM_A / EM_B =36.11% and EC_A / EC_B =700%.

Table 6.24: Productions, expenditures and man-power of before and after the project.

Year (t)	Productions ($Y[t]$)		Expenditures ($C[t]$)	Man-power ($M[t]$)
	fish ($Y[tf]$)	incomes ($Y[ti]$)		
1992	7826100	13944600	297874.6	165
1993	7253640	10186187	500038.6	168
1994	8618080	29279949	358283.3	171
1995	9359280	32445176	278481.1	171
1996	8877760	37710955.6	348111.4	175
1997	7181460	29866406.6	317048.1	175
Total	49116320	153433274.2	2099833.1	1025
1998	5481180	14724347	626693.2	173
1999	4395940	9524652	435746.9	173
2000	6003620	12824576	951933.9	173
2001	5518590	9845820	498218.4	172
2002	4081100	1593200	679029.1	172
2003	5636210	7426371	745683.4	172
Total	31116640	55938966	3937305.9	1035

It appears that government performance as measured in term of effectiveness and efficiency, is failing. The performance was not effective as production and income after perturbation did not improve and inefficient as well, as the same amount of expenditure and man-power utilization did not produce output at par or more than the period before perturbation. These performance measures apparently inform that government effort was curtailed by the perturbation and therefore its monetary losses should be included in any benefit-loss calculation.

6.6 Section 4: Losses measured on forecasted data

6.6.1 *Introduction*

The aim of this section is to provide another avenue in the calculation of the losses caused by the perturbation. It was shown that consumer and producer surpluses were compared between the six year period before and the six year period after the perturbation and the difference was found to be the losses as they were getting less than before (sections 1 and 2). In the estimation of government losses, fish production was compared against expected production, money spent and man-power utilized (section 3). In this section, forecasted data were compared against actual data obtained after the perturbation and the differences were benefits/losses incurred by consumers, producers and the government.

6.6.2 *Materials and methods*

The forecasting technique was used to forecast fish landings, Q_t, in years t = 1998,1999,2000...n= 2003 and then fitting the forecasted values into the demand equation $P_t = 8.318 - 7.70E - 07Q_t$. The consumer surplus is then obtained by inserting the value P_t and Q_t into $CS_t = ½ [8.318 - P_t] [Q_t]$. Similarly, the PS is obtained by imputing Q_t into the supply equation $P_t = 2.71 + 2.9890E - 07Q_t$ and the P_t obtained into $PS_t = ½ [P_t - 2.71] [Q_t]$. Since the interest here is to measure the difference in benefits received by the consumer between the forecasted and the actual fish landings, the consumer net benefit is given by $CNB_{FA}= \sum_{t=1998}^{n=2003} FCS_t - \sum_{t=1998}^{n=2003} ACS_t$ where FCS_t is the forecasted consumer surplus at time t and ACS_t is the actual consumer surplus at time t. A similar treatment is also applied to the producer's net benefit/loss, i.e. $PNB_{FA} = \sum_{t=1998}^{n=2003} FPS_t - \sum_{t=1998}^{n=2003} APS_t$, where P is the producer. The Total Economic Surpluses (TES), i.e. the surpluses benefited/lost by the society, is then given by $TES = CNB_{FA} + PNB_{FA}$.

Time-series analysis

Recording observations of a variable that is a function of time results in a set of numbers called a time series (Harnett and Murphy, 1980) and usually at equal intervals (Mulholland, and Jones, 1977). The objective of a time series analysis is to identify the components that exist to identify their causes and to forecast future values of the time series (Mendenhall, *et al.* 1986). Fisheries statistics collected on a monthly or annual basis take the form of a time series, for example, the monthly and annual fish landings of a district, monthly estimation of fishing vessels in operation and monthly fish prices in the market. Table 6.25 shows the time-series data of fish landings collected on a monthly basis in South Manjung.

Table 6.25: Monthly time-series data of fish landings of South Manjung

	Years									
Months	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Jan.	361.16	338.1	446.05	535.62	364.46	451.79	479.21	397.21	294.44	370.18
Feb.	354.86	856.21	603.69	398.35	404.14	380.98	415.64	412.16	273.7	400.08
Mar.	572.36	925.15	888.83	791.88	394.33	417.62	418.12	426.81	295.41	500.58
Apr.	1273.95	779.26	635.62	1012.44	326.45	371.87	534.01	567.39	368.91	499.63
May	1270.3	784.87	648	610.72	461.95	305.25	497.03	590.79	259.69	561.39
June	529.45	591.58	814.56	934.71	586.27	399.87	412.42	519.7	270.76	504.1
July	353.25	680.95	928.44	618.21	547.17	393.04	474.89	350.25	347.56	452.72
Aug.	419.66	371.02	649.87	523.48	576.71	329.31	470.53	533.65	463.96	452.56
Sep.	500.37	373.64	733.48	356.14	536.15	307.97	465.31	639.48	306.78	598.91
Oct.	532.44	513.91	662.46	392.23	518.2	321.31	528.05	409.72	404.01	412.44
Nov.	427.5	513.77	776.31	457.67	421.2	316.67	699.35	347.83	396.06	420.64
Dec.	403.16	488.22	675.26	477.61	344.14	400.25	609.06	322.89	399.73	462.98

Source: FDOM, 2004

The analysis of time series data in such circumstances usually focuses on two types of problems:

1. attempting to estimate the factors (or components) that produce the pattern in the series; and
2. using these estimates to forecast the future behavior of the series.

According to Harper (1991), if a graph is drawn of a time series over a long enough span of time the following features may well be seen :

(a) seasonal variation – this is a regular up-and-down pattern that repeats annually and is due to the effect of seasons on the variables;

(b) cyclical variation – this is a regular up-and-down pattern that repeats over a span of years. In the main it reflects the boom/depression economic cycle;

(c) trend – this is an overall tendency for the curve to rise (or fall);

(d) Random (residual) variations – these are odd movements of the curve which fit into no pattern at all.

Forecasting technique

Forecasting involves finding the future trend value for any season to be forecast, adjusting for the seasonal variation, and showing a potential margin of error based on the random variation. In general, forecasting is the act of predicting the future; in econometrics, forecasting is the estimation of the expected value of a dependent variable for observations that are not part of the sample data set (Studenmund, 1997). One objective of analyzing economic data is to predict or forecast the future values of economic variables (Griffiths, *et al.* 1993). Provided no new factor entering the series, the forecasted values are assumed to be in conformity with the trend. There is no such thing as a single best forecasting model to use in all instances (Mendenhall, *et al.* 1986). Broadly speaking, there are four approaches to economic forecasting based on time series data: (1) single-equation regression models; (2) simultaneously-equation regression models; (3) autoregressive integrated moving average (ARIMA) models; and (4) vector autoregression (VAR) models (Gujarati, 1995).

ARIMA models stands for Autoregressive Integrated Moving Average models or known as Box-Jenkins models or sometimes called the "p,d,q" models since these three parameters have to be specified in advance before it can be run. The parameters p is the autoregressive component, d is the integrated component indicating how many times differencing must occur to achieve stationary and q is the moving-average component. Following Studenmund (1997), the ARIMA approach combines two different specifications (called *processes*) into one question. The first specification is an *autoregressive* process (hence the AR in ARIMA), and the second specification is a *moving average* (hence the MA in ARIMA).

An autoregressive process expresses a dependent variable Y_t as a function of past values of the dependent variable, as in:

$$Y_t = f(Y_{t-1}, Y_{t-2}, \ldots, Y_{t-p}),$$

where Y_t is the variable being forecasted and p is the number of past values used. Since there are p different lagged values of Y in this equation, it is often referred to as a "pth-order" autoregressive process.

A moving-average process expresses a dependent variable Y_t as a function of past values of the error term, as in :

$$Y_t = f(\varepsilon_{t-1}, \varepsilon_{t-2}, \ldots, \varepsilon_{t-q})$$

where ε_t is the error term associated with Y_t and q is the number of past values of the error term used. Such a function is a moving average of past error terms that can be added to the mean of Y to obtain a moving average of past values Y. Such an equation would be a qth-order moving-average process.

To create an ARIMA model, both the autoregressive and moving-average processes are added to an econometric equation having no independent variables, $Y_t = \beta_0 + \varepsilon_t$ to form:

$$\begin{aligned} Y_t = \beta_0 + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \ldots + \theta_p Y_{t-p} + \varepsilon_t \\ + \varphi_1 \varepsilon_{t-1} + \varphi_2 \varepsilon_{t-2} + \ldots + \varphi_q \varepsilon_{t-q} \end{aligned}$$

where the θs and the φs are the coefficients of the autoregressive and moving-average processes, respectively.

Box-Jenkins Approach

The method, as laid out by Maddala (2001) consists of five steps (Figure 6.6). They are, (1) differencing the series so as to achieve stationary; (2) identification of the tentative model;

(3) estimation of the model; (4) diagnostic checking (return to step 2 if the model is inadequate); and (5) using the model for forecasting and control.

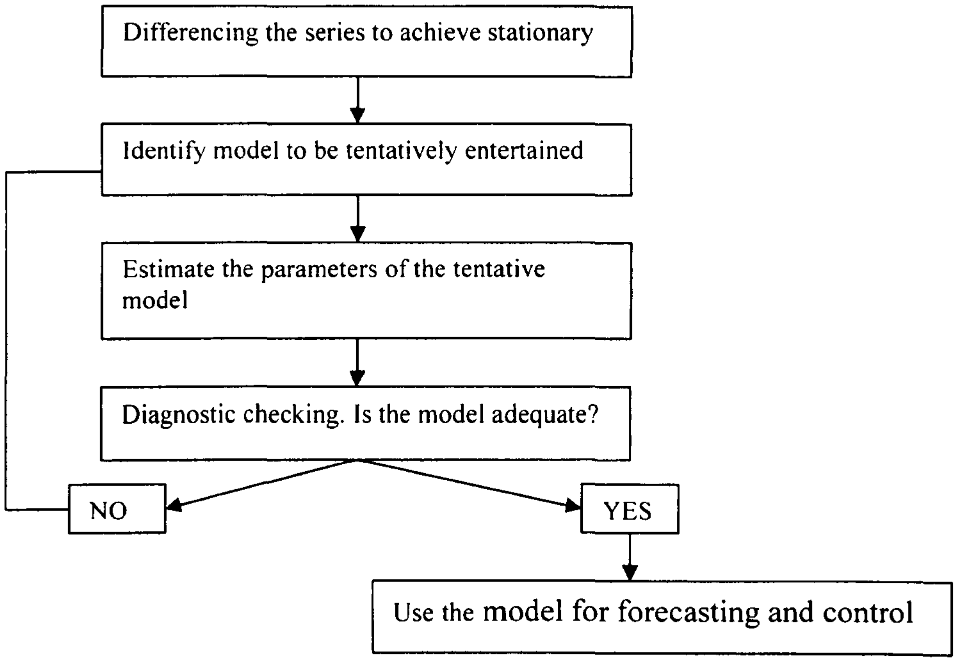

Figure 6.6: A Five-step Box-Jenkins approach for ARIMA model

6.6.3 *Results*

In any time series analysis, a visual plot of the data is usually the first step (Gujarati,1995). Table 6.26 shows a time-series data of monthly fish landings from 1994 to 1997 and Figure 6.7 is the time-series plot of monthly landings (t) plotted against time. Landings were not affected by seasons since the patterns show irregular peaks and troughs over time.

Table 6.26 : Time-series data of monthly landings of South Manjung (t)

	Year			
Month	1994	1995	1996	1997
January	361.16	338.1	446.05	535.62
February	354.86	856.21	603.69	398.35
March	572.36	925.15	888.83	791.88
April	1,273.95	779.26	635.62	1012.44
May	1,270.30	784.87	648	610.72
June	529.45	591.58	814.56	934.71
July	353.25	680.95	928.44	618.21
August	419.66	371.02	649.87	523.48
September	500.37	373.64	733.48	356.14
October	532.44	513.91	662.46	392.23
November	427.5	513.77	776.31	457.67
December	403.16	488.22	675.26	477.61

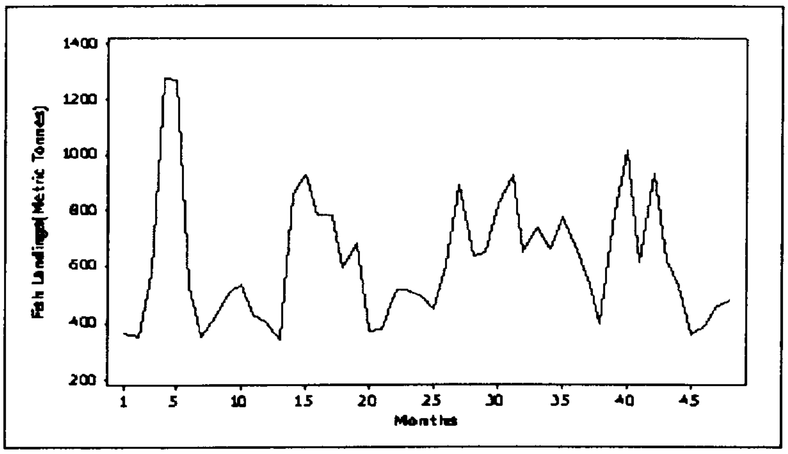

Figure 6.7: Time-Series plot of South Manjung fish landings between 1994-1997
Note: Months 1-12 (1994), months 13-24 (1995), months 25-36 (1996), and months 37-48 (1997).

Before the ARIMA model can be applied to a time series, it must be assured that the time series is stationary (Studenmund, 1997). According to Studenmund, the time-series variable, X_t, is stationary if, (1) the mean of X_t is constant over time, (2) the variance of X_t is constant over time, and (3) the simple correlation coefficient between X_t and X_{t-k} (also called an autocorrelation function) depends on the length of the lag (k) but on no other variable (for all k). The test for equality of variances (Wheater and Cook, 2003) on the time-series data showed that the F_{max} = 6.22 at P= 0.05 which is higher than the critical value of F_{max} = 5.23 (df= 11, k= 4) indicating that the variances are significantly different, thus the data were logarithmic transformed. The transformed data (natural logarithm) offered F_{max} = 5.10 indicating equal variances among the samples. To conclude whether the time series is stationary or not can be done by studying the graph of the correlogram of the series (Maddala, 2001). The correlogram is the plot of an autocorrelation function, ACF against the lag length. Figure 6.8 is the correlogram of the log-transformed monthly fish landings time series from 1994 to 1997. The time series shows no differencing (d=0) as it signifies a stationary feature since the ACF drops off as k, the number of lags becomes large which is usually not the case for a nonstationary series (Pindyck and Rubinfeld, 1998) or as put by Studenmund, a nonstationary series will show little tendency for the ACFs to decrease in size as the number of lags increases. The correlogram is produced by using the Minitab program and plugging the maximum number of lags = 48.

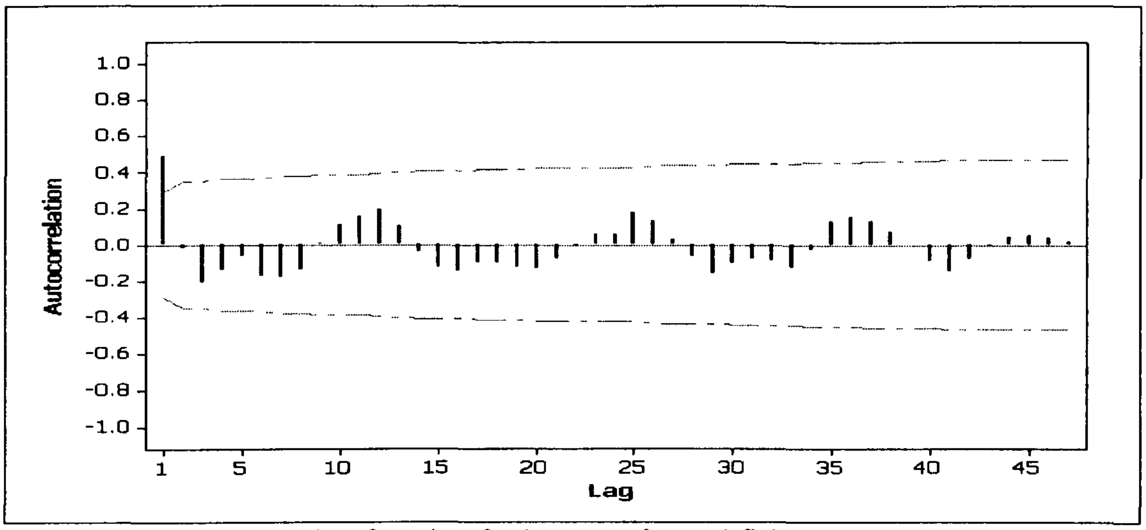

Figure 6.8: Autocorrelation function for log-transformed fish landings
(with 5% significance limits for the autocorrelations)

The next step is to arrive at the tentative ARIMA model that is, to choose the integer values for p and q having decided that $d = 0$. This is the identification process where the ACF and PACF are used to estimate p and q. Figure 6.9 is correlogram of the PACF plotted against the lag length. In particular, the last lag before the PACF tends to zero is typically a good value for p, and the last lag before the ACF tends to zero is typically a good value for q (Studenmund, 1997). Thus, in this case the tentative ARIMA model is ARIMA (2,0,1) or an equivalent to ARMA (2,1).

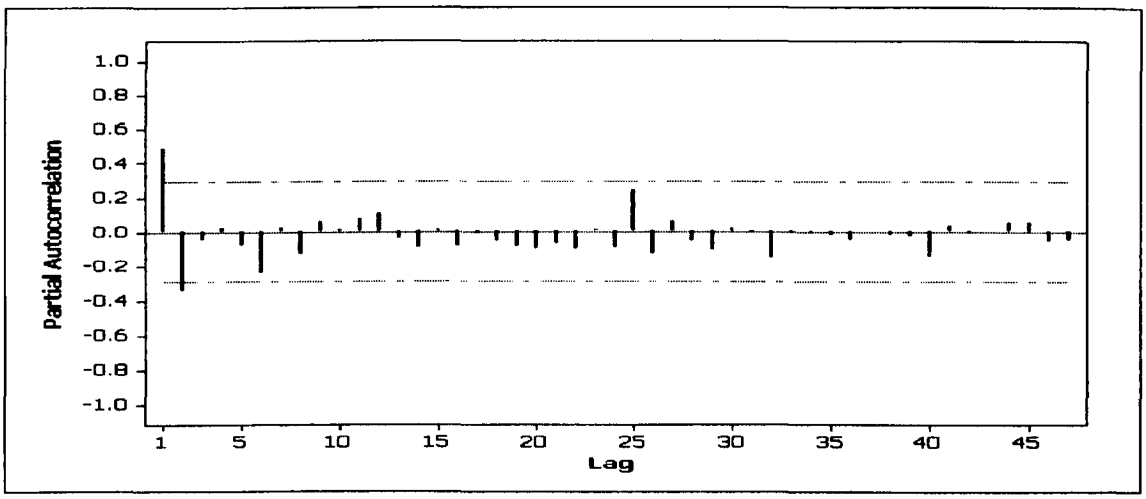

Figure 6.9: Partial autocorrelation function for log-transformed fish landings
(with 5% significance limits for the partial autocorrelations)

The tentative ARMA (2,1) was then fitted using the Minitab program and followed by the diagnostic checking on the residuals of the ACF and PACF. Other ARMA models such as ARMA (1,1), ARMA (2,1), ARMA (1,2), ARMA (2,2) were also fitted and diagnosed in similar fashion in attempt to select the best model. It was found that ARMA (2,2) represents the best model having the lowest Mean Square Error value (MSE= 0.08298) and the highest Box-Ljung statistic of nonsignificant level of P= 0.741(at lag 12) indicating that the residuals appeared to be uncorrelated.

The Minitab forecasting procedure for the next 72 months (1998 - 2003) was then performed using the model ARMA (2,2) and tabulated in Table 6.27. Thus the total annual fish landings forecasted are 6,569.67 t in 1998, 6,798.69 t in 1999, 6,860.05 t in 2000, 6,921.01 t in 2001, 6,982.58 t in 2002 and 7,044.82 t in 2003.

Table 6.27 : The forecasted fish landings

	Annual Forecasted Fish Landings (Metric Tons)					
Month	1998	1999	2000	2001	2002	2003
January	501.0635	563.9916	569.3578	574.413	579.519	584.6821
February	521.0425	564.5332	569.7735	574.8383	579.948	585.1149
March	534.6225	565.0302	570.1953	575.2638	580.3773	585.548
April	543.8048	565.4994	570.6174	575.6839	580.8069	585.9815
May	550.012	565.952	571.0398	576.11	581.2369	586.4152
June	554.2356	566.3879	571.4568	576.5365	581.6671	586.8493
July	557.1529	566.8242	571.8798	576.9633	582.0977	587.2837
August	559.2013	567.2494	572.3032	577.3846	582.5228	587.7185
September	560.6851	567.675	572.7211	577.812	582.954	588.1535
October	561.7963	568.0952	573.145	578.2397	583.3855	588.5889
November	562.6678	568.5158	573.5693	578.6678	583.8174	589.0246
December	563.3828	568.9366	573.9882	579.0961	584.2496	589.4606
Total	6569.667	6798.69	6860.047	6921.009	6982.582	7044.821

6.6.4 The forecasted net social benefit

In the absence of perturbation between period 1998 - 2003, the forecasted total consumer surplus, as the result of the surpluses summed up in those years, was $\sum_{t=1998}^{n=2003} FCS_t$ = RM 15,660,609.67 while the producer surplus, was $\sum_{t=1998}^{n=2003} FPS_t$= RM 42,253,890.14 (Table 6.28). The actual surpluses gauged for the same period of time, indicate a lower consumer surplus ($\sum_{t=1998}^{n=2003} ACS_t$= RM 12,086,913.00) and producer surplus ($\sum_{t=1998}^{n=2003} APS_t$= RM

24,474,436.90). Thus, CNB_{FA}= RM15,660,609.67 - RM 12,086,913.00 = RM 3,573,696.67, and likewise, the PNB_{FA}= RM 42,253,890.14 - RM 24,474,436.90 = 17,779,453.24. Therefore, excluding the aquaculture component, the NSB = CNB_{FA} + PNB_{FA} = -RM 21,353,149.91. The negative sign of the NSB indicates a loss to the society since it is the value that they should receive in the absence of perturbation.

Table 6.28: The forecasted consumer and producer surpluses.

Year	Q(t), Forecasted Landings (Kg)	Fish Disposition Fraction (Fresh and Chilled)	Total Fish Sold in Markets (Kg)	P(t), Consumer Price (RM/Kg)	CS(t), Consumer Surplus (RM)	P(t), Producer Price (RM/Kg)	PS(t), Producer Surplus (RM)
1998	6569667	0.54	3547620.18	5.59	4845459.442	4.67	6450340.385
1999	6798690	0.49	3331358.1	5.75	4272709.514	4.74	6907905.655
2000	6860047	0.5	3430023.5	5.68	4529548.566	4.76	7033153.592
2001	6921009	0.19	1314991.71	7.31	665743.231	4.78	7158709.636
2002	6982582	0.15	1047387.3	7.51	422352.7601	4.8	7286651.66
2003	7044821	0.22	1549860.62	7.12	924796.1574	4.82	7417129.212
TOTAL					15660609.67		42253890.14

When the accounting method was used to calculate the producer surpluses based on the forecasted fish landings, the forecasted producer surplus was given by $\sum_{t=1998}^{n=2003}$ FPS_t= RM 120,132,760 as compared to the actual producer surplus, $\sum_{t=1998}^{n=2003}$ APS_t= RM 57,292,915 (Table 6.29). Thus the PNB_{FA}= RM 120,132,760 - RM 57,292,915 = RM 62,839,844. Again, the NSB without the aquaculture component is, NSB = CNB_{FA} + PNB_{FA} = -RM 66,413,541.

Table 6.29: Producer surplus by accounting method.

	Year/No. of Vessels	Q(t), Fish Landings	P(t), Producer Price (RM/Kg)	TR(t), Total Revenue (RM)	TVC(t), Total Variable Cost(RM)	PS(t), Producer Surplus (RM)
Forecasted	1998/515	6569667	4.67	30680344.89	8203332	22477012.89
	1999/529	6798690	4.74	32225790.6	8498702	23727088.6
	2000/898	6860047	4.76	32653823.72	15392438	17261385.72
	2001/802	6921009	4.78	33082423.02	14601533	18480890.02
	2002/792	6982582	4.8	33516393.6	14731200	18785193.6
	2003/770	7044821	4.82	33956037.22	14554848	19401189.22
	Total					120132760.1
Actual	1998/515	5481180	4.43	24281627.4	8203332	16078295.4
	1999/529	4395940	4.1	18023354	8498702	9524652
	2000/898	6003620	4.7	28217014	15392438	12824576
	2001/802	5518590	4.43	24447353.7	14601533	9845820.7
	2002/792	4081100	4	16324400	14731200	1593200
	2003/770	5636210	3.9	21981219	14554848	7426371
	Total					57292915.1

Supposing in the worst case scenario, where fish production indicates zero value after perturbation, then all money spent would be considered a loss. If the total value spent by the government is S and the value loss is L, then in the worst case scenario $L = S$, but as is evident, even after perturbation there was still fish production as denoted by Y. Assuming X is the fish production in the absence of perturbation, then X - Y is the production loss that should be compensated. Therefore $L = S * X - Y / X$, thus implying the loss is proportionate to the lose of fish production. The government expenditures come into two components; (1) s_{mc}, management costs, and (2) s_{fc}, fuel costs. Meanwhile, fish production X is composed of the forecasted fish landings as obtained by methods described in section 6.6 and the aquaculture production as shown in Table 6.9. Table 6.30 illustrates how the total government losses of RM 5,477,537 for the duration of six years after perturbation are calculated.

Table 6.30: Government losses as proportionate to the fish production

Year	Forecasted Fish Landings (kg)	Cockles Production (kg)	Fish Production (X) (kg)	Actual Fish Production (Y) (kg)	Production Loss, (X - Y) (kg)	Government Expenditure ($S=s_{mc}+s_{fc}$) (RM)	Government Loss, $L=S*\frac{X-Y}{X}$ (RM)
1998	6,569,667	0	6,569,667	5,481,180	1,088,487	2,677,526	443,622
1999	6,798,690	0	6,798,690	4,395,940	2,402,750	2,560,422	904,888
2000	6,860,047	0	6,860,047	6,003,620	856,427	4,800,043	599,250
2001	6,921,009	0	6,921,009	5,518,590	1,402,419	4,148,601	840,639
2002	6,982,582	0	6,982,582	4,081,100	2,901,482	4,361,829	181,2476
2003	7,044,821	0	7,044,821	5,636,210	1,408,611	4,384,395	876,659
Total	41,176,816	0	41,176,816	31,116,640	10,060,176	22,932,818	5,477,537

6.7 Discussion

Perunding Utama (1997) predicted that in the worst case scenario, the catch by traditional fishers would be reduced by 11% and in the case of less severe scenario[12], the reduced catch would be about 6%. In monetary terms, the reduction in catch would cost fishers about RM 19,769,138 in worst scenario and RM 10,783,166 in the less severe scenario or RM 3,294,856per year and RM 1,797,194 per year respectively. This is an underestimate of the actual loss incurred since it does not take into consideration the welfare of other parts of society, i.e. the non-fishers who are the consumers of the fish caught. Moreover, the prediction made by Perunding Utama (1979) was also an underestimation since the actual

[12] According to Perunding Utama (1997), the less severe scenario is when only the Phase 1 project is being completed.

total catch for the six years after the impact was 31,116,640 kg or about a 19 % reduction. Thus, the situation was worse than any predicted.

Using catch data or rather the total revenues (Q_t * P_t) to describe the change in the economic well-being of the society is too simplistic, although it may provide some indication about the level of the economy, for example as it is commonly used to build a national's Gross Domestic Product (GDP). GDP is the total value of all goods and services produced in the country by the factors of production located in the country, regardless of who owns them (Ghatak, Healey and Jackson, 1995). It is a common practice of the DOF to describe the economic growth of fisheries in term of its contribution to the GDP. For example, the importance of fisheries as a food contributor in the agricultural sector is highlighted in its 18.24% portion to GDP (Annual Fisheries Statistics 2000). Comparison was also made between the previous years as an indicator of how fisheries have been progressing. However, GDP does not measure all our society's production, and certainly does not provide a perfect measure of welfare, or well-being (Rohlf, 2001). Moreover, according to Rohlf, an increase in GDP does not always mean improve living standard, and similarly, a decrease in GDP is not always a cause for concern and corrective action. Therefore, it is difficult in making any meaningful inferences from GDP behavior without further scrutinizing of the data and apparently it may mislead many readers of the reports. GDP, as it has been advocated by DOF, is an inefficient methodology to explain society well-being.

The alternative way of describing the impact of fish catch on society is using the concepts known as consumer surplus and producer surplus. By comparing these measures before and after a market disturbance, it is possible to quantify how society has been affected (Callan and Thomas, 2000). Both concepts stem from the change in commodity price and the amount they are willing to pay if he or she is a consumer or the amount produced if he or she is a producer. Consumer surplus can be gauged from the demand curve that is econometrically constructed with the availability of time-series data on market price of the commodity and the quantity consumed. Similarly, the producer surplus can be obtained from the supply curve that is econometrically constructed using the time-series data on selling price and amount supplied. In addition to econometric method of obtaining the producer surplus, the accounting method offers a much easier way provided there exist, apart from time-series data on revenues, variable cost data.

In the absence of required data, the extrapolation method was used to generate data based on certain assumptions. For instance, although there were two studies providing cost data for particular years of fishing activities, the time-series data on the variable costs were absence in any other literature. Thus, annual cost data were extrapolated from the use of Consumer Price Index (CPI) acting as price deflator or inflator of the goods bought by fishers as their total variable cost. The use of CPI was relevant as goods bought by fishers were consumer goods (food, ice and fuel) rather than the use of Producer Price Index that according to Stiglitz and Driffill, (2000) measures the average level of prices of goods sold by producers. For cockle culture, CPI was also used as wage deflator for preceding years as the average wage in 1997 was known assuming that wage rate was in concurrence with inflation rate.

In this study, the demand curve for marketable fish of South Manjung was found to be represented by $P_t = 8.318 - 7.7E\text{-}07Q_t$ and the consumer surplus by $CS_t = ½ [8.318 - P_t] [Q_t]$. Likewise, the supply curve by $P_t = 2.71 + 2.989E\text{-}07Q_t$ and the producer surplus by $PS_t = ½ [P_t - 2.71] [Q_t]$. By substituting data collected on fish prices and catches into these equations, the annual surpluses were obtained for 1992 - 1997 to represent the before period and for 1998 - 2003 to represent the after period. The total surpluses of the after period were then subtracted from the total surpluses of before period. Since the concern here is to measure the whole benefits or loss as a result of the impact on fisheries, another fisheries component, the aquaculture, particularly the cockle culture was added as well. The consumer benefit loss as gauged by this study is RM 16,715,424 whereas the producer benefit loss of fishing is RM 13,283,609 and the producer benefit loss of cockles culture is RM 1,965,146. The overall loss to society, was NSB = - RM 31,964,179 (The negative sign indicates the surpluses loss). This is the loss over the six-year period after the projects and averaged -RM 5,327,363 per year. A much higher losses is observed if the producer surpluses were gauged by the accounting method where PNB_{BA}= RM 93,271,666. The NSB then increased to -RM 111,952,236 or -RM 18,658,706 per year.

Another way of comparing the effect of fish catch before and after impact, was to forecast the catch should it be landed in the absence of impact and then to compare with the actual catch. Fitting the forecasted fish landings data using the ARMA (2,2) model into the demand and supply curves provided the values of the benefits received by consumers and producers alike should there be no perturbation. The difference between the forecasted surpluses and the actual surpluses indicates the benefit loss of the society. In this study, the benefit loss to the capture fisheries was NSB = - RM 21,353,149. Adding the aquaculture component, then NSB is increased to -RM 23,318,295 or -RM 3,886,382 per year, which is lower than the NSB gauged by comparing the before and after data. Using the accounting method to measure the producer surpluses, the higher benefit loss is observed, i.e. NSB = - RM 68,378,687 or -RM 11,396,447 per year.

Different methods and approaches of measuring surpluses give different values. Lipton, *et* al. (1995) suggested that for measuring producer surplus, it is not necessary to estimate the supply curve but it is essential to estimate the demand curve for measuring the consumer surplus. The variable costs measured under the supply curve at price P_t is much higher than the variable cost estimated from the extrapolation method explaining the much lower producer surplus gauged from the supply curve. On the average, fisher's spent RM 150.65 per fishing trip as calculated from the supply curve compared with only about RM 56.73 per fishing trip obtained from the estimated data. Thus, the latter is much realistic to represent the variable cost in the accounting method. Moreover, the variable cost as estimated from the supply curve differed greatly from the costs estimated by LKIM (1998) which was RM 40.60 and by this study at RM 77.50 (See Chapter 3). Therefore, the accounting method in measuring the producer surplus is much more preferable over the supply curve method. Nonetheless, in the situation where variable costs are impossible to be obtained, whereas there are data on fish landings and the relevant prices that permit the construction of the supply curve, then producer surplus can be presented.

This study offered two approaches to compare the state of fisheries with regard to the introduction of perturbation: (1) the total surpluses of the six-year period before perturbation was compared with the total surpluses of the six-year period after the perturbation, and (2) the predicted surpluses of six-year period after perturbation was compared with the actual surpluses of the same period. The first approach expected that the surpluses received by the society before perturbation should be at least equal in the absence of perturbation while the second approach proposed that the difference between predicted and actual surpluses was the benefit that should be received by the society in the absence of perturbation. Which of these approaches is superior to another is based on whether fish landings, which parallel surpluses, were stable or increased in the absence of perturbation. If it is the case, then comparing surpluses before perturbation may provide more discerning results. Alternatively, forecasted data are preferred if the trend is in a decreasing pattern, as it can be inferred that the difference in surpluses between before and after periods may be as a result of natural causes so that the surpluses from the before period may no longer be appropriate for comparison with the after period. Figure 6.10 illustrates the upward trend (dotted line) of fish landings between 1992 to 1997 of South Manjung validating surpluses were increasing in the absence of perturbation but severely affected by the perturbation as landings fell, was better for explaining the change.

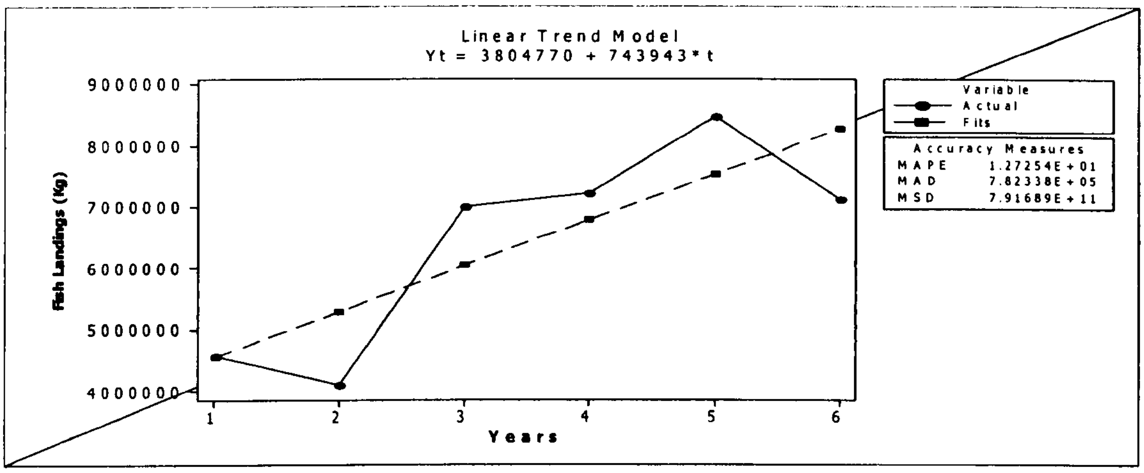

Figure 6.10: Trend analysis plot for fish landings 1992-1997

Similarly, for cockle culture, benefits lost by the producers are shown by; (1) the total surpluses received in the period before the perturbation are losses to producers since they received none after perturbation; and (2) the estimated surpluses should there be no perturbation are benefits lost to producers. If the latter is accepted as the benchmark, then it can be argued that since the producers in the past never fully utilized their farms' potential, what would make them be more productive in the future? With this kind of remark, it is sensible to accept the former, but with slight adjustment for the last two years of farm production (1996 and 1997). It is known that in 1996, farmers were forewarned by the Land Office to stop operating their farms and even refused the TOL permit renewal. With such uncertainty, farmers reduced their potential as seen by the sudden drop in cockle production in both years. These figures cannot represent the real potential of the farms, thus, to compensate such losses, the average producer's surplus of cockle production from previous years (1992 - 1995) was obtained and assumed to reflect the surpluses in 1996 and 1997. Therefore, since the average producer's surplus was RM 478,115, then the total producer surplus of the six-year period before perturbation was RM 2,868,694.

Another monetary loss neglected by Perunding Utama (1997) is the government's loss mostly spent on the development of fisheries and fuel subsidy. Since there was no total collapse of fisheries as a result of perturbation, it is inept to rest the entire burden on the project owners. A more reasonable approach was sought, such that the loss was calculated in proportion to the fish landings foregone in the absence of the perturbation. A total of RM 5,477,537 was loss due to decreased fish landings during the six-year period after perturbation.

The overall benefits lost to society as estimated by this study were RM 118,333,321 or about RM 19,722,220 per year. The components that make up the loss are as follows; RM 16,715,424 lost by consumers (RM 2,785,904 per year), RM 93,271,666 lost by fishers (RM 15,545,278 per year), RM 2,868,694 lost by farmers (RM 478,116 per year), and RM 5,477,537 lost by government (RM 912,922 per year).

Although this study has used of the demand curve in search of consumer surplus, the accounting method for producer surplus together with the before-after perturbation comparison, other approaches should also be considered. For example, in the situation where variable costs are impossible to be obtained, whereas there are data on fish landings and the relevant prices that permit the construction of the supply curve, then producer surplus can be presented. Another scenario, the forecasting technique can be useful, as explained earlier, when there is an indication that catch is declining during the before period, and expected to continue even after the perturbation period, may be as a result of natural causes. As such, the predicted surpluses measured in the after period can be used to compare with actual surpluses where the difference is the benefit before the perturbation. In section 6.8.4, the forecasted fish landings data could also be used to calculate net government costs.

CHAPTER 7: LEGAL ISSUES

7.1 Introduction

In situations where the developers refuse to restore the damaged condition to the state before the introduction of the pollutants, the aggrieved individuals have two options; (1) Government intervention; and (2) court action. The government can force market participants to absorb the external costs or benefits through the assignment of property rights. Another approach is that government could impose a tax that will raise the price of the product thus reduces the demand. This will somehow help internalizing the environmental costs in the decision by the consumers and the producers of the product. On the other hand, court action is the least preferred option, although effective in pollution prevention effort, since it could invoke high legal procedural costs and long trial time. Bringing legal suits by individuals against polluters is common and there are cases where the victims were rewarded.

Malaysian environmental legislation is based on the Polluter Pays Principle (PPP). The principle is explicitly embedded[1] in an integrated approach to pollution prevention, in control of pollution and environmental degradation contained in Malaysia's Green Strategies (MOSTE, 2004), although no specific definition is provided. Two laws that are enacted and directly related to marine pollution are the Environmental Quality Act 1974 (Act 127) Malaysia (EQA) and the Exclusive Economic Zone Act 1984 (EEZ Act), that contain preventive and punitive provisions to deter activities that pollute the marine environment; and the other legislation, the Merchant Shipping (Oil Pollution) Act 1994 (MSA), which provides a regime of liability and compensation for parties affected by oil

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[1] Malaysia's environmental Green Strategies consist of 7 strategies; among which is the Strategy no.4 on the Prevention and control of pollution and environmental degradation. In this strategy, industries will be encouraged to develop policies that result in operations and products that have lower environmental impacts. An integrated approach to pollution prevention and control is to be adopted, through:

- (i) The application of a combination of corrective, preventive, and precautionary measures, as appropriate;
- (ii) Control at source for all major emissions to air, land and water;
- (iii) Adoption of best practicable means for reduction of pollution and promotion of cleaner production technology; and
- (iv) Application of the Polluter-Pays-Principle and other appropriate techno-economic incentives and disincentives.

pollution[2]. However, the EEZ Act does not have the jurisdiction over territorial waters and the MSA concerns only pollution caused by oil spills. Thus, these two Acts are not pertinent to the nature of pollution caused by the projects under study.

The EQA is the principle legislation in Malaysia regulating the prevention, abatement, control of pollution as well as the enhancement of the environment, and is the legislation most often invoked to deter marine pollution in Malaysia (Teong, 2004). The EQA requires that all dischargers pay a fee to obtain a license: to discharge hazardous substances, pollutants or wastes into the atmosphere (Section 22[1]) or into any inland waters (Section 25[1]) or into the Malaysian waters (Section 29[1]); to emit or cause or permit to be emitted any noise greater in volume, intensity or quality (Section 23[1]); and to pollute or cause or permit to be polluted any soil or surface of any land (Section 24[1]). Failure to comply with Section 22(1) or Section 24(1) or Section 25(1), result in a fine not exceeding RM 100,000 or a term of imprisonment not exceeding five years or both, and in addition a fine not exceeding RM 1,000 imposed daily commencing the day the notice to cease discharging or polluting is served by the Director General[3] until compliance. In case of non-compliance of Section 23(1), in addition to a RM 100,000 fine, the daily charge for failure to obey the order to stop emitting noise is reduced to RM 500 per day. The penalty for non-compliance of Section 29(1) is somewhat severe; that the offender is liable to a fine not exceeding RM 500,000 or to imprisonment not exceeding five years or both but being exempted from the daily charges.

However, at present, the ability to discharge or pollute by way of being given licenses is rather limited since the DOE only approve two kinds of contravention licenses: (1) under Section 25(1) to relieve from the standard effluent discharges into inland waters as stipulated in Environmental Quality (Sewage and Industrial Effluent) Regulations 1979

[2] The International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund) was adopted at a Conference held in Brussels in 1971. Under the first of its purposes, the Fund is under an obligation to pay compensation to States and persons who suffer pollution damage, if such persons are unable to obtain compensation from the owner of the ship from which the oil escaped or if the compensation due from such owner is not sufficient to cover the damage suffered (IMO, 2004). In Malaysia, the Fund is established under the MSA where Section 19 (1) stipulates that the Fund shall be liable for pollution damage in any area of Malaysia if the person suffering the damage has been unable to obtain full compensation.

[3] Director General means the Director General of Environmental Quality (Section 2 of EQA).

(P.U.[A] 12/79); and (2) under Section 22(1) to relieve from the standard emission into the atmosphere as stipulated in Environmental Quality (Clean Air) Regulations 1978 (P.U. [A] 280/78). Although there are provisions for dischargers to apply for the other types of contravention licenses as it is stated under the EQA, the departmental procedures itself indicate that such licenses will never be approved. Thus, no one has been given any contravention license to emit or cause or permit to be emitted noise (Section 23[1]) or to pollute or cause or permit to be polluted any soil or surface of any land (Section 24[1]) or to discharge environmentally hazardous substances, pollutants or wastes into the Malaysian waters (Section 29[1]).

Payment made by dischargers is not compensation for the actual damage costs but, as pointed out by ESCAP (2004), contributes to capital cost for pollution abatement. The payment system supposedly serves as an incentive for the dischargers to reduce the biological oxygen demand (BOD) by being charged at a lower rate. In the example of effluent control in the palm oil industry, the effluent related fee which is based on the quality and quantity of the effluent is RM 100/t for BOD loads above the standard and RM 10/t for BOD loads equal or less than standard. However, ESCAP (2004) found that the charge is so low that it does not act as sufficient deterrent, and some mills find it cheaper to pay the fine than treat their effluent sufficiently to meet the standard. According to Israngkura (2000), the fees should be higher than the cost of controlling pollution so that the mills will choose to treat pollution instead of paying the fee, but in Malaysia the fees for the palm oil pollution control were set arbitrarily at levels that were believed to be high enough to reduce the pollution. SERI (2004) reported that the estimated cost of waste treatment (excluding transportation charges) to be between RM 630/t to RM 3,600/t, explaining the convenient choice for the mills to pollute, thus decreasing the net social benefit of the society.

Unlike the MSA, which ensures that those engaged in the act of polluting the sea have to pay for the cleaning costs as well as compensating those affected by the damage, the EQA remains an inadequate deterrent and economically inefficient since it does not encompass other societal losses. The licensed polluters may resort to polluting the environment and pay the fine rather than investing into a more costly method of treating the wastes. On the other hand, those caught in non-compliance of Section 22(1), 23(1), 24(1) and 25(1) of EQA, may be fined up to RM 100,000 and Section 29(1) up to RM 500,000 and in addition to that, the Director General may take such action as is necessary to remove, disperse, destroy or mitigate the pollution and may recover from that person all costs and expenses incurred in connection therewith (Section 47 of EQA); but what if the environmental costs are estimated to be higher? Moreover, the sentences are not deterrent enough, since the imprisonment penalty is not mandatory. Abdul Rashid Mat Amin, Director General of Forestry Department Malaysia said that the mandatory jail sentence contained in the National Forest Act 1984 had successfully reduced the offences committed under the Act (Berita Harian, 25 October 2004). In 1997, of the 275 environmental offences prosecuted in court with a total of RM 2,391,400 fines collected, none of the polluters were sent to prison (Anon., 1997). Similarly, no one was sent to prison in 1998 for polluting the environment although a total of 253 premises and companies were prosecuted in court with a total of RM 2,570,700 fines collected (Anon., 1998B). Fines imposed were low, however; in 1997, the average fine was RM 8,696 per polluter and RM 10,161 per polluter in 1998, despite higher ceilings as provided by the laws. Even in the case of dumping 2,050 kg of *Potassium cyanide* in 1995 in Pangkor island where the polluters had killed 15,000 fish at an estimated loss of RM 150,000, and potentiality of killing seven million people, a company director and his brother-in-law were only fined RM 15,000 and a term of seven-days imprisonment (The Sun, 14 August 1996).

However, a judicial decision by the High Court of Kuala Lumpur on 15 May 2002 by the Public Prosecutor on the insufficient RM 5,000 fine imposed by the lower court provided an encouragement for environmental protection and improvement in the country[4]. The judge, allowed the said appeal, and set it aside and substituted with a heavier sentence. The High Court of Appeal had thus substituted the RM 5,000 fine with much higher fine of RM 90,000 for offence of discharging effluent into inland waters without a license in which the discharged effluent consisted of suspended solids and nickel with concentrations of 1,200 mg/l and 1.2 mg/l respectively, and a pH of 4.0. These effluent parameters had exceeded the standard B limits as specified in the Third Schedule of the Environmental Quality (Sewage and Industrial Effluents) Regulations, 1979. In addition, the judge made, *inter alia*, remarks about the failure of the trial judgement to give appropriate consideration to the

[4] *Public Prosecutor V NCK Aluminium Extrusion Sdn. Bhd.* (2002) 6 MLJ 96.

purpose of the Act (the EQA), public interest and the seriousness of the offence, and to prevent future offences during the passing of the sentences.

Malaysian legislation followed strictly the PPP definition *per se* given by the Organization for Economic Cooperation and Development (OECD) that it concerns only the recovery costs of cleaning-up the pollution as also observed in other legislations. In 2004, the European Community (EC) governments and lawmakers concurred on new legislation that will force industries guilty of polluting the environment to pay for the clean-up (Agence France Presse, 21 February 2004). This new EC legislation under the Directive 2004/35/CE of the European Parliament and of the Council, dated 21 April 2004, on environmental liability with regard to the prevention and remedying of environmental damage does not apply to cases of personal injury, to damage to private property or to any economic loss and does not affect any right regarding these types of damages. Similar measures are also seen in US's Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA of also known as Superfund) that imposes liability on the polluter to pay for the losses of natural resources. The Superfund program established three ways to pay for the cost of cleanups: (1) the company or individual responsible for creating the site pays for the cleanups of the site; (2) the Environmental Protection Agency (EPA) performs the cleanups and recoups the costs from the responsible party or parties; and (3) for those "orphan" sites where no responsible party can be found, or the party is insolvent or no longer in business, the clean up is paid for out of the trust fund. Superfund offers compensation for the loss or destruction of natural resources controlled by the state or federal government, but similar to the EC, does not provide any compensation for injured individuals (Tietenberg, 2000).

In economic terms, the OECD's PPP definition lacks economic efficiency, as it does not include the external costs which is also known as the externality suffered by society. An optimum trade off between production and environmental protection is reached if industry and individuals are made to internalize the full costs of their activities (including the social costs of damage to the environment) for their exploitation of valuable environmental resources (Keay and Prez, 2001). Since the producer accounts only his private costs, the market price of his produce is distorted as it does not reflect the negative externality. In this respect, the definition of PPP as proposed by the OECD, and which has been incorporated into their environmental legislation by many countries would not remedy the market failure, because it does not encapsulate the externalities. After all, as pointed out by Israngkura (1996), the PPP is only a payment method designed to finance pollution control activities, it cannot guarantee efficiency or cost effectiveness in environment protection. However, India's courts have taken a more robust step in combating environmental degradation by extending the interpretation of the PPP. In *Enviro-Legal Action V Union of India* the Supreme Court held that the PPP is a sound principle and that, '...not only to compensate the victims of pollution but also the cost of restoring the environmental degradation'. The Court then ordered the polluting industries to compensate the villagers in the affected area, and to take all necessary measures to remove sludge and other pollutants lying in the affected areas.

This chapter is devoted into establishing whether fishers or any other persons aggrieved by the environmental impairment as caused by the 'projects' have the right to be compensated for the economic loss incurred. The causal links between the polluting activities and inflicted harm in terms of reduced catches are described in Chapter 2, on socio-economic impact of fishers in Chapter 3, and on impacts before and after perturbation in Chapter 4. The degraded mangroves were valued using the Contingent Valuation Method (CVM) (Chapter 5) and the economic losses of fishers, farmers, fish consumers and government were calculated in Chapter 6. Supposing the aggrieved persons were to sue the polluters and claim compensation, the possible outcome of the trial is discussed in this chapter based on previous courts rulings[5]. Some suggestions to improve and strengthen the environmental legislations are also made with the intention of curbing the growing activities of polluters in Malaysia, as the present laws are inadequate to deal with the problems.

7.2 The facts of case

From the commencement of the reclamation works until the completion and operation of the power plant, the public experienced misfortune. Dredging works caused foul water, coastal sedimentation and mangrove death. Fishers complained about low fish catches,

[5] According to 497[th] CTS/SJA (2004), Malaysia is a common law country with the same adherence to the doctrine of precedence, which includes the concepts of *ratio decidendi, obiter dictum, stare decisi, res judicata*, etc., as found in the United Kingdom, most other commonwealth countries, and the United States. Only Malaysian cases (post 1956) in general are binding on Malaysian courts, but lawyers and judges routinely cite English, Singaporean, Hong Kong, Australian, and even American case law as persuasive argument.

which was substantiated by fish landing data collected by the Department of Fisheries. As a result of low fish catches, retail prices have escalated, and those non-fishers who bought fish at the market grumbled about higher fish prices. Cockle farmers were technically[6] forced to close down their farms and mangrove coverage declined. The company responsible for the reclamation works, and the power plant owner have ignored the plight of the public, which was conveyed through the media and by elected representatives.

The affected public were identified as: (1) fishers living in three sub-districts or Mukims of South Manjung district; namely Mukim Lekir, Mukim Sitiawan and Mukim Lumut, adjacent to the sea and fishing in the area known as the Lekir waters; (2) non-fishers living in Mukim Lekir; (3) cockle farmers operating in Mukim Lekir coasts; and (4) fish consumers (excluding fishers) of South Manjung district. Those living outside the boundary of South Manjung were assumed to be little affected. Each group claims that they have experienced monetary losses. Fishers find that their catches have reduced markedly and consequently their incomes. On the other hand, non-fishers, being fish consumers feel that fish prices have gone up compared with previous prices and unhappy. Former cockle farmers lost annual earnings of RM 327,524. Lastly, the public put value on mangroves by stating their willingness to pay preferences in a hypothetical market. Destroying mangroves is tantamount to denying their recreational use of to a value estimated at RM 42,854 per year.

The position of the various key players in this case are discussed below:

7.2.1 *Defendants*

The owner of the land reclamation project is a private limited company named DKSB. To carry out the works, it hired a dredging company, the Van Oord ACZ (M) Sdn. Bhd. (VOA) to act on their behalf. The owner of the power plant is TNB, which appointed its subsidiary company, TJSB to carry out construction, and later operation of the power plant. It is believed that the owners should be liable, but *Tenggara Gugusan Holidays Sdn. Bhd. V Public Prosecutor*[7] showed otherwise. In this appeal case, the appellant, convicted and

[6] It is said to be 'technical' since there was no official letter from the authority to do so. However, they were refused TOL license renewal beginning in 1996 believed in connection with the reclamation projects.
[7] (2003)1 MLJ 508

fined RM 20,000.00 by the session court for failure to comply with Section 34A (6) of the EQA 1974 (Amended) 1985 (Act A 636), sought High Court opinion that the words 'Any person' under Section 34A of the EQA referred to the owner of whom they worked to build 100 units of chalet. Judge Nik Hashim on dismissing the appeal, held, *inter alia*, it was the appellant developer and not the owner who carried out the prescribed activity by constructing the 100 chalets without first submitting the EIA report to, and getting approval by, the Director General. Ownership was not the issue of the offence. Thus, the appellant was rightly convicted by the sessions court. Similarly in *Wu Siew Ying V Gunung Tunggal Quarry & Construction Sdn. Bhd. & Ors*[8], the High Court judge held only the operator (first defendant) of a quarry liable for damage inflicted upon the plaintiff's plant nursery, not the owner (second defendant) of the land where the operator worked. Judge Kang Hwee Gee said that it is abundantly clear that the second defendant was not the operator of the quarry and could not therefore have been responsible for the omissions mentioned in the particulars.

Taking heed of the court judgment in *Tenggara Gugusan Holidays Sdn. Bhd.*, the EQA seems to place liability on the person who actually carried out the activity, although he may be acting on behalf of the owner of certain property. Thus, in this case, the first defendant will be VOA while the second one is DKSB[9].The construction of the power plant was not observed to have any effect on surrounding area but its operation was known to have notable influence on the environment, thus TJSB is liable as third defendant. TNB, on the other hand, being the owner of the power plant is selected as fourth defendant.

7.2.2 *Plaintiffs*

Aggrieved persons in this context are identified earlier and discussed below:

(a) ***Fishers***

[8] (1999) 4 MLJ 9

[9] Note that the approval to carry out the land reclamation works under Section 34A of the EQA was given to the DKSB in 1997. In 2003, the Court of Appeal made a judgment in *Tenggara Gugusan Holidays Sdn. Bhd.* that those who carried out the prescribed activities are to submit to Section 34A of the EQA. Therefore, the 1997 action was a wrong interpretation of the law. At this point, it is thought to be proper that VOA is liable though not putting aside the possibility of DKSB as a defendant too depending on the argument by the former. Similarly, the relationship between TJSB and TNB requires that the former is assigned as third defendant while the latter as fourth defendant.

Fishers have no property rights over the sea and its natural resources; so, do they possess the right to claim for compensation for damage of goods that do not belong to them? Fishers are merely given a right to fish by way of licenses[10] within a stipulated period of time[11], where license may be renewed[12], and subjected to conditions as specified by the authority[13]. In US Law, as in *Burgess V M/V Tamano,* the court stated, *inter alia*, that it is also unambiguous that the right to fish or harvest clams in Maine's coastal waters is not the private right of any individual, but it is a public right held by the State 'in trust for common benefit of the people'. In *Jan De Nul (UK) Ltd. V NV Royale Belge*[14] , Judge Moore-Bick concurred with the counselors of the defendant that only those claimants who could show legal ownership or a possessory title to property damaged by siltation could pursue a claim in negligence. Similarly, in the tort of nuisance, Lord Goff in *Hunter V Canary Wharf*[15] pointed out that an action of private nuisance will usually be brought by a person in actual possession of the land affected, either as the freeholder or tenant of the land in question, or even as a licensee with exclusive possession, but a mere licensee on the land has no right to sue.

Fisheries resources, mangroves and most environmental goods are public properties or common property, *res communis omnium*, and nobody has individual rights to them (Wetterstein, 1997). Supposing a factory is emitting noxious gases into the air at the nearby residential area causing adverse effects on public health, then the factory is said to cause a public nuisance. It is an offence under common law, to do an act not warranted by law, or failing to discharge a duty imposed by law, the effect of which is to endangered the life, health, property, morals or comfort of the public (see R V Shamrock, (CA) (1994) QB 279). English common law allows the Attorney General to act on behalf of the public to bring an action against any act of public nuisance,[16] or an individual can bring an action on behalf of others only by his permission (Ansari, 2000). An individual will only be able to file a suit on public nuisance if he is able to prove that he has suffered damage over and above the general inconvenience suffered by the public as a whole, as shown in the case of *Jan De*

[10] Section 11(1) of Fisheries Act 1985.
[11] Section 14(1) of Fisheries Act 1985.
[12] Section 13(1) of Fisheries Act 1985.
[13] Section 10 (1)to(3) of Fisheries Act 1985.
[14] (2000) 2 Lloyd's Rep 700
[15] (HL) (1997) AC 655.
[16] (2000) 2 Lloyd's Rep 700.

Nul (UK) Ltd., when Judge Moore-Bick held that fishers could pursue a claim for public nuisance. Similarly, in *Burgess,* the court pointed out that the commercial fishers and clam diggers have a special interest, quite apart from that of the public in general, to take fish and harvest clams from the coastal waters of the State of Maine. In this respect, fishers are deemed to display sufferance over and above the general suffering as endured by other members of the public. Otherwise, no one else is allowed to act on behalf of others due to the strict adherence to the doctrine of *locus standi* (see *Ketua Pengarah Jabatan Alam Sekitar & Anor V Kajing Tubek & Ors*). For this reason, Ansari (2000) is of the opinion that the requirement of *locus standi* in many environmental matters, in cases where action is required to be brought immediately to avert further damage or where the people who are the sufferers of polluting acts are too poor to afford the financial burden of the cases, impedes rather than promotes justice.

(b) ***Cockle farmers***

Cultured cockle production in South Manjung ended officially in 1998 when all farmers ceased their operation. No production was recorded in the 1998 statistical report by the DOF (1998 Annual Fisheries Statistics). According to Wang (pers. comm.), the closing of the farms was to relinquish to the need of the land reclamation project to address the problem. The affected farmers did not file any official complain to the authority although they did convey their despair to the fisheries officers of FDOM. They left the farms peacefully.

There was no direct damage to their farms as consequent of the project. The only losses they incurred were not being able to continue with the normal operation of the farms, thus losing revenue. This is also a public loss since the it has deprived them of the use of the resources but similar to fishers, the farmers suffered over and above the general public by being given the TOL license to breed cockles and moreover, which had been in existence since 1992.

(c) ***Fish consumers***

Claiming compensation for 'damage' of consumer surplus is still alien to Malaysian legislation history. None has been reported so far. For marketable goods such as fish, the concept of consumer surplus can be easily depicted by the demand curve data. For non-marketable goods, the application of consumer surplus to depict the loss or benefit gained of the individual or society has received skeptical views. In *Re Kershaw's Application Land Tribunal*[17], Frank Douglas ESQ., QC., did not find it practicable while Lord Mustill provided reasons for difficulties in quantifying the loss, although calling for the loss to be compensated in *Ruxley Electronics and Construction Ltd. V Forsyth, Laddingford Enclosures Ltd. V Forsyth*[18] when he stated that;

> for the law must cater for those occasions where the value of the promise to the promisee exceeds the financial enhancement of his position which full performance will secure. This excess, often referred to in the literature as the "consumer surplus" (see for example the valuable discussion by Harris, Ogus and Philips (1979) 95 L.Q.R. 581) is usually incapable of precise valuation in terms of money, exactly because it represents a personal, subjective and non-monetary gain. Nevertheless where it exists the law should recognise it and compensate the promisee if the misperformance takes it away.'

However, the acceptance the valuation of non-marketable goods has been implied in several court suits in U.S. For example in *State of Ohio V Department of the Interior*, the judges of the Court of Appeal for the District of Columbia Circuit upheld on review the issue of, *inter alia,* the adoption of contingent valuation methodology by CERCLA. When the ship 'Exxon Valdez' spilled 10,000 t of crude oil into Alaskan waters, the United States and the state of Alaska (hereinafter "the governments") filed suit against the oil company Exxon in their capacities as "trustees for the public" under Section 311(f) of the Clean Water Act (CWA), 33 U.S.C. Section 1321(f)(5), and Section 107(f)(1) of the CERCLA, as amended, 42 U.S.C. Section 9607(f)(1)[19]. Subsequently, Exxon agreed to pay for "natural resource damage," which is defined as: *compensatory and remedial relief* recoverable by the Governments in their capacity as trustees of Natural Resources on behalf of the public for injury to, destruction of, or loss of any and all Natural Resources . . . whether under the Clean Water Act, ... the Trans-Alaska Pipeline Authorization Act, ..., or any federal or state statute or maritime or common law relating to the environment, including (1) costs of damage assessment, (2) compensation for loss, injury . . . *loss of use value,* non-use value,

[17] 31 P&CR 187, 235 EG 449, (1974) EGD 744.
[18] (House of Lords), (1996) AC 344.
[19] *United States v. Exxon Corp.,* No. A91-082 (D. Alaska 1991); *State of Alaska v. Exxon Corp.,* No. A91-083 (D. Alaska 1991).

option value, amenity value, bequest value, existence value, consumer surplus, economic rent, or any similar value of natural resources.

Since fish were sold in the markets of South Manjung, the affected population would be the 28,399 domestic households of that district (excluding fisher households).

(d) *Inhabitants of Mukim Lekir on mangroves degradation*

The market value of Mukim Lekir mangroves was determined at RM 81,959 per annum (Chapter 5). This is the market value of the mangroves as placed by the Lekir population. Unlike the change in consumer surplus being affected by the whole households of South Manjung, mangrove degradation affects only the Lekir households as they live close to the areas (Chapter 4). Following the case of *State of Ohio V Department of the Interior*, the government may file a suit on behalf of the Lekir households against the companies concerned.

7.3 Legal issues

In the court of law, the primary concern is whether a plaintiff has the right to sue. Consequently, various legal issues are discussed below:

7.3.1 *Private or public property*

The sea and its 'contents' are public property because it possesses the characteristics of non-rivalness and non-excludability (Callan and Thomas, 2000). Non-rivalness means when the good is consumed by one individual, another person is not pre-empted from consuming it at the same time, while non-excludability means that preventing others from sharing in the benefits of a good's consumption is not possible. The opposite is private property which refers to exclusive rights over objects or information vested in a single legal entity and individuals or corporations holding such rights can exclude others from the benefits of their property and regulate its use (Kameri-Mbote and Cullet, 1999). However, fishing is not a free access entity, given that the public involvement is being restricted by existing statutory laws. Section 8 of the Fisheries Act 1985, *inter alia*, prohibits any person operating or allows to be operated a vessel for the purpose of fishing without a valid license, and a penalty for failure to comply with the said provision is stipulated under Section 25 of the same Act that the offender shall be fined an amount not exceeding RM 20,000 or a term of imprisonment not exceeding two years. Section 13(1) of the Act, empowers the Director-General in matters of issuance, renewal, canceling or suspending any license stipulated under the Act for reasons of the proper management of the fisheries, but any person aggrieved by his decision may appeal to the Minister (Section 13(4) of the Act). Sometime in 1983, the DOF ceased to issue new fishing licenses to the public in conjunction with the implementation of New Licensing Policy making fishing a privilege enjoyed by a restricted number of persons.

7.3.2 *Locus standi*

It is said that once a property is assigned to the ownership, much of the problem relating to compensation can be resolved. Laws are compassionate to the private person holding property rights but when a property is public, it does not permit a person claiming compensation on his own, unless he is successful in showing the damages incurred are over and above the general public. A failed representation in the court on this basis is shown in the Court of Appeal in *Ketua Pengarah Jabatan Alam Sekitar & Anor v Kajing Tubek & Ors and other*[20]. In this case, the appellants were the Director General of Environmental Quality, the Government of Malaysia, the Natural Resources and Environment Board of Sarawak, the Government of Sarawak and Ekran Bhd which appealed for the court to decide, *inter alia,* whether the respondents had *locus standi* to bring this action. The court took a more restricted view and denied the native residents *locus standi* to raise this matter in the courts for the following reasons, *inter alia*;

> (a) the respondents were, in substance, attempting to enforce a penal sanction. This was a matter entirely reserved by the Federal Constitution to the Attorney General of Malaysia in whom resided the unquestionable discretion whether to institute criminal proceedings; (b) the complaints advanced by the respondents amounted to deprivation of their lives under art 5(1) of the Federal Constitution. Since such deprivation was in accordance with the law, that is, the Land Code (Sarawak Cap 81), they had on the totality of the evidence suffered no injury and there was thus no necessity for a remedy; (c) there were persons, apart from the respondents, who were adversely affected by the project. There was no special injury suffered by the respondents over and above the injury common to others.

[20] (1997) 3 MLJ 23

7.3.3 *Pure economic loss*

Whenever there is an environmental degradation caused by an individual or firm during the production of goods, there will be other individual or firm prone to incur some losses, normally in monetary term. In economic terms, the cost borne by other people is the external cost or externality not accounted for by the people who caused the pollution, whereas the same cost may be termed as pure economic loss in a legal arena. Pure economic loss is specifically dedicated to loss that is not related to physical injury to person or property other than the defective property itself (Wetterstein, 1997, Matta, 2003), whereas, as pointed out by Stiglitz and Driffil, (2000), externalities are present whenever an individual or firm can take an action that directly affects others, but for which it neither pays nor is paid compensation. In dealing with these losses, an economist and a counsellor for the defendant differ, that the former insists externality to be internalized to correct market failure while the latter argues whether the plaintiff has the capacity to claim compensation on such cost. For example, an oil-spill on the beaches caused by an oil-drilling company could cause hoteliers to loose guests, fishers losing of income consequential of reduced fish catches, fish consumers having to pay higher fish prices after the perturbation, cockles farmers being denied the prospect of continuing their activities and society losing the benefit of mangroves as they are depleted; are all claiming for pure economic loss except the municipality which is paying the beach clean-up costs claiming the economic loss. With the exception of fishers, as shown in *Jan De Nul (UK) Ltd* and *Burgess*[21], other pure economic loss claimants may face problems in seeking compensation. Nevertheless, in economics, both losses are the same, that they are the externalities borne by other environmental users and preferably included in the total costs of the individual or firm producing the goods.

There is also a problem of claiming pure economic loss. Normally, an infringed private property is an economic loss to the owner; who may ask for compensation. On the other hand, environmental degradation caused by a firm producing paper creates various pure economic losses to the society; such claims may not be welcomed in the court of justice.

[21] Judge Moore-Bick said, "...the fishermen suffered as a result of siltation of the shellfish beds was in one respect the same as that which was suffered by the public generally, namely, a loss of stocks available to be fished, but because they were licensed to sell their catches and had established commercial enterprises based on their access to the fishing grounds they did in my judgment suffer special loss as a result of the damage to the shellfish stocks which would enable them to pursue a claim in public nuisance."

For instance, The courts in the United Kingdom reject claims for the recovery of loss suffered by a person due to the negligent act of another, if it is a claim for pure economic loss (Matta,2003), and in some cases recoverable only under narrowly constrained, special conditions (Jansen, 2004). English Common Law does not permit the claims on pure economic loss to be recoverable[22] to avoid the prospect of an incident giving rise to indeterminate claimants asserting indeterminate liabilities even where causation and foreseeability can be established (Black, 2003). However, in Malaysia, there was an attempt to depart from English law on this matter, when in 1997, Judge James Fong of the High Court in *Dr Abdul Hamid Abdul Rashid & Anor V Jurusan Malaysia Consultants (sued as a firm) & Ors*[23] said that a claim for pure economic loss can be entertained in an action for negligence giving high hopes to many house buyers. He reasoned that non-allowance of such claim would leave the entire group of subsequent purchasers in this country without relief against errant builders, architects, engineers and related personnel who are found to have erred. He even reaffirmed his judgement on pure economic loss in *Steven Phoa Cheng Loon & ors V Highland Properties Sdn. Bhd. & ors*[24] .Unfortunately, Judge James Fong's assertion was short lived as it was not well received in *Pilba Trading & Agency V South East Asia Insurance Bhd. & Anor*[25], where the High Court Judge Muhammad Kamil, in dismissing the appeal of the appellant for claiming pure economic loss, said that it was a financial or pecuniary loss and did not involve any physical damage or danger of physical damage to the property of the appellant and it was quite distinct from cases of economic loss involving physical damage. Finally, in *Arab-Malaysian Finance Bhd. V Steven Phoa Cheng Loon & ors and other Appeals*[26] the court of appeal judges verified that Judge James Fong was wrong when he held that as a matter of policy he could award pure economic loss thus bringing back the Malaysian court under the wings of its mentor, the English Common Laws as far as pure economic loss is concerned.

In *Algrete Shipping Co. Inc. & Another V International Oil Pollution Compensation Fund and Others (The "Sea Empress")*,[27] it was made clear that pure economic loss is non-recoverable in the law of tort, with the exception of fishers. The court of appeal dismissed

[22] Merlin V British Nuclear Fuels Ltd (1990) 3 All ER 711 at 721.
[23] (1997) 3 MLJ 546
[24] (2000) 4 MLJ 200
[25] (1998) 2 MLJ 53
[26] (2003) 1 MLJ 567
[27] (2003) EWCA Civ 65, (2003) 2 All ER (Comm) 1, (2003) 1 Lloys's Rep 327

the case brought by Tilbury[28] for loss of profit since it was unable to receive supply of whelks from the fishers who were banned by the authority from fishing as a result of oil spill from a ship 'Sea Empress' owned by Algrete Shipping Co. Inc. The Tilbury loss was incurred on land far away from the contaminated area and thus termed by the court as secondary economic loss, which was outside the intended scope of a statute which closely focused on physical contamination and its consequences. On the other hand, the court also held that; damage consisting of economic loss might well be recoverable under the statute by persons such as fishermen accustomed to fish in the waters which became contaminated; and the interest and losses of such fishermen could be very closely related to the physical waters and the physical contamination that occurred.

The Algrete Shipping case tells that while fishers may claim compensation, fish consumers shall not since their losses are secondary economic loss, unconnected and far away from the contaminated area. Mangrove users may then be eligible for compensation if their direct connection with mangroves is recognized, and does not characterize a pure economic loss.

7.3.4 *Public nuisance*

The word 'nuisance' is derived from the French word 'nuire,' which means to injure, hurt or harm and may be described as an 'unlawful interference with a person's use or enjoyment of land or some right or in connection with it' (Batra, 2000). Nuisance comes under two categories; a private nuisance which is an act or omission and is an interference with, disturbance of, or annoyance to, a person in the exercise or enjoyment of his ownership or occupation of land or of some easement, profit or the right used or enjoyed in connection with land (Clerk, 1947); and a public nuisance when the interference is with the general right of the public. However, nuisance is not necessary happening on land, as it could also occur elsewhere (*Paxhaven Holdings Ltd v Attorney General* (1974) 2 NZLR 185). In *Halsey v Esso Petroleum Co Ltd*[1961] 1 WLR 683, it was held that unreasonable noises or vibration interferes with one's enjoyment, one's quiet, one's personal freedom, and anything that discomposes or injuriously affects the senses or the nerves.

[28] Tilbury is R.J. Tilbury & Sons (Devon) Ltd. who brought an action against the owners of Sea Empress.

A public nuisance is an offence at common law (Archbold, 2002), and is an unlawful act or omission to discharge a legal duty, which act or omission endangers the lives, safety, health, property or comfort of the public are obstructed in the exercise or enjoyment of any right common to all Her Majesty's subjects (Clerk, 1947). When the sea is infringed by pollution, it is a public nuisance; as is when mangroves are degraded by human actions. In both cases, it is public because it affects many people, but Lord Justice Denning declined to specify how many instead said that a public nuisance is a nuisance which is so widespread in its range is so indiscriminate in its effect that it would not be reasonable to expect one person to take proceedings on his own responsibility to put a stop to it, but that it should be taken on the responsibility of the community at large.[29] Action against those causing public nuisance seems to be suited for environmental litigation in the public interest but the common law of England has delimited its scope (Ansari, 2000), and is further hampered by the decisions taken in Malaysian courts. In the House of Lords, it was held that it was a fundamental principle of English Law that public rights could only be asserted in a civil action by the Attorney-General as an officer of the Crown representing the public, except where statute otherwise provided, a private person could only bring an action to restrain a threatened breach of the law if his claim was based on an allegation that the threatened breach would constitute an infringement of his private rights or would inflict special damage on him[30]. In Malaysia, although a private person has successfully proved his damage to be special, in the light of Section 8(1) of the Government Proceedings Act 1956 (Act 359, Revised 1988), an Attorney General consent is mandatory. This decision was made in *Koperasi Pasaraya Malaysia Bhd. V Uda Holdings Sdn. Bhd. & Ors*[31] where the high court made the ruling that for the plaintiff to bring an action based on public nuisance, he must satisfies two conditions: (1) the plaintiff must not only prove that he suffered special damages; he must also (2) conform and comply with requirements under Section 8(1) of the Government Proceedings Act 1956 (Act 359, Revised 1988) that stipulates;

> 'In the case of a public nuisance the Attorney General, or two or more persons having obtained the consent in writing of the Attorney General, may institute a suit, though no special damage has been caused, for a declaration and injunction or for such other relief as may be appropriate

[29] (1957) 1 All ER 894, (1957) 2 QB 169
[30] *Gouriet V Union of Post Office Workers and others* (1978) AC 435, (1977) 3 All ER 70, (1977) 3 WLR 300, 141 JP 552, (44 CLJ 6).
[31] (2002) 7 MLJ 174

to the circumstances of the case.'

Although Judge Azmel in *Koperasi Pasaraya Malaysia Bhd.* made no reference to *Pengarah Jabatan Alam Sekitar* , the issues of right to bring action and *locus standi* in the latter are analogous. To summarise, in public nuisance, an individual can bring an action only when he has the *locus standi* on the matter raised. As reaffirmed by the Court of Appeal in *Pengarah Jabatan Alam Sekitar*, an individual's representation in the court be expelled if he does satisfy two conditions that constitute *locus standi*; (1) obtaining the consent of Attorney General as he is the guardian of the public interest and it is he alone who can enforce the law (Kanniah, 2000); and (2) provide prove that his damage is special, i.e. over and above the damage incurred by the others. A similar requirement is also acknowledged in *Koperasi Pasaraya Malaysia Bhd.*

7.3.5 *Negligence*

Negligence can be proved to have been committed by the defendants if their actions depart from the normal conduct that would have been expected from others doing the same tasks. In it barest and most practical form, negligence has been defined by Judge Baron Alderson in *Blyth v Birmingham Waterworks*[32] as 'the omission to do something which a reasonable man, guided upon those considerations which ordinarily regulate the conduct of human affairs, would do, or doing something which a prudent and reasonable man would not do'. For example, in *Foo Fio Na V Hospital Assunta & Avor*[33], a defendant doctor was found to be in negligence by the High Court for failing to exercise the care and skill of an ordinary competent practitioner in that profession. According to Honore (1999), "negligence" refers to civil liability, in whatever system, for unintended harm, where this is caused by someone's failure to meet the required standard of competence. In *Halsbury's* Laws of England 3rd Edn. Vol. 28 pages 1 and 2 under the sub-heading "meaning of negligence" appears the following passage.

> "Negligence is a specific tort and in any given circumstances is the failure to exercise that care which the circumstances demand. What amounts to negligence depends on the facts of each particular case, and the categories of negligence are never closed. It may consist in omitting to

[32](1856) 11 Exch 781
[33] (1999) 6 MLJ 738

> do something which ought to be done or in doing something which ought to be done either in a different manner or not at all. ...The degree of care required in the particular case depends on the accompanying circumstances, and may vary according to the amount of risk to be encountered. ..."

In practice, proving negligence on the manner of which the reclamation works were carried out is difficult, although not impossible. It should be borne in mind that negligence per se is not a cause of action (Radhakrishnan, 2002). To succeed in a negligence action, the plaintiff must be able to demonstrate that a duty of care is owed to him by the defendant; that the duty has been breached; that the damage of which he complains was caused by that breach of duty (causation) and that damage of that kind was a reasonably foreseeable consequence of the breach of duty (Pugh and Day, 1991). In *Eng Thye Plantations Bhd. V Lim Heng Hock & Ors*[34] , the Court of Appeal reiterated that for an action in negligence to succeed, the plaintiff had to establish that the defendant owed them a duty of care, that the duty was breached and that the breach occasioned harm that was not remote. In relation to environmental torts, Ansari (2000) provided three conditions that needed to be satisfied to bring an action in negligence against a polluting act. They are: (i) it has to be proven that the plaintiff suffered some damage due to the polluting act of the defendant; (ii) it has to be established that there was a duty not to pollute, and there was breach of the duty; and (iii) it will have to be proven that statutory authority, if any, in the form of a license or otherwise, does not exonerate the defendant from the liability.

Proof of damage by pollution

It is settled in law where a plaintiff brings an action for damages, he must prove it and before he can recover; he has to discharge the burden of proving both as to the fact of damage and as to the amount[35].

One fundamental question to be answered is whether it is project the owners who are the polluter? In Chapter 4, Perunding Utama (1997) disclosed that the two major impacts on environment were: (1) during sand sourcing of which they had anticipated the potential impacts of water pollution (increase turbidity and sediments), hydrographical changes, and

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[34] (2001) 4 MLJ 26

[35] *Kokomewah Sdn. Bhd. V Desa Hatchery Sdn. Bhd.* ([1995] 1 MLJ 214)

ecological loss due to elimination of benthic habitats and fisheries; and (2) during reclamation works where there would be erosion of sand bunds, water pollution, ecological loss and, hydrographical and shoreline changes at the reclamation and adjacent areas. On the other hand, Tenaga Nasional (1997) claimed that during construction and the operation of the power plant, the impacts on flora and terrestrial fauna to be minimal since the construction takes place on a reclaimed island, but recognized some minimal thermal discharge effect on species and marine organisms. Using the diversity measures and comparing them in time and space showed the differences were caused by the perturbation. Similarly, the before-after study on fish landings proved the differences in catches were project-made rather than by other naturally occurring phenomena, or even by over-fishing. The existence of the projects undoubtedly altered the natural properties of the environment in such manner that it disturbed the living resources and thus deprived the beneficial use of the resources by society. It complements the definition of pollution by the EQA, that:

Any direct or indirect alteration of the physical, thermal, chemical or biological properties of any part of the environment by discharging, emitting, or depositing environmentally hazardous substances, pollutants, wastes so as to affect any beneficial use adversely, to cause a condition which is hazardous or potentially hazardous to public health, safety, or welfare, or to animals, birds, wildlife, fish or aquatic life, or to plants or to cause a contravention of any condition, limitation, or restriction to which a license under this Act is subject .

Duty of care was breached

In Malaysia, the Federal Court decision of *Lembaga Kemajuan Tanah Persekutuan v Mariam & Ors*[36] accepted the proposition that *Donoghue v Stevenson*[37] overrides cases that preceded it where courts insisted upon a pre-existing contractual relationship for a duty of care to arise[38]. Lord Atkin in *Donoghue V Stevenson* said that;

> 'The rule that you are to love your neighbour becomes in law, you must not injure your neighbour; and the lawyer's question, Who is my neighbour? receives a restricted reply. You must take reasonable care to avoid acts or omissions which you can reasonably foresee would be likely to injure your neighbour. Who, then, in law is my neighbour? The answer seems to be -- persons who are so closely and directly affected by my act that I ought reasonably to have them

[36] [1984] 1 MLJ 283
[37] [1932] AC 562
[38] *Sri Inai (Pulau Pinang) Sdn. Bhd. V Yong Yit Swee & Ors* ([2003] 1 MLJ 273)

in contemplation as being so affected when I am directing my mind to the acts or omissions which are called in question.'

Judge Gopal Sri Ram of the Court of Appeal in *Eng Thye Plantations Bhd.*, in applying the Lord Atkin's general conception of relations giving rise to a duty of care, affirmed the High Court judgement that found the defendant liable of negligence of discharging 'black water' into a river causing fish death owned by the fish breeders operating at the said river mouth. He said;

> 'Here, the defendant was clearly the plaintiffs' neighbour both in terms of physical proximity and consequence of action. The plaintiffs are persons whom the defendant ought to have had in its contemplation when it discharged the effluent in question. It must be taken to have known of the harm that its activity would cause to the plaintiffs' livelihood. It did not act as a reasonable person would have acted in the circumstances. The damage that the plaintiffs suffered was caused by the defendant and was clearly within its reasonable foresee ability. The defendant was therefore clearly guilty of the tort of negligence. The sessions court was obviously wrong in holding for the defendant. The High Court was obviously correct in reversing the trial judge. I am therefore of the view that this appeal should fail.'

Duty of care was explicitly imposed on the project proponents under several provisions of the EQA. Section 34A (7) of EQA requires the person carrying out the prescribed activity[39], in the course of carrying out such activity, to provide sufficient proof that the conditions attached to the report (if any) are being complied with and that the proposed measures to be taken to prevent, reduce or control the adverse impact on the environment are being incorporated into the design, construction and operation of the prescribed activity. With respect to the coastal environment, Section 29 of EQA prohibits anyone, unless licensed, to discharge environmentally hazardous substances, pollutants or wastes into the Malaysian

[39] The Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987, made under Section 34A of EQA, which was enforced since 1 April 1988, specified 19 activities to be prescribed activities thus needing any person intends to carry out such activity to submit EIA report to the Director General (Section 34A (2) of EQA). The activity shall only be carried out after gaining approval from the relevant approving authority (Section 34A (6) of EQA). Two of those prescribed activities which are relevant here are coastal reclamation involving an area of 50 hectares or more and the construction of power generation and transmission facilities such as a steam generated power station burning fossil fuels having a capacity of more than 10 megawatts. Since DKSB intended to reclaim 1,000 acres (about 405 hectares) of land on a coastal area and TJSB to construct 2,100 megawatts coal-fired power station, each project proponent must then submit an EIA report to the Director General.

waters in contravention of the acceptable conditions specified under Section 21[40] (of the same Act). Failing to abide these provisions, the project proponents would fail to provide care of duty to the people living nearby. In the words of Judge Ong Hock Thye in *Guan Soon Tin Mining Co V Wong Fook Kum*[41] ;

> 'It is generally accepted that if the law grants a person a licence to do an act, it does not permit the person to do the said act negligently. That person must take reasonable care to abstain from *unlawful* acts which may be expected to harm his neighbour in the widest sense of that word. The lawfulness or otherwise of such conduct will depend, for the most part, upon whether the activity which may cause damage is one which could be carried out in such a way that if the person took reasonable trouble to do so, it would not cause that damage. An act which if done in the exercise of a licence is lawful becomes unlawful *if done for the purpose of injuring one's neighbour,* since the injury is consequent neither on the exercise of a legitimate interest, nor is it one which is unavoidable even by the taking of reasonable care...'

Although the project proponents must prove that they have carried out all the necessary measures to prevent, reduce or control the adverse impact on the environment in due course of their actions, proving otherwise is the burden rested on the plaintiff, as held in *Guan Soon Tin Mining Co.* Here the Federal Court of Kuala Lumpur judges allowed the appeal by the mining company on grounds of: (1) they were doing what they were authorised to do and there was no suggestion that they could have done the authorised act in any other manner which could have prevented loss and damage to the respondent; and (2) it was not established that there was any direct or traceable relation of cause and effect between the appellants' conduct and the respondent's loss.

Damage to the environment was foreseen[42] by the project proponents as evidenced by the statements made in the EIA reports. The summary of foreseeable impacts and mitigating measures at each stage of the reclamation activities were presented in the EIA reports

[40] This Section allows the Minister to specify conditions for the emission, discharge or deposit of environmentally hazardous substances, pollutants or wastes into the environment.
[41] (1969) 1 MLJ 99
[42] At this juncture, the word 'expected' which had been used often in EIA reporting is replaced by the word 'foreseen'. Both carry virtually the same meaning (expected = to think or believe something will happen, foreseen = to know something before it happens. Look Cambridge Dictionaries Online in http://dictionary.cambridge.org/ dated 21 November 2004). 'Foreseen', 'foreseeable' and 'foresee ability' are words used predominantly in Law of Torts. As such they are used here to reflect the legality of the action.

prepared by Perunding Utama (1997) for DKSB and the construction and operational phases of TJSB prepared by Tenaga Nasional (1997). Both project proponents were obliged to incorporate the proposed mitigating measures into the design, construction and operation of their activities to prevent, reduce or control the adverse impact on the environment as required by Section 34A (6) of EQA. The project proponents are said to be negligent if they fail to adhere to the proposed and approved measures by the law, since they have duty of care to prevent environmental degradation. A breach of duty arises where the conduct of the defendant is 'unreasonable' in the sense of failing to reach the appropriate standard of care (Deakin, *et al.* 2003) or, as put by Judge Gopal Sri Ram in *Eng Thye Plantations Bhd.*, the plaintiff did not act as a reasonable person would have acted in the circumstances thus has committed a tort of negligence.

Several incidents about which fishers and some members of the public complained to the DOFP were forwarded to the State Government of Perak through a letter dated 24 October 1997 (with reference number Prk. Pk. 018/13) signed by the Director of Fisheries for the state of Perak. Among the complaints recorded, were the damages caused by the dredger on drift-nets, the trail of suspended sediments seen along the dredger routes from the borrow site to the reclaimed area, and sludge being dumped even before reaching the prescribed dumping area. A non-governmental organization (NGO), the Sahabat Alam Malaysia (Friends of the Earth, Malaysia) also wrote to the DOFP enquiring several matters pertaining to the land reclamation works in Sitiawan (letter dated 3 November 1997 with reference number SAM/Per/3/97/ZY). A fisheries trader association, namely, the Marine Product Association of Pangkor, further complained about the matter to the Menteri Besar of Perak (Chief Minister) through their letter dated 24 October 1997 (no reference provided). This association was more worried about the effect of dredging on the members' privately-owned jetties and on the general scale, the adverse effect on the fisheries resources that might interrupt the livelihood of fishers and the tourism industry. Mr. Mohd Azmi Abdul Hamid, chairman of the NGO, Majlis Muafakat Pembangunan (Council of Development Co-operation), in his press statement called for the government to step in to investigate the plight of the fishers (Berita Harian, 3 November 1997). He expressed despair of the government's silence towards fishers problem and supported the order planned by the Land Office to stop the dredging and sludge dumping in Pangkor's water. Ironically, according to the Marine Department of Lumut, prior to the 13 October 1997, the trailing suction hopper dredger "Volvox Hansa" had been operating without a valid shipping license, since it was permitted to operate only thereafter.

There was a problem of enforcement too. Although the company VOA had voluntarily compensated some claims made by fishers on their fishing nets damages, their dredging activities were almost unmonitored by any of the authoritative agencies. The two government agencies directly responsible to ensure compliance of the related regulations were the Marine Department, which oversees the adherence to the designated shipping routes and the Department of Environment responsible to watch over environmental hazards that may result from human error or simply non-compliance of the specified dredging programme and methods[43]. The dredger Volvox Hansa, which started to operate illegally in September 1997, was seemingly left unnoticed by the Marine Department, indicating lack of inspectorate works by the department and strict procedure in handling the case, since the owner of the dredger was never been penalized. Apart from the complaint of mishandling of the sludge by the dredger, there was a complaint on the rate of the trips made by the dredger. Some fishers from Pulau Pangkor reported to the DOFP that the dredger had made 23 trips during the night and two trips during the day (in a letter with reference number Prk. Pk. 018/13 dated 24 October 1997). It was believed that the action by the dredger was to borrow at night to avoid detection by the authority, since the specified dredging programme was only two trips per day. Again, such irresponsible behaviour by the dredger was left unpunished by the responsible authority, particularly the DOE. In Malaysia, as in many developing countries, limited manpower and funds is a major factor in the poor enforcement of legal instruments and environmental conservation and improvement programmes (Brookfield and Byron, 1993). In general, it can be assumed that no one could tell if compliance had been met and with the huge amount of complaints received from the public, it was unlikely for the dredger to adhere closely the specified conditions as laid in the approved EIA, especially when no one was monitoring.

Impacts on the environment were foreseen by the project proponents that would affect the well-being of the society, especially fishers. They have duty of care to prevent, reduce or

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[43] It had specified that a trailing suction hopper dredger was to be utilized by the project at the rate of four hours daily or about 17% of time daily (Hydec Engineering, 1998). Approximately the dredger would make two return trips from the borrow area to the rehandling pit per day. Hydec Engineering also reminded that a proper dredging methodology to be implemented in order to ensure minimal impacts to the environments.

control the adverse impact on the environment as required by the law so as not to injure or damage their neighbours' properties and not to discharge any substances that may damage the waters. However, proving that the duty has been breached is often difficult because evidence cannot be based on possibilities[44] (Look *Guan Soon Tin Mining Co*) as there must be hard evidence or positive proof for the plaintiff to claim damage, as shown in *Granby (Marquis) v Bakewell Urban District Council*[45] where the defendant was held liable only after it was proven that the water samples collected on several occasions contained matter highly poisonous to fish.

EIA is not a 'license' to pollute

An EIA is about making prediction about what is going to happen and what mitigation measures are necessary to be employed if the effect is undesirable. Essentially, it is a process that identifies and predicts adverse consequences on the environment as a result of any proposed activity and recommends alternatives or other measures to mitigate these consequences (Kanniah, 2000). The rationale underlying EIAs is to ensure that the development will not infringe on human health and safety and that the development will not cause damage to the natural and physical environment (Spellerberg, 1991). However, what is written on paper is not necessary reflected in reality. In describing the advantages of the use of the trailing suction hopper dredger, Perunding Utama (1997), claimed that the dredger would have minimal impact on the marine environment. The dredger itself may have met the highest standard of machinery in use but its operation was negligent. For example, why was the sludge dumped in an area it was not supposed to be dumped?

The EIA is essentially a planning tool for preventing environmental problems due to an action, and it seeks to avoid costly mistakes in project implementation, either because of the environmental damages that are likely to arise during project implementation, or because of modifications that may be required subsequently to make the action environmentally acceptable. Section 34A (6) of the EQA stipulated that any person

[44] On evidences provided by the plaintiff in this case, Judge Suffian said, "I do not find here sufficient evidence entitling the court to hold that the plaintiff has by the ordinary standard of proof in civil actions shown at least that on a balance of probabilities it was the defendant's breach that caused or materially contributed to the plaintiff's injury. All that the plaintiff has merely proved is that it was *possible* that his injury might have been so caused.

[45] (1923) 87 JP 105, (1923) 21 LGR 329

intending to carry out a prescribed activity[46] shall not carry out such activity until the report[47] required under this section to be submitted to the Director General has been approved. Upon approval by the Director general, the person carrying out the prescribed activity, or in the course of carrying out such activity, shall provide sufficient proof that the conditions attached to the report (if any) are being complied with and that the proposed measures to be taken to prevent, reduce or control the adverse impact on the environment are being incorporated into the design, construction and operation of the prescribed activity (Section 34A (7)). A fine not exceeding RM 100,000 or a term of imprisonment not exceeding five years or both can be imposed on any person who fails to comply with any provision under the Section 34A (Section 34A(8)).

There are provisions under the EQA that stipulate the restrictions of any person to pollute the environment[48] and none whatsoever exempt any person from doing so except being granted a license to pollute,[49] which must not contravene acceptable conditions as specified by the Minister[50] under Section 21 of EQA. Even if a person is granted an approval to carry out certain activities under Section 34A (3), it does not exempt that person the responsibility to comply with specified conditions as set by the Minister. The EIA approval does not exempt the responsibility of the project owner from protecting the environment in due course of his action. It is required, for example, under Section 34A (2) of EQA that the EIA report shall be in accordance with the guidelines prescribed by the Director General and shall contain an assessment of the impact such activity will have, or is likely to have, on the environment, and the proposed measures that shall be undertaken to prevent, reduce or control the adverse impact on the environment. Lastly, based on the common law, it can be said that holding a licence or planning permission is not enough for exonerating the

[46] Prescribed activity is an activity as specified in the Schedule of the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order, 1987 that came into force on the 1 April 1988.
[47] An EIA report as required under Section 34A of EQA.
[48] Section 22 of EQA is about restrictions on pollution of the atmosphere, Section 23 restriction on noise pollution, Section 24 restrictions on pollution of the soil, Section 25 restrictions on pollution of inland waters, Section 25 prohibition of discharge of oil into Malaysian waters, Section 29 prohibition of discharge of wastes into Malaysian waters, and Section 29A prohibition on open burning.
[49] Section 22(1) of EQA states the need of a license to emit or discharge wastes into the atmosphere in contravention of the acceptable conditions specified under Section 21, Section 23 (1) is the need of a license to pollute or cause or permit to be polluted any soil or surface of any land in contravention of the acceptable conditions specified under Section 21, Section 25 (1) is the need of a license to emit, discharge, or deposit into any inland waters in contravention of the acceptable conditions specified under Section 21, and Section 29 (1) a need of a license to discharge waste into Malaysian waters.
[50] Minister means the Minister charged with the responsibility for environment protection (Section 2 of EQA).

holder from the liability, as shown in cases presented in British court: *Gillingham BC v Medway Dock*[51]; *Wheeler v Sanders*[52]; and *Hunter v Canay Wharf*[53] which are applicable in Malaysia by virtue of the Civil Law Act 1956[54]. This has also been the view of the House of Lords Select Committee which maintains that the environmental licence should not provide a defence to civil liability, as the costs of the damage would remain on the public, thereby directly contradicting the 'polluter pays' principle (Ansari, 2000). An EIA permit does not exempt the project proponents from social liability as demonstrated in the case *Enviro-Legal Action V Union of India* [(1996) 3 SCC 212 : JT (1996) 2 SC 196], where the court ruled that,

'.... once the activity carried on is hazardous or inherently dangerous, the person carrying on such activity is liable to make good the loss caused to any other person by his activity irrespective of the fact whether he took reasonable care while carrying on his activity. The rule is premised upon the very nature of the activity carried on'.

7.3.6 *The rule in Rylands V Fletcher*

The rule in Rylands V Fletcher stated that anyone who in the course of 'non-natural' use of his land 'accumulates' thereon for his own purpose anything likely to do mischief if it escapes is answerable for all direct damage thereby caused (Deakin, *et al.* 2003). A defendant is not held liable under *Rylands v Fletcher* unless two conditions are satisfied: (i) that he has brought something onto his land likely to cause mischief if it escapes; and (ii) that those things happened in the course of some non-natural use of the land (*Mason v Levy Auto Parts of England Ltd*[55]). When such a situation is found to exist, then there is no necessity for the plaintiff to prove the negligent act of the defendant; this is a case of strict liability (*Steven Phoa Cheng Loon & Ors V Highland Properties Sdn Bhd & Ors*[56]). However, this rule has undergone changes in recent years in the common law practising countries. In England, the House of Lords in *Cambridge Water Co Ltd v Eastern Counties Leather plc* has added to this principle the necessity to prove that the defendant could reasonably foresee the thing might, if escaping, cause damage to the plaintiff, whereas in

[51] [1993] QB 343
[52] [1995] 3 WLR 466
[53] [1996] 1 All ER 482
[54] Section 3 - Application of U.K. common laws, rules of equity and certain statutes.
[55] (1967) 2 QB 530
[56] (2000) 4 MLJ 200

Australia, in the case of *Burnie Port Authority v General Jones Pty Ltd* 120 ALR 42, the High Court after describing this rule as having 'all its difficulties, uncertainty, qualifications and exception' completely discarded it as an independent cause of action, and incorporated it into the law of negligence. The situation in Malaysia is at the crossing point where two High Court judges adopted a different stand. Judge Foong during his deliberation in Steven Phoa Cheng Loon, chose to follow *Burnie Port Authority* when he said,

> 'I tend to favour the Australian approach since after the case of *Cambridge Water Co Ltd* the requirement of foreseeability had deprived this independent cause of action of its attractiveness. Since foreseeability is required to be proved, it might as well be absorbed into the liability of negligence.'

On the other hand, in a more recent High Court ruling, the trial judge found for the plaintiff and held the defendant liable under the rule in *Rylands v Fletcher* in *Milik Perusahaan Sdn Bhd & Anor V Kembang Masyur Sdn Bhd*[57]. In this case, the defendant conducted some activities on its land and as a result, there was a mudslide causing a considerable amount of earth to be deposited onto the plaintiff's land. The plaintiff was then awarded a sum of RM7,462,377.93 for damages of its land. Since both courts are not bound by each other's decisions, and furthermore in the absence of higher court decision on the matter, this dichotomy should be resolved by a higher court, the sooner the better, to re-establish certainty in the law (Chin, 2003). In the mean time, the doctrine of *Rylands V Fletcher* is sought in this present case, since, if fulfilled, exempts the plaintiff from proving negligence on the part of defendant, which is difficult.

If dumping of sand into an area or 'land' owned by them constitutes 'accumulates,' and if escaped to the neighbouring land would do mischief to the occupier of the land or his property, as in this case, the escape of suspended solids into the sea could harm marine life, then the rule partly has been satisfied. The next difficult question is whether the reclamation works are 'non-natural' use of the land since, as put by Professor Newark (1961), it is an ambiguous phrase. What is 'natural' is viewed differently from different cases, as described in the passage in the opinion of Lord Porter in *Read v Lyons*[58] which reads:

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[57] (2003) 1 MLJ 6
[58] [1947] AC 156

"For the present I need only say that each seems to be a question of fact subject to a ruling of the judge as to whether the particular object can be dangerous or the particular use can be non-natural, and in deciding this question I think that all the circumstances of the time and place and practice of mankind must be taken into consideration so that what might be regarded as dangerous or non-natural may vary according to those circumstances."

Non-natural use of the land can also be inferred if the defendant does not abide by the normal practice of the works in question. In Hoon Wee Thim V Pacific Tin Consolidated Corporation[59], Judge Gill of the OCJ Singapore, concluded that the action of the defendant building a large water reservoir exceeding three feet high above ground was a non-natural use of the land, although it was suggested that having a series of step ponds was a part of their mining scheme to prevent erosion. The court found that from the evidence that they did not require a big reservoir for that purpose as all that was required was a certain height of water not exceeding 3 feet. Judge Gill was in opinion that had the pond been confined to that depth, the accident would in all probability had never happened and therefore the case falls fairly and squarely within the rule in *Rylands V Fletcher*. In the appeal case by the same defendant in *Pacific Tin Consolidated Corporation V Hoon Wee Thim*[60], in dismissing the appeal, *inter alia*, the Federal Court judges held that natural user of their property does not imply that miners had *carte blanche* to carry on mining operations in any manner they think fit, however hazardous to their neighbours; that the use to which the sand bund was put in this case was a non-natural user; and the rule in *Rylands V Fletcher* accordingly applied. Here, the court stressed that the question of non-natural use is secondary so long as it is potentially capable of inflicting harm to its neighbours, it falls under the doctrine of *Rylands V Fletcher*.

Apart from eye-witnesses that reported the misconduct of the Volvox Hansa during its operations, no other hard evidence is available. Evidence that the obligations of the project proponents, as stipulated under the EIA report, had been breached, particularly on the level of water quality, mitigation and abatement measures, are not available. For example, during sand sourcing the rate of slurry discharge was to be controlled so that the Total Suspended

[59] (1966) 2 MLJ 240
[60] (1967) 2 MLJ 35

Solids near Volvox Hansa be kept below 100 mg/l and the overflow from the dredger be directed below water surface, preferably at depths that do not allow the upwelling of sediment resulting from the wake created by the moving ship, to ensure that the discharged fine sediment settles out rapidly onto the seabed (Perunding Utama, 1997). However, their adherence to such obligations was unknown, since, according to Wang (pers. comm.), no-one had been assigned to monitor their works. At the reclamation area, the project proponents were also obliged to prevent the sediment plume from reaching the coastline of Mukim Lekir by providing barriers of various kinds enclosing the area. Again the effectiveness and the implementation of such effort was not monitored or reported. Nonetheless, as pointed out earlier, in *Pacific Tin Consolidated Corporation*, the effort of proving 'non-natural use of land is secondary so long as it can be proven that the escaped substances, such as suspended solids, are detrimental to the aquatic organisms or plants. The reclamation works are therefore 'non-natural' use of the land and thus fall under the doctrine of *Rylands V Fletcher.* There is also the need to prove that the defendant could reasonably foresee the substance might, if escape, cause damage to the environment as decided by the House of Lords in *Cambridge Water Co Ltd* case, which had appended to the doctrine of *Rylands V Fletcher*, the necessity to prove foreseebility of harm that the escaped substances may do upon its neighbours. Fortunately, by referring to the approved EIA report, the project proponents were fully aware of the harm that may be inflicted upon the society had the substances 'escaped' into the environment.

7.4 Environmental compensation in Malaysia

The purpose of awarding substantial damages is to restore the plaintiff to the position he or she would have been had the tort not been committed (Batra, 2000). Normally, awards given are in the form of money as damages are assumed capable of being valued or quantified. In the case *Ramachandran A/L Mayandy V Abdul Rahman bin Ambok Laongan & Anor*[61], Judge Abdul Malik Ishak, while expressing his sympathy to the one-legged plaintiff as a result of an accident, said, "...the plaintiff is entitled to the best as the purpose of compensation is to put the plaintiff as the victim, so far as money can do the trick, in as near a position as he was before the tort was committed." Compensation can appear in other forms, as observed in a case *Sunrise & Co Pte. Ltd & Anor V Marco Shoe Sdn.*

[61] (1997) 4 MLJ 237

Bhd.,[62] where, in addition to pure monetary compensation, the plaintiffs, who were concerned in protecting their reputation in the shoe business, were also 'awarded' an order by the court to destroy the defective shoes the defendant is keeping and they were not allowed to be circulated in the market.

There is no case yet brought before a judge pertaining claims on fishing losses against any polluter in Malaysia. Although there have been several major oil spills[63] in Malaysian fishing waters and fishers complained about their losses, nothing more was heard except the issues being debated in the newspapers[64] for several days and then gradually forgotten by everybody. But the damage remains with the fishers and their families. The most probable reason was that fishers were not properly represented to voice their grievances. In the Tanjung Karang oil-spill, despite wide coverage given by the local newspapers, the voice of the fisher's association was not heard, although several fishers interviewed by reporters claimed loss of income. One of them, Ibrahim Salleh, said, "Since the oil slick, I have not been able to catch any fish at all. I used to be able to catch at least RM50 worth of fish daily but now I would be lucky if I catch anything at all." (New Straits Times, 24 December 1997).

With the exception of the provisions contained in the MSA pertaining to oil pollution, no other environmental laws in Malaysia give due regard to the damage incurred by the people, let alone providing a proviso for compensation. There is hardly any legislation that provides for civil liability for such pollution, let alone one that spells out the determinative criteria or its consequences (Chin, 2003)[65]. Thus, aggrieved individual or individuals could

[62] (1998) 5 MLJ 627
[63] In 1994, there were 92 cases of oil-spills reported. Hasbullah Zakaria, an enforcement officer from the Department of Environment Malaysia admitted that although the department had not kept an exact records of the losses caused by the oil-spills, they acknowledge its adverse effect on the eco-system that had caused the economic losses to the nation (Laura Junus of WATAN, ICI-CCM Environmental Journalism Award 1995-1996). Ahmad (1995) noted 75 shipping incidents were reported between 1975 and 1993 of which 54 resulted in oil spills and three (the Showa Maru, the Diego Silang and most recently the Nagasaki Spirit) are considered as major spills. The three incidents involved the spillage of over 30,000 tons of oil and a clean-up cost of US$ 3 million. In the press statement to New Straits Times dated 2 July 1998, the Minister of Environment, Science and Technology, Mr. Law Hieng Ding stated that there had been four major oil-spill incidents in 1998 of which two cases were caused by ships *MT Bunga Melati* and *MV Wan Hai Lions No.222.*
[64] Example in the Tanjung Karang oil-spills (The New Straits Times dated 24 December 1997 through 7 January 1998, The Star dated 30 December 1997 and 3 January 1998, Berita Harian dated 15 January 1998 and The Sun dated 13 January 1998).
[65] (2003) 3 MLJ i; (2003) 3 MLJ A 1.

only resort to the law of torts, which is based on the English common law principles[66]. Conservatively, a person or a group of persons aggrieved by the damage could summon the polluter and then presenting his or their case before a civil court judge use the law of torts to go against those responsible for polluting acts. There are several examples where environmental damage claims have been made in the courts of Malaysia. In an appeal case in the High Court between *Eng Thye Plantation Bhd V Lim Eng Hock & ORS,*[67] several fish breeders were compensated for the lost of income by the oil palm plantation responsible of discharging 'black water' into the river where their fish cages were located. Judge Gopal Sri Ram in dismissing the appeal made by the plantation company at the Court of Appeal, said, "to the extent that the environmental protection law is dependent on common law, the relevant principles that deal with the protection of the environment are to be found in the law of nuisance and in the tort of negligence". Looi (2002) pointed out that the *Woon Tan Kan*'s[68] case illustrates claims pertaining to environmental matters can be made, and usually have been based upon common law causes of action such as negligence, the rule in *Rylands v Fletcher* and nuisance.

7.5 Problems faced by the plaintiffs and their remedies

Bringing matters to court is not an easy thing. In rural areas, where society organization is still problematic, getting them together is almost unattainable. Then, there are several legal problems; property rights, *locus standi,* the question of economic or pure economic loss and the usual high legal fees to be paid to lawyers. Only if individuals or firms are truly compassionate will most of the problems discussed in this chapter be solved, but, even laws, in the eyes of the laymen lack compassion. For example, if A does harm to B's property, C cannot claim damages since it is pure economic loss even though C did lose some income that was supposed to be gained had B's property not been damaged by A. C will feel that he is being victimised since his losses are real but laws do not recognize such losses. B on the other hand can claim and here it is said that the law is compassionate to B but not to C.

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[66] In *R V Civil Service Appeal Board ex parte Cunningham* , it was held that although there was no statutory duty to give reasons, there was a common law requirement of 'natural justice' to outline sufficient reasons to indicate whether the decision has been lawful (Nik Mahmod and Yaqin,2003). It indicates that, in the absence of statutory laws, common law is referred.

[67] (2001) 4 MLJ 26

[68] *Woon Tan Kan (Deceased) & Seven Ors v Asian Rare Earth Sdn Bhd* [1992] 4 CLJ 2299 (escape of dangerous radioactive gases from factory).

The present law of torts are not much help to the pollution victims. In the absence of specific statutory law facilitating victims of pollution in making claims, the remedies against violation of right is depended solely on the law of torts but there are some problems pertaining to such dependency. Ansari (2000) argued that due to some inherent contra factors, like technicalities as the basis of relevant torts, exceptions appended to some of them, a lengthy and expensive procedure and the requirement of *locus standi* have made the remedy in the law of torts insignificant and of least help to pollution victims. Ansari, then suggested that the courts should make efforts to liberalize the availability of a tortious remedy in favour of those who suffer from polluting activities in view of the fast increase in environmental damage. A similar call was made by Chuan (1999) to allow public spirited individuals and NGOs with a responsible track record to voice the concerns of the general public with a relaxation of the rules on standing as many environmental damages may not always have a direct impact on specific individuals

The following is discussion on some major problems faced by the plaintiffs along with suggested remedies.

7.5.1 *Property rights*

Environmental problems persist as long as no one has the legal private rights over an environment. For economists, the conventional starting assumption is that all forms of environmental problems are ultimately property problems and that given the right set of property rules, environmental problems would be self-remediating (Cole, 2002). If property right is clearly assigned to any of the disputing parties, Coase's Theorem would be appropriate. Coase's Theorem proposes that proper assignment of property rights to any good, even if externalities are present, will allow bargaining between the affected parties such that an efficient solution can be obtained, regardless of which party is assigned those rights (Callan and Thomas, 2000) however the model's prediction of an efficient outcome depends on two very limiting assumptions: the transactions are costless; and that damages are accessible and measurable. Thus, for the theory to hold in practice, at minimum it must be the case that very few individuals are involved on either side of the market.

Usually, where negotiation has failed between the two parties, legal action is inevitable. It failed because there is no clear property rights assignment, that is, whether the 'projects' have acquired the rights to pollute or fishers having rights of fishing resources in the area. When both parties believe each has the right either to pollute or to have clean air, then the difficulties emerged (Varian, 1990). Supposing through government's intervention, fishers, being represented by a legitimate association are given the right of fishing in an area, then negotiation between the two conflicting parties is feasible. In this example, it holds since the polluters are few, so is the affected party being represented by an association acting on their behalf and fish are marketable goods. Since fishers have the right to the fisheries resources, the 'projects' will have to bribe them in monetary terms to be able to proceed with their works, and Coase's Theorem tells that if the 'projects' are liable for the damage caused, the amount imposed on them will be the benefit loss of fishers. They will continue to proceed provided the benefit gains from their activities are higher than the amount of bribe offered together with other production costs. Unless the liability is higher than the cost of pollution abatement, they will continue to pollute and pay bribes to fishers. On the other hand, if the revenues of the remaining undamaged fisheries resources are lower than the total cost of fishing, it is profitable for fishers to stop fishing altogether and thus accepting bribes from the 'projects'. In this situation, both fishers and the 'projects' are in good bargaining power that both parties profit from their actions.

If government does not intervene, no one is assigned the property rights. Bargaining between the two parties is unattainable. Unless the 'projects', due to their own conscience, social responsibility or morality, help voluntarily relieve fishers of their hardship, then the questions of property rights and compensation need be answered by the court system. Initially, those answers are reviewed using stipulated provisions under the statutory laws, but where such provisions are absent or inadequately satisfying the aggrieved party, the Common Law in the civil court system is sought. Common Law works best when the number of parties in dispute is small. When a number of parties involved in a dispute is large, and the circumstances are common, the inefficiency is more appropriate to be corrected by the statutory laws. Therefore, without government intervention, fishers are forever victimised by these circumstances. They do not hold individual right to the fisheries resources but only public right, provided, of course, if the statutory laws explicitly address the question of property rights and compensation. Unfortunately, this is not the case.

In fisheries, there has been a suggestion by Hannesson (1993) to establish property rights to fish stocks but for the purpose of improving fisheries management, where, according to him, the owner of a fish stock has a strong incentive to limit fishing to whatever level maximizes profit, whether he cashes in the profit by fishing himself or by selling or leasing to others the right to do so. Assigning property rights to fishers is not new, as it has already been applied in most developed countries, such as Japan, where fisher's cooperatives have been given exclusive rights to inshore resources (Asada *et al.,* 1983). In England, clubs own the right to fish along some rivers and they protect their "beats" from pollution (Adler, 1995). Property rights are important not only for the betterment of fisheries management, but for the protection of the rights itself, since laws are more compassionate towards those owners of the properties. Moreover, with property rights in hand, an owner and a polluter may exercise the Coase's Theorem. Unfortunately, the practice of assigning property rights to public goods in Malaysia is still unusual. The government is quite reluctant as yet to dispose its authority to other organizations for fear of mismanagement and incompetence. According to Mhd Shah Abdul Hamid[69] (pers. comm.), the major obstacle in the success of Community Based Fisheries Management programme is the government's apprehensiveness on the ability of the fisheries association to manage and maintain the portion of fishing area, if given to them.

7.5.2 *Locus standi*

If government does not intervene and no one is assigned the property rights, then aggrieved individuals must now seek for compensation, since amicable negotiation is inaccessible. If compensation is asked for damages on private property, as illustrated earlier, the plaintiff may be successful since the law is compassionate on such claims. However, fisheries resources and mangroves are all public properties for which bringing action against the polluters is the prerogative of Attorney-General. However, in cases where the government itself has a stake in the polluting company, the situation will put the Attorney-General in a dilemma It is difficult to imagine an Attorney General to bring a government - interest company into a court for causing a public nuisance. This is because the Attorney-General is entwined in the Government as its lawyer and when the Government is sued, it is the Attorney-General's chamber that defends it (Singh, 2003). Fishers are, however,

[69] The Fisheries Director of State of Perak.

exceptional, that they may successfully demonstrate their damages are over and above the damages incurred by general public by virtue of their right to fish with licenses issued by the authority. With this privilege, they are able to prove *locus standi* as well, the condition gravely demanded by the courts in Malaysia.

Following Singh (2003), the guidelines for the development of the law on *locus standi* in public interest actions in Malaysia should be based or developed on the following flow-chart;

Decide what the cause of action is

If the cause is a breach of law by another, causing no specific injury to any person or a determinate class of persons, then any citizen must be able to move the court. If not, laws can be disobeyed with impunity.

In such cases, the court should, as far as possible, evaluate, at a preliminary stage, the merits of the case. If a prima facie case is made out, the court must assume standing. If at the end of the day, the case is dismissed on its merits, the discretion would not go to standing but rather the substance of the case itself. If on the particular facts of the case, the court feels that it should skip the preliminary stage and that it would be a waste of time and costs to have a two stage process, then the court must assume standing and hear the case on its merits.

If a person or a determinate class of persons is affected, then any one of those persons must have standing to sue. Further, anyone else with a genuine, special *bona fide* interest must also be allowed to sue. That anyone maybe a natural person or much more likely, an organization. In deciding whether such person or organization has a genuine, special bona fide interest, factors to be taken into consideration would include inter alia:

(i) evidence of the person's or organization's commitment to the cause;

(ii) public or governmental recognition of such person or organization in relation to such cause;

(iii) strength of the organization's membership;

(iv) evidence of the representative character of the person or organization;

(v) length of time the person or organization has served the cause;

(vi) the organization's constitution, charter or if applicable, the statutory provisions governing it;

(vii) the nature of the breach or complaint;

(viii) the importance of the cause;

(ix) whether effective legal redress could still be obtained if the court refused standing.

These guidelines proposed by Singh (2003), will allow NGOs, such as World Wildlife Fund (WWF) to represent the environmental cases, Consumer Associations (such as Consumer Association of Perak and Consumer Association of Penang,) to protect the consumers benefits and Fishers Association in cases pertaining fisheries resources. Moreover, if, for example fisheries are being affected, any fisher can bring the matter to court or other person proven to possess genuine and *bona fide* interest on the matter.

7.5.3 *Pure economic loss*

Judge James Fong allowed pure economic loss in *Dr Abdul Hamid Abdul Rashid*, when he said that non-allowance of such claim would leave the entire group of subsequent purchasers in this country without relief against errant builders, architects, engineers and related personnel who are found to have erred. He described how the non-allowance of pure economic loss claim had produced an unfair result in *Candlewood Navigation Corp Ltd v Mitsui OSK Lines Ltd & Anor*, where the owner of the ship which was damaged in an accident, failed in his claim for the loss of hire charges he had paid to the 'bareboat' charterer of the vessel and the revenue he lost for not being able to use the vessel, because at the time of the accident he was not, in law, in possession of the vessel but had a mere contractual interest through a time charter from the 'bareboat' charterer (Matta, 2003). To prevent 'the allowance of pure economic loss creating liability for an indeterminate amount for an indeterminate time to an indeterminate class', the Common Law judges should wisely deliver their opinions as to where and when these liabilities end but not to put aside wholly such claims. Economic loss, as commonly defined, should also be dealt with by the Common Law judges to provide just results as their damages are real and factual.

7.5.4 *Inadequacy of statutory laws*

There is no statutory law that permits such compensation measures except when the damage is caused by oil at sea. In the USA, the designated trustee of natural resources can seek claim through CERCLA for injuries to natural resources resulting from a release of a hazardous substance and to recover monetary damages from the responsible party. Private individuals cannot make claim for environmental damages under CERCLA but may proceed with common law actions, such as public nuisance, private nuisance, trespass and actions under the Public Trust Doctrine. The EC also seems to adopt similar measures, allowing private individuals to seek remedial under Common Law.

The existing environmental laws are inadequate to deal with the environmental problems, simply because of their soft approach in the name of encouraging development and protecting the developers. Polluters are made to pay less than the damage caused. Penalties stipulated under the EQA do not reflect the actual cost, but are ambiguously set at a certain maximum level, although Section 47 of the EQA does provide the Director General power to recover the clean-up costs from the concerned polluters. Still, the costs that are being discussed here, the human costs, are at distance from the Malaysia's statutes. In Japan, a highly industrialized country, its environmental laws are exemplar of laws compassionate to people. It is compassionate because of the 1970 law concerning the Settlement of Environmental Pollution Disputes (1970 SEPD), to settle environmental pollution disputes as an alternative to civil trials that were not deemed satisfactory to victims since: (1) they must establish a cause-effect relationship, which was very difficult; (2) a large sum of trial costs was required; and (3) trial proceedings were rigid and a long time was required before a final judgement (Ministry of the Environment Japan, 2004). The 1970 SEPD was enacted following the prescribed responsibility of the State to take necessary measures to implement effectively conciliation, mediation, arbitration and adjudication with regard to disputes related to environmental pollution, and take other necessary measures to smoothly resolve problems arising from environmental pollution as stipulated under Article 31 of the Basic Environmental Law of Japan. The dispute settlement process requires both parties to agree to succumb to remedies of any of the measures with the exception of adjudication process where the 1970 SEPD gives a certain legal effect to a judgment of an adjudication committee unless an appeal to the judicial court is made within 30 days after the adjudication. The adjudication committee will establish whether: (1) cause-effect relationship in legal terms exists between the alleged harmful act and the damage in an environmental pollution case; and (2) a party is responsible for the monetary compensation for an environmental pollution damages case, and the amount of compensation thereof. With the enactment of such measures, Japan has successfully resolved 1,661 disputes or 96.3% of the total environmental complaints between 1970 and March 2001 and more importantly had opened up quick and just settlement avenues for the environmental victims and polluters alike. Malaysia should also promote such a move, turning away from the judicial complexity of claiming compensation in civil courts by inserting provisions into the present statutes or enacting a new one that perhaps could provide quick and just remedies. Japan's remedies are society-friendly, and following its example could bring justice to poor environmental victims. Moreover, polluters are accommodated as well since they have to voluntarily accept the settlement processes.

There should be a change in environmental laws in Malaysia, particularly giving due regard to economic losses resulted from the pollution. The fundamental issue here is justice, followed by the rights to live in a better environment. The principle that the harmed person should be compensated should be upheld in a society where justice is paramount. The PPP, as adopted by many countries, including Malaysia's environmental laws, has been narrowly defined not to include harms or costs to human beings. Many advocates of market-based instruments misuse the economic theory by redefining the concept of costs and damage to apply to things rather than to people (Cordato, 2002). As such, laws enacted to prevent pollution do not include the rights of harmed people to claim compensation for their losses. The inadequacy of the PPP is acknowledged by the Supreme Court of India in *Enviro-Legal Action* when it stressed that people should be compensated as well. Therefore, the environmental policy makers should accept the broad definition of PPP so that laws enacted not only penalize polluters to pay for clean-up costs, they also provide some room for people to claim compensation for their losses.

7.6 Conclusion

This study is about the environmental problems affecting the society at large. The problems commenced the very first day Volvox Hansa dredged sand in Lekir waters for the 405 ha land reclamation project. Taking advantage of the deficiency of the EIA requirement, the project proponents DKSB and TNB ignored their responsibility towards the society by disposing the need to tackle the costs or externalities incurred by the society as the result of its activities. In economics, pollution can be eradicated if a firm internalizes the externalities; a novel act to correct market failure. For factory emitting noise, internalization is by two approaches; either by making effort to reduce the noise; or simply compensate the losses incurred by the people living nearby. DKSB could seek similar approaches by adopting a much better dredging technology which would increase its private costs or simply compensating the people involved, which normally would be cheaper. As it is, neither DKSB nor TNB is willing to take up the burden

As is it now, the laws are not compassionate enough to the environmental victims. Ansari (2000) said the judicial delineation of tortuous remedy has utterly failed to control environmental pollution and to bring justice to the doorstep of the indigent and poor people. Fishers may test the courts since they have *locus standi* and moreover their claims are economic loss contrary to non-recoverable pure economic loss in the law of torts. They may take action against first and second defendants based on nuisance, negligence and the rule of *Rylands V Fletcher* but the latter is more preferable since being strict liability, exempts them from proving negligence. What is essential is to prove that reclamation works are the act of accumulating something on defendant's land, as in this case sand, gravels, pebbles *etc.* and during the course of its operation had allowed or caused the thing to escape resulting in damages to fishing catches. Damages to fishing catches can be instigated by presenting scientific findings in swept-area method survey, as in Chapter 2, and Before-After study on mangroves and fish landings, as in Chapter 4. The requirement of foreseeability is supposedly not difficult to prove as one reads the EIA report prepared by the defendant that depicts their wide knowledge on the possible damage inflicted on environment as a result of its act. Other claimants who are relying on pure economic loss may find it almost impossible to succeed. They may hope for government intervention to rescue them from their misery

CHAPTER 8: CONCLUSION

The flow of this study was tailored to follow an investigative procedure. Firstly, damage was detected; secondly, the perpetrator was identified; thirdly, damages were valued; and finally compensation issues were highlighted. These chapters attempt to answer some questions that may be asked by the defendants, and the rest to fulfil the legal needs to align with Judge Ong Hock Thye in *Guan Soon Tin Mining Co V Wong Fook Kum*[1] who quoted Lord Goddard C.J. in *Bonham-Carter V Hyde Park Hotel Ltd*, saying, "Plaintiffs must understand that if they bring actions for damages it is for them to prove their damage; it is not enough to write down the particulars and so to speak, throw them at the head of the court, saying, 'This is what I have lost: I ask you to give me these damages.' They have to prove it." This chapter recapitulates the key findings of this study and makes recommendations to revitalize the fishing communities by way of creating local economic activities funded by the developers, as well as suggesting further research.

8.1 Summary of the previous chapters

There is little doubt that fisheries were affected quite badly by the reclamation project. The catch rates and annual total biomass declined from 1997, i.e. the year before intervention, to 2002 and further declined in 2003 (Chapter 2). For example, by the end of 1998, the total fish landed by the traditional fishers of South Manjung dropped to 5,481 t from the previous year of 7,109 t. Although fish landings indicated a declining trend beginning in 1996, i.e. before the intervention, the fall in landings in 1998 was considered abrupt by many fishers. The continuation of the fish stock decline after the intervention reinforced the belief that the stock was affected by the project. Fishers were prompted to blame the reclamation works as they had seen the physical impacts on the water at their fishing grounds. As the coastal land reclamation also affected the mangroves, it further degraded fisheries resources, and the livelihoods of the fishers living in the area, both in the short and long term. Fishers' losses in particular, and society's losses in general, then became the main concern of this study and to begin with, concurrently, two surveys were carried out by this researcher to explore and investigate if there really was a decline in the living resources with subsequent effects on the fishers. Fisheries resource assessment surveys were carried

[1] (1969) 1 MLJ 99

out by swept-area method on 17 August 2002 and 21 August 2003. The primary purpose of these surveys was to validate fishers' claim of declining catch in the area by providing catch-rate and biomass trends. The fisheries exploitation status was determined by estimating the Maximum Sustainable Yield (MSY) and comparing it with the present rate of exploitation. It was shown that the exploitation levels had superseded the MSY in both survey years indicating greater fishing pressure that could further deteriorate the present fish stocks.

To investigate the effect of the reclamation works on society, particularly on fishers, a socio-economic survey (interview questionnaires) was carried out between 15 July 2002 and 31 August 2002. The main purposes of this survey, was to verify if the impacts predicted by DKSB and TJSB were well founded and conform to the reality, approximately five years after the start of the reclamation works, This study determined if the impacts predicted are still manifest within the coastal community or whether the strength of the impacts have subsided since the beginning of the reclamation works; thus providing justification for lack of compensatory action.

The socio-economic study served as an impetus to pursue this study further because of the realized social and economic problems prevalent during and after the completion of the project. Detailed results of the socio-economic survey are elaborated in Chapter 3, using questionnaires specifically designed to measure these problems through face-to-face interviews with 1,282 respondents, of which 59.04 % were fishers.

Fish stock decline is known to be caused by many factors, for example over-exploitation; badly managed mangroves; siltation caused by infrastructural development upstream leading to sedimentation problems; coastal erosion; and pollution caused by human activities on land. This serves as a good defence case for the perpetrator who argues that reclamation works are not the only cause of the environmental degradation. To rebut this argument, the before-after study proved the intervention had actually caused the damage (Chapter 4). Two damages were assessed; mangrove deterioration and fish landing decline. Insufficient pre-project intervention data prevented the study on impacts on mangroves using the BACI approach, thus Impact versus Reference Site design was used. Sites nearer to the impact were affected more than those situated further away, and moreover, mangrove deterioration was found to be a slow process that could only be detected several years after the intervention. However, fish landings data, as collected by the DOFP, provided both the before and after data that permitted the use of a BACIP design. A nearby fishing area was chosen as a control site that was assumed to resemble the impacted site. After the perturbation, each site reacted differently, with no holistic decline at the control site implying that fish depletion at the impacted site was caused by the 'island', since it was not present at the control site.

The lost benefit of mangrove use was estimated to be at RM 81,959/year by using CVM. The survey involved 648 respondents residing in Mukim Lekir to elicit their WTP on a hypothetical market scenario (Chapter 5). Indirect uses of the mangroves by Lekir residents exist, and 39.3 % of residents give positive WTP values. Those who were WTP generally thought it compensated their feeling of responsibility to protect the environment.

The first valuation approach was based on consumer and producer surpluses compared with revenues obtained before the intervention. The difference between the benefit gained before and after the intervention, as in this case, was the benefit loss as incurred by fishers, fish consumers and farmers. Following the demand and supply principles, any changes in fish production affects both consumers and producers, that the former pay more for a unit price of fish if the supply becomes scarce or the latter gains a reduced profit as a result of increasing fishing costs to catch the shrinking fish stocks. The economic benefits or losses from the marketed goods were quantified in monetary terms (Chapter 6). Consumer and producer surpluses were measured econometrically to derive the benefit loss at RM 2,785,904/year and RM 15,545,277/year respectively. Losses incurred by cockle farmers were straight forward in derivation, i.e. the benefit that would be gained by them had the 'island' not been there in the first place. The loss benefit of the farmers was calculated at RM 478,115/year. In addition to losses incurred as a result of fish depletion and the prohibition of farming, government's failure to achieve its objectives was regarded as losses and measured by the funds spent on projects or programme proportional to its failure. Government's losses were determined to be RM 797,157/year.

The second approach was to adopt the forecasting technique to predict landings after the land reclamation works. However, since fish landings between 1992 to 1997 exhibited an upward trend, it was decided to adopt the difference of benefit gains between before and after the perturbation as more appropriate than using the forecasted data. The upward trend indicates that fish landings were not affected by any perturbation but a change in direction after perturbation points to its presence. The forecast data were used in other ways. Total expenditures spent on programmes and projects cannot be regarded as total loss but proportional to the loss of fish production. The forecasting technique played an important role in providing data in the absence of perturbation to be compared with the actual fish landed.

Chapter 7 reviewed legal matters pertaining to claiming compensation and determining the standing of claimants in the courts of law. The welfare of society is supposed to be protected by laws. Article 5 of the Federal Constitution was concluded by Ansari (1998)[2] to mean the right to healthy environment. This right is further emphasized in Malaysia's National Policy on the Environment, which is intended at continuing economic, social and cultural progress of Malaysia, and enhancement of the quality of life of its people, through environmentally sound and sustainable development (DOE, 2004). Its main framework of environmental legislation, the Environmental Quality Act 1974 (EQA) and various regulations enacted thereunder (Tan, 1998), are enforced to protect the environment from being polluted and provide penalties for those who have failed to abide by it. To further oversee that the progress of development does not create environmental problems, the mandatory requirement of the EIA report for some prescribed activities is provided under the Section 34A of the Environmental Quality (Amendment) Act 1985 (this 1985 Act amended the EQA) and officially came into force on the 9 January 1986[3].

Fishing grounds and the rights of the fishers are protected under law. Although the project proponents had been granted approval to carry out the reclamation works under Section 34 (A) (6) of the EQA, they must take due care not to pollute. Failure to comply with pollution preventive measures (if directed by Director General of DOE) will subject the offender a monetary fine or imprisonment or both (Section 34 [A] [8]).However, bringing offenders to

[2] 'Right to a Healthful Environment as a Means to Ensure Environmental Justice: An Overview with Special Reference to India, Philippines and Malaysia' [1998] 4 MLJ xxv

[3] However, the prescribed activities only came into force on 1 April 1988 when an order was formally enacted and cited as the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment)Order ,1987 (Order 1987 was later amended by the Order 2000). So, technically speaking, the EIA requirement in Malaysia only began on 1 April 1988.

court action is the prerogative of the Attorney General. This is difficult, as in this case, the government is among the major shareholders of the companies. Consequently, fishers could seek justice in the civil court suing the perpetrators since they may have *locus standi;* that their damage is over and above the general public.

8.2 Fishers actions

Two most important actions to be considered by fishers are: (1) to prevent similar problems from recurring in the future; and (2) asking compensation for losses currently incurred. Fishers should be more aware of the happenings within their areas and taking instantaneous action when their interests are threatened. In Lekir's land reclamation, it was observed that fishers were naïve and did not voice their despair vigorously. Most probably, they failed to envisage the problems that awaiting them in the future due to lack of scientific knowledge on the impacts of the land reclamation on fisheries resources. Moreover, fishers did not make use of their association (Fisheries Association of Manjung) to act on their behalf in voicing their grievances. It is suggested here that fishers should unite under the sanctuary of the association and building up the relationship with environmental-related NGOs to fight their cause. On the government part, it is suggested that fishers should be represented in the EIA Panel so that their interest can be heard at the very beginning of the project.

Taking court action against the environmental perpetrators is expensive and lengthy business, so much so that individual action is almost impossible. Hence, the Fisheries Association could play its role as representative of the fishers in the court. Their standing in the court should be based on the rulings made in *Jan de Nul (UK) Ltd. V NV Royale Belge* and *Burgess V M/V Tamano*, where fishers could pursue a claim if they proved to have suffered damage over and above the general public as a whole. Since proving damages is difficult and complex, it is suggested that fishers should constrict their claims based on *Rylands V Fletcher* where they need to prove that the reclamation works caused damages to fishing resources.

8.3 Compensation

The most common method of compensation adopted by many countries to force individuals or firms to internalize the environmental costs is by imposing a tax on industries potential of endangering public health or the environment, or environmental tax that compensates other social taxes. For example, in the U.S.A., the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) was enacted on 11 December 1980, among other things, to create a tax on the chemical and petroleum industries (CERCLA was later on amended by the Superfund Amendments and Reauthorization Act on October 17, 1986). The tax goes to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites (EPA, 2002a). Another pollution prevention law enacted in U.S.A. is the Oil Pollution Act (OPA) of 1990 which streamlined and strengthened the U.S. Environmental Protection Agency's (EPA) ability to prevent and respond to catastrophic oil spills. A trust fund financed by a tax on oil is available to clean up spills when the responsible party is incapable or unwilling to do so (EPA, 2002b). In Britain, the Climate Change Levy is imposed on business. It is the Environmental Tax Reform, a policy that raises taxes on the use of energy (or other environmentally-damaging activities) and lowers other taxes, usually those on employment. The higher taxes on energy will lower pollution while lower taxes on labor will increase employment (Surrey, 2002). Australia, U.S.A., Britain, Canada, Denmark, Germany and Japan along other 23 countries member to the Organization for Economic Cooperation and Development (OECD) adopted, as advised by the organization, the 'Polluter-Pays Principle' (PPP) in 1974. PPP means that the polluter should bear the expenses of carrying out the (control) measures, to ensure that the environment is in an acceptable state. In other words, the costs of these measures should be reflected in the costs of goods and services which cause pollution in production and/or consumption (CIESIN, 2002). Other method, as practiced by Malaysia, is the requirement to prevent, reduce and control the adverse impact on the environment which must be incorporated into the design, construction and operation of the prescribed activity (Section 43A (7) of the EQA).This mitigation effort must be itemized and clearly described in the EIA report presented to be approved by the authority.

To remedy the externalities, apart from complying with the general practices of developed countries, recommendations from several sources are being considered here. Call and Holahan (1983) described three approaches of solving the externalities: Coarsian bargaining, effluent charges and quotas. Griffiths and Wall (1999) suggested that those who impose external or social costs must be controlled through legislation (pollution controls, Clean Air Acts), or penalized through taxation.

This study proposed that government should intervene by making a mandatory requirement for compensation elements to be included in EIA reports. It must be clearly defined and methods of dissemination be laid out. The projects proponents must have anticipated some losses that are going to be incurred by the people living in the areas. As to the amount required, it can be implemented in various stages. The payment can be in two forms; (1) short-term, and (2) long-term.

8.3.1 *Short-term*

This is an immediate relief payment as a result of loss of income. The amount paid should be in tandem with the amount lost. Basically, incomes before are compared with the incomes after perturbation, and the difference is paid to each fisher as short-term compensation. The compensation stops when the authority is satisfied that the income has return to its pre-perturbation level.

8.3.2 *Long-term*

It is proposed that the project proponents are to support financially various existing and new fisheries community projects.

Project 1: Training in fish processing

The objective of this project is to provide knowledge in theory and practice of fish processing works where raw fishes are value-added into products such as fish cakes, fish balls and fish crackers. A medium-sized factory is proposed to be set up and run by the fishers to produce the products and marketing them locally, as well as exporting them to other places.

Project 2: Fishers economic group

They are two economic groups, namely, the Kg. Permatang Economic Group and the Pulau Pangkor Economic Group initiated and supervised by the DOFP. Their main economic activities are supplying ice blocks to fishers, providing out-board engine services and fish marketing in local area. Currently, their activities are slowed down for two reasons: (1) decrease in fish landings has resulted in lesser demand for ice blocks and revenues from fish trading; and (2) lack of capital to improve the services provided. It is proposed that both economic groups diversify their activities into goods retailing, given the additional capitals. Apart from present activities, they should also sell groceries, hardware materials and spare-parts for boat's engine. Training for these new activities should also be provided.

Project 3: Inland aquaculture: training

Training opportunities should be extended to many more fishers. The objective of this training is to transform fishers into fish farmers and at the same time phasing out the present fishing in the area. Training modules, include basic courses in inland aquaculture, freshwater fish breeding, pond prawn culture, brackish-water prawn culture, brackish-water cage culture and crab culture. The trained fishers may later on be assisted into practicing their own aquaculture projects or be employed in existing projects in other places.

Project 4: Inland aquaculture: the fish nursery projects

At present, there are three nurseries operating in the area by private individuals. The objective of these nurseries is to supply fish fingerlings and prawn juveniles and to meet the demand of local aquaculture projects in the state. According to DOFP, the effort which is promoted by them is also to reduce the dependency of fingerlings and juveniles imported from the neighbouring countries, particularly from Thailand. The types of nurseries are:

(a) Catfish nursery project.
(b) Giant Perch or Barramundi (*Lates calcarifer*) nursery project.
(c) Tiger Prawn (*Penaeus* sp.) nursery project.

The demand for catfish and giant perch fingerlings is increasing. Both the catfish and giant perch productions increased from 1,614 t and 359 t in 2000 to 2,276 t and 573 t in 2001 respectively. Similar increasing trends were observed in tiger prawn production, which increased from 2,657 t in 2000 to 5,357 t in 2001. The average percentage increase of these species 68% between the years 2000 and 2001. It is then anticipated that the demand for fingerlings and juveniles is encouraging and therefore these projects should be expanded by capital inputs from the project proponents. New and bigger hatcheries are planned to get more fishers involved actively in these projects.

Project 5: Ornamental fish hatchery

Although Perak's ornamental fish production decreased by 4.3 % in 2000 compared with 1999, it was still the second largest producer of ornamental fish in Malaysia, after Johor. The demand in ornamental fish keeps increasing, as shown by Malaysia's annual export data to Singapore and other countries (Annual Fisheries Import-Export Statistics 1998-2001). According to the DOF's Director General, Junaidi Che Ayub, by 2010, the target set by the department is to produce 388 millions of fish of over 200 species (New Straits Times, 9 February 2004).

Production of the present hatchery operated by one individual is too small. In 2000, it produced 100 pieces of Discus and 1,000 pieces of angelfish, which was not economically viable. However, given that the prospects of this industry are encouraging, the project should be expanded by more capital inputs and revival in management and operation capacity. With proper guidance and technical assistance from the DOFP, this project is certain to be successful.

Project 6: Mangroves rehabilitation

This project involves the planting of mangroves species on to the degraded area. In Matang, Malaysia, a reforestation plan is prepared before planting, listing the extent and areas to be planted, complete with an estimate of supporting resources needed (FAO,1994). The planting spacing is 1.5 m * 1.5 m within the swamp for *Rhizophora apiculata* and 1.8 m * 1.8 m beside the waterways for *Rhizophora mucronata.* Seedlinds are planted by pushing the radicals gently into the soft mud up to about 5-7 cm deep. Rhizophora sp. is preferred because of its large propagules and ease of replanting it but due to its susceptibility to attack from crab or monkey, and death from toppling by oysters, barnacles, algae or other organisms settling on the seedling, the propagules are grown in the nurseries for a few months and planting them out when large and robust enough to cope (Hogarth, 1999).

8.4 Suggestions for further research

Suggestions for further research include: (1) improving data collection; (2) developing comprehensive stock assessment protocols; and (3) improved EIA procedures. The main agencies responsible or having interest in these activities are DOF, FDAM, DOE and universities conducting marine-based research. However, it is suggested that to avoid overlapping effort which may result in funding wastage and redundant data, efforts must be collaborative and overseen by a selected agency. It is not the intention of this study to suggest how the research framework in Malaysia should be organized, as its problems have been discussed elsewhere (Chua and Scura, 1992; EPU, 1993; MIMA, 1995 and Miles, 1996). Suffice to point out that as it is now, there has been no conscious attempt to integrate oceanographic research into the overall national development and policy making structure (Basiron and Ahmad, 1999). Recently, a national policy on Integrated Coastal Zone Management (ICZM) was prepared and is awaiting Malaysian government's approval (Herriman, 2004). It is hoped that with the emergence of this policy, better coordination between relevant agencies can be achieved, especially in conducting coastal research.

8.4.1 *Improving fisheries data collection*

Most of the components of this study lingered around information relating to comparison of before and after the perturbation. While gathering the after data was relatively straightforward, the before data were, on the other hand, problematic. At present, data on fisheries are collected by the DOF and published annually. The State Fisheries office also prepares an annual statistical report at the state level, but it is unpublished. The suggestion here is to include new data inputs to the department's database. These new inputs are to be described at the lowest level possible (Figure 8.1) to permit study at the lowest level.

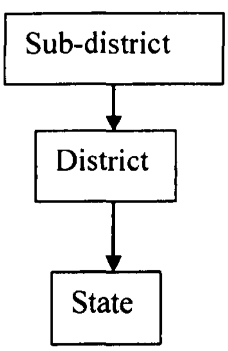

Figure 8.1: The flow-chart of data collection

Fisheries statistics prepared at the State level should be published for easy public access. By being published, it has credibility to represent official data valid for research and other uses. As experienced by this researcher during data collection for this study, certain data on socio-economics were not found, but are vehemently needed; thus, they should be included in future statistical monitoring by the DOF. These data and its method of collection include;

(1) The number of unregistered fishers and unlicensed vessels should be collected since their presence places substantial pressure on fish resources. Their number could be gauged by recording the number of vessels present in each fishing base and multiplying by a factor appropriately to present a number of crew in accordance to the type of fishing gear used. These data should be collected on a weekly basis and averaged on a monthly and yearly basis for reporting.

(2) Socio-economic data are important for two reasons: (a) to record demographic characteristics of fishers and their families; and (b) to assess their well-being by knowing their incomes. Demographic characteristics should be collected once a year by way of a questionnaire survey. Respondents should be sampled randomly to provide information on age, sex, race, education level, employment status and fishing activities. To determine their incomes, it is suggested that information on operational fishing costs is collected on a weekly basis. Fishing cost components include fuel cost, food, ice and other expenditures. Other information needed to determine income is fish ex-vessel price and profit sharing ratio. Thus, the income of a vessel owner and his crew, whenever applicable, could be gauged using the equation given in Chapter 3.

(3) Socio-economic data of fish farming should also be collected.

8.4.2 *Stock Assessment*

Although the history of fish assessment in Malaysia began in 1970 (Mohammad Shaari *et* al, 1974), followed by several other surveys (Chang *et al,* 1975; Latif and Leong, 1976; Pong, 1981; Pong and Nuruddin, 1988; Nuruddin, 1987 and Department of Fisheries Malaysia, 2000), there has been no attempt by DOF, nor by any other agencies, to assess fisheries resources within inshore areas. As a result, most of the fisheries management policies are based on findings of surveys carried either in areas far away or deeper waters than the area of concern. For example, surveys between 30 November 1971 to 11 January 1972, between 16 November 1974 to 11 December 1974, between 17 October 1978 to 18 November 1978, between November 1980 to December 1980 and between October 1981 to November 1981 were all carried out in areas between Langkawi Island and Penang Island ,

and between Penang Island and Pangkor Island, except a survey between 15 September 1997 to 9 October 1997 that was carried out in water adjacent to Lekir waters but beyond 12 nautical miles from the shoreline. Lack of funding could be the main reason for the limited survey area coverage, since according to Centre for Marine and Coastal Studies of the Universiti Sains Malaysia, in the 7th Malaysia Plan Period (1995 – 2000) only RM 12.3 million was allocated to oceanography-related projects. This is only 3 per cent of a total of RM 408 million allocated for research under the IRPA[4] scheme.

It has been shown by this study that fish assessment could be done at the State level with minimum research expenditures. State Fisheries Departments should be encouraged to undertake the task. It is suggested that to reduce the costs, the survey must be in collaboration with fishers or their associations. Research applying holistic models based on either the swept-area method or surplus production model, is considered the most appropriate due to the less demanding data requirements (Sparre and Venema, 1998). The existing staff can be trained in sampling procedures, species identification and recording procedures. The swept-area method should be implemented once a year.

8.4.3 *Improving EIA procedures*

EIA reports presented by Perunding Utama (1997) and Tenaga Nasional (1997) did not address the issue of costs and benefits satisfactorily. This is a weakness, among other things, being identified by Rahman, Md. Mizanur *et al.* (2002) in many other Malaysian EIA reports. Although small parts of the reports described them, it was only a prediction and subjectively described without attaching any quantified data. Therefore, this study suggests that in future EIA reports, especially pertaining to the construction of power plants, the project proponents shall include a quantified study on the CBA based on the premise of the following equation; NSB = SBDE + NEE, where NSB is the Net Social Benefit, SBDE is Social Benefit for Direct Effect and NEE is Net effect of Externalities (Watson, 2002).

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[4] Support for oceanographic research in Malaysia comes under the government's Intensified Research in Priority Areas (IRPA) scheme.

In LCDP, the government had a stake in the power plant (holding 64.02 % stake in TNB) as well as in the JVC (holding 13.26 % of the total stake). Since it was a government-related project, it is suspected that the EIA Panel, which consisted mainly of government officials, acted to support the project despite the lack of detailed information on CBA in the report. To avoid future repetition of this kind, where the proposed prescribed activities are government-related, the following suggestions are proposed:

1. Government should appoint an EIA Commission; an independent body that that oversees regulations, enforcement and the appointment of the EIA Panel and the Approving Authority;

2. the EIA Panel should consist of professionals in related fields, environmental-related NGOs and members representative of the affected communities;

3. where damages are expected to be incurred by society, the EIA Commission should appoint a consultation agency to evaluate them and present the findings to the EIA Panel. In turn, the EIA Panel should use the monetary values incurred as the basis for compensation.

8.5 Fishers solution

This study investigated the impacts of the land reclamation and the building of coal-fired power plant that capable of generating 2,100 MW of electricity to supply the nation's energy needs, on the fisheries resources and fishing communities. Phase 1 of the project reclaimed 450 hectares of land on which to locate the coal-fired power plant. While the electricity benefited people living far away from the coastal area, the livelihoods of the fishers dependent on the fisheries resources were hampered by low fish catch and other environmental hazards. The is no doubt the benefits of 2,100 MW of electricity supplied to the nation will surpass the value of the fisheries resources, but the environmental degradation and the economic losses of fishers as gauged by this study are substantial to the fishing communities.

Instead of letting fishers going through expensive and lengthy court procedures, the government should step forward acting as mediator between them and the project owners. Government intervention seems necessary as fishers may face difficulties in the court of laws, especially in the question of *locus standi* and proving damages. One possible option is to bestow fishers the property rights on fishing grounds. The fisheries associations may play an important role as the keeper of the property on behalf of the fishers. With property rights legally assigned to fishers, Coarse's Theorem will come into practice.

In fighting their cause, fishers should not stand alone. Under the patronage of their associations, they must develop and strengthen the relationship with other NGOs interested in environmental protection. Legal advice, monetary assistance and public support may be gained by such a relationship. Fishers must also demand their presence on the EIA Panel so that they are well-informed of the implementation of the project and their grievances can be heard and considered by other members of the EIA Panel.

Existing environmental legislation is not much help to fishers. Although the laws follow the PPP, they are restricted to paying the clean-up costs or penalties that are set up on ambiguous methodology, which most of the time is less than the costs inflicted by the perpetrators. Therefore, through fisher's representatives in Parliament, they should urge the government to amend some provisions of the EQA to suit relevant problems faced presently. For example, Section 34A (8) of the EQA provides a RM 100,000 penalties for EIA offenders which is inadequate to compensate damages inflicted. It is suggested that penalties should reflects the societal costs gauged by independent bodies. The money paid by the offenders could then be used to regenerate those impacted. With this sort of statutory laws, fishers are not tempted to bring their grievances to the Common Law court, which does not ensure their standing.

As suggested, the EIA Commission, if appointed, would introduce great changes to Malaysia's environmental laws concerning land reclamation and other prescribed activities that require compliance to Section 34A of the EQA. Currently, the action on offenders of the laws is under the prerogative of the Attorney General, which is seemingly ineffective pertaining to government-related companies. For example, it was found that DKSB had failed to fulfil its promises, such as providing employment to affected population and controlling pollution from wide spreading. This is an offence under Section 34A (7) of the EQA, which was not given proper attention by the authority. The EIA Commission thus, being an independent body, with power bestowed on them, would press the Attorney General to take necessary action.

Although there are provisions under the present environmental laws in Malaysia that penalize non-compliance of the EIA regulations (Section 34A of the EQA), the relevant authorities are reluctant to take action when the perpetrators are government-related companies. This is evident that although complaints were made by fishers and public on the failure of the developers to abide EIA requirement on pollution abatement, none of the relevant authority had made any further legal action. The appointment of EIA Commission is hoped to solve this problem, first by setting up an independent body to monitor the compliance of the EIA regulations and second to initiate legal action by consulting the Attorney General.

At present, fishers are the most vulnerable segment of the society. They are generally poor and uneducated. The Lekir land reclamation showed how they were being ignored and their losses unattended by those responsible. For Malaysia to strive forward, due care should be taken in environmental preservation and protection parallel to the global inspiration on the environment. Injustice to fishers or to those inflicted by development is tantamount to denying their human rights, which is another important issue of concern by world communities. Therefore, Malaysia should regard environmental problems with due regard that need to be resolved wisely.

REFERENCES

1998 Annual Fisheries Statistics. Department of Fisheries, Perak.

497th CTS/SJA (2004). Country law study: Malaysia. US Air-Force in Singapore. Available on-line at https://www.sing.af.mil/Legal%20Office/Malaysia%20CLS_files/Malaysia%20CLS,%2025%20May.doc dated 17 December 2004.

Abas, S., Alias, R., Shazali, A.B. and Afizah, M. (2000). Willingness to Pay for Conservation of Recreational Site of Damai District Kuching, Sarawak. Paper presented at the First Conference for Resource and Environment Economists. Paradise Malacca Village Resort, Ayer Keroh, Malacca 29-31 July 2000.

Ali, A. Y. (2004) The holy Quran. Available on-line at http://info.uah.edu/msa/quran/yusufali/030.TheRomans.html dated 14 May 2004.

ABIM (2003) Available on-line at www.abimjohor.org.my/alamsekitar.htm dated 17 November 2003.

Adair, R.J. & Groves, R.H. (1998). Impact of environmental weeds on biodiversity. (ISNB 0 6422 1412 3). Dept. of the Environment and Heritage, Australian Government.

Adamowicz, V. (1995). Alternative Valuation Techniques: A Comparison and Movement to a Synthesis. In Willis, K.G. and Corkindale, J.T. (eds.) *Environmental Valuation: New Perspectives.* UK:CAB International

ADB (1997) *Environmental Impact Assessment For Developing Countries In Asia, Volume 1: Overview.* Manila: Asian Development Bank.

Adler, J. H. (1995) Making the polluters pay. Available on-line at *http://www.cei.org/utils/printer.cfm?AID=3110* dated 16 April 2004.

Ahmad, A.T. (1988) Population dynamics of big-eye croaker (*Pennahia macrophthalmus,* Sciaenidae) off Kedah, Penang and Perak States, Malaysia. In S. Venema, J.M. Christensen and D.Pauly (eds.) *Contribution to tropical fisheries biology: papers by participants of FAO/DANIDA follow-up training courses.* FAO Fisheries Report 389. FAO, Rome: 142-152

Ahmad, Razif (1995). Funding the Strait of Malacca: The Japanese contribution. Paper presented at the workshop on the Straits of Malacca, Kuala Lumpur, Malaysia, 24 - 25 January 1995. Unpublished

Ahmad, Yusuf J. 1985. *Guidelines to environmental impact assessment in developing countries.* London: Hodder and Stoughton.

Ahmad, A.T., Isa, M.M., Ismail, M.S. and Yusof, S. (2003). Status of demersal fisheries resources of Malaysia. In G. Silvestre, L. Garces, I. Stobutzki, M. Ahmed, R. A. Valmonte-Santos, C.Luna, L. Lachica-Alino, P.Munro, V. Christensen and D. Pauly (eds.) *Assessment, management and future directions for coastal fisheries in Asian countries.* Penang: World Fish Centre and Asian Development Bank.

Alias R. and Shazali, A.B. (2000). Use of dichotomous choice contingent valuation method to value the Manukan Island Sabah. Paper presented at the First Conference for Resource and Environmental Economists. Paradise Malacca Village Resort, Ayer Keroh, Malacca 29-31 July 2000.

Alias Man (2003) Tropical model of the coastal fisheries ecosystem of the west coast of Peninsular Malaysia. In G. Silvestre, L. Garces, I. Stobutzki, M. Ahmed, R. A. Valmonte-Santos, C.Luna, L. Lachica-Alino, P.Munro, V. Christensen and D. Pauly (eds.) *Assessment, management and future directions for coastal fisheries in Asian countries.* Penang: World Fish Centre and Asian Development Bank.

Amemiya, T. (1981) "Qualitative response models: a survey," *Journal of Economic Literature* 19(4): 1483-1536

Anon. (1983) "The effect of El Nino on Ecuadorean fisheries," *Mar. Fish. Rev.*, 45(10-12): 68-69, 1983

Anon. (1988) Deep-sea fisheries resource survey within the Malaysian exclusive economic zone final report. Kuala Lumpur: Department of Fisheries Malaysia.

Anon., (1997). Malaysia Environmental Quality Report 1997. Kuala Lumpur: Dept. of Environment, Ministry of Science and Technology Malaysia.

Anon. (1998A) Laporan kajian socioekonomi nelayan 1995. Lembaga Kemajuan Ikan Malaysia. Kuala Lumpur: Kementerian Pertanian Malaysia.

Anon. (1998B). Malaysia Environmental Quality Report 1998. Kuala Lumpur: Dept. of Environment, Ministry of Science and Technology Malaysia.

Ansari, A. H. (1998) "Right to a healthful environment as a means to ensure environmental justice: An overview with special reference to India, Philippines and Malaysia," *Malayan Law Articles,* 4 (25).

Ansari, A. H. (2000) "Environmental protection through law of torts: a critical appraisal," *Malayan Law Journal Articles,* 4 (81).

Ansari, A. H. (2004) "Legal issues in forest management in India and Malaysia," *Malayan Law Journal Article,* 2 (21).

Asada, Y., Hirasawa, Y., and Nagasaki, F. (1983). Fisheries management in Japan. FAO Fish. Tech. Pap. 328. Rome: Food and Agriculture Organization.

Ault, J. S., McGarvey, R., Rothschild, B. J. and Chavarria, J. B(1996). Stock assessment computer algorithms. In V. F.Gallucci, S. B. Saila, D. J. Gustafon and B. J. Rothschild (eds.) *Stock assessment : Quantitative methods and applications for small-scale fisheries.* Boca Raton, U. S. A :Lewis Publishers, Boca Raton. p. 501-515

Archbold, John Frederick (2002) *Criminal pleading, evidence and practice.* London: Sweet & Maxwell

Arrow, K.; Solow, R.; Portney, P.R.; Learner, E.; Radner, R. and Schuman, H. (1993). Report of the NOAA Panel on contingent valuation. Federal Register, 58:4601-4614.

Ayob,A.M.,Rawi, S.B., Arzemi, A. and Ahmad, S. A. (2001). Pulau Payar Marine Park:Non-use value.Paper presented at the Second Conference for Resource and Environmental Economists,Malaysia,organized by the Malaysian Association for Resource and Environmental Economics (MAREE),11 August 2001.

Asia Times, October 28, 2000

Asimakopulos, A. (1978) *An introduction to economic theory: Microeconomics.* Canada: Oxford University Press

Babbie, Earl and Halley, Fred (1998) *Adventures in social research – Data analysis using SPSS™ For Windows 95®. California:* Pine Forge Press

Bann, Camille (1998) The economic valuation of tropical forest land use option: A manual for researchers. Economy and Environment Program for Southeast Asia, Singapore.

Bann, Camille (1999) A Contingent valuation of the mangroves of Benut, Johor State, Malaysia. Johor State Forestry Department /DANCED/Darudec: Preparation of an Integrated Management Plan for the Sustainable Use of the Johor Mangrove Forest .

Bann, Camille (2002) Biodiversity valuation – An overview of valuation techniques: Advantages and limitations. A paper prepared for ASEAN Regional Centre for Biodiversity Conservation (ARCBC), Third Research Conference. Biodiversity Valuation: Approaches and Case Studies.

Barg, Stephen (1996) "Eliminating perverse subsidies: What's the problem?" In *Subsidies and environment, exploring the linkages.* OECD document, 1996

Bartholomew, David J. (1981) Handbook of applicable mathematics. In W. Ledermann (ed.) *Mathematical methods in social science*. New York: John Wiley & Sons, New

Basiron, M. N. and Ahmad, A. R. H. (1999) Role and contribution of oceanographic research in maritime policy making in Malaysia. Kuala Lumpur: Maritime Institute of Malaysia

Bateman, I. J., Langford, I., Willis, K. G., Turner, R., and Garrod, G. (1993). The impacts of changing willingness to pay question format in contingent valuation studies: An analysis of open-ended, iterative bidding and dichotomous choice formats. CSERGE Working Paper GEC 93-05. University of East Anglia

Bateman, I.J. and Turner ,R.K. (1993). Valuation of the environment, methods and techniques:the contingent valuation method. In R.K. Turner (ed.), *Sustainable environmental economics and management: principle and practice.* London: Belhaven Press.

Batie, S. and L. Shabman (1982) "Estimating the economic value of wetlands: principles, methods and limitations," *Coastal Zone Management Journal,* 10 (3): 255-277.

Batra, Manjula (2000). Water rights. In Telbir Singh (ed.), *Seminar* (Issue number 492). New Delhi : Malvika Singh.

Benedetti-Cecchi, L. (2000) "Beyond BACI: optimization of environmental sampling designs through monitoring and simulation," *Ecological Application.* 11(3), 783-799.

Berg, D.; Fisher, S. and Dornbusch, R. (2003). *Foundation of economics.* London: McGraw Hill Education.

Bergstrom, T. C. and Miller, J. H. (1997) *Experiments with economic principles.* New York: The McGraw-Hill Companies, Inc.

Berita Harian, 21 July 2003.

Bernama (19 May 2004). A special report by M. Saraswathi and Massita Ahmad on petrol price in Malaysia: Still one of the cheapest in Asean. Available on-line at http://www.bernama.com/bernama/v3/news_business.php?id=67834 dated 26 June 2004.

Besanko, D. A. and Braeutigam, R. R. (2002) *Microeconomics: An integrated approach.* New York: John Wiley and Sons, Inc.

Bishop, R. and Heberlein T. (1979),"Measuring values of extramarket goods :are indirect measures biased?", *American Journal of Agricultural Economics*, 61:926-360.

Blaber, S.J.M. (2000) *Tropical estuarine fishes: ecology, exploitation and conservation.* Oxford: Blackwell Science Ltd.

Black, T. R.(1999) *Doing quantitative research in the social sciences.* London: SAGE Publications

Black, R. (2203) "The legal basis for control of imports of animal and plant material into the United Kingdom - does the polluter pay on the high seas?" *Environmental Law Review*, 53(193).

Blomquist, G. C., and Whitehead, J. C. (1998) "Resource quality information and validity of willingness to pay in contingent valuation," *Resource and Energy Economics* 20(2) 179-196.

BLS (2004) U.S. Bureau of Labour of Statistics. Available on-line at www.bls.gov/oco/ocos 177.htm dated 27 March 2004.

Blumenschein,K., Magnus J., Glen C. Blomquist, B. L. and Richard M. O. (July1998) "Experimental results on expressed certainty and hypothetical bias in contingent valuation," *Southern Economic Journal*; 65(1):169-177.

BNM (2003). Bank Negara Malaysia Annual Report 2003. Available on-line at http://www.portsworld.com/banknegara/bnegara.htm

Boehlert, G.W. and B.C. Mundy (1988) "The role and behavioral and physical factors in fish recruitment to estuarine nursery areas," *Amer. Fish. Soc. Symp.* 3:51-67

Boyle, K. J. and Bishop, R. C. (1988) "Welfare measurements using contingent valuation: A comparison of techniques," *American Journal of Agricultural Economics*, 70(Feb.):20-28.

Braden, J.B.; Kolstad, C.D. and Miltz, D. (1991). Introduction. In Braden, J.B.; Kolstad, C.D. and Miltz, D. (eds), *Measuring the demand for environment quality* Amsterdam: Elsevier. p.3-15.

Bray, J.R. and Curtis, J. T. (1957). "An ordination of the upland forest communities of southern Wisconsin," *Ecological Monographs,* 27:325-349

Breffle, William S.; Morey, Edward R.; Lodder, Tymon S.(1998) "Using Contingent Valuation to Estimate a Neighborhood's Willingness to Pay to Preserve Undeveloped Urban Land," *Urban Studies*; 35(4), 715-27.

Brewer, J. and Hunter, A. (1989) *Multimethod research- a synthesis of styles.* NewburyPark, U.S.A.: SAGE Publication

Brookfield, Harold and Byron, Yvonne (eds.). (1993). *South-East Asia's environmental future- the search for sustainability.* Kuala Lumpur : Oxford University Press.

Brookshire, D.S.; Eubanks, L.S. and Randall, A. (1983). "Estimating option price and existence values for wildlife resources," *Land Economics,* Vol.59, N0.1, p.1-15.

Brown, K. M., and L. O. Taylor (2000) "Do as you say, say as you do: evidence on gender differences in actual and stated contributions to public goods," *Journal of Economic Behaviour & Organization;* 43(1) 127-139.

Bullock, James (1997). Plants in Sutherland. In William, J. (ed.), *Ecological census techniques-a handbook.* Cambridge: Cambridge University Press. p. 111-138

Burgess J., J. Clark, and C. Harrison (2000) "Culture, communication, and the information problem in contingent valuation surveys: a case study of a Wildlife Enhancement Scheme," *Environment and Planning C-Government and Policy* 18(5) 505-524.

Button, Kenneth J. and Barker, Peter J. (1975)*Case studies in cost-benefit analysis.* London: Heinemann Educational Books

Caddy, J.F. and Mahon R. (1995) Fisheries management reference points. FAO Fish Tech. Paper No. 347.

Calia, P., and Strazzera, E. (2000) "Bias and efficiency of single versus double bound models for contingent valuation studies: a Monte Carlo analysis," *Applied Economics;* 32(10), 1329-1336.

Call , S. T. and Holahan, W. L. (1983) *Microeconomics.* Belmont, California: Wadsworth Publishing Company

Callan, S. J. and Thomas, J. M. (2000) *Environmental Economics and Management: Theory, Policy, and Applications.* U. S. A.: The Dryden Press

Calvo, Peter and Waugh, Geoffrey (1977) *Microeconomic: An Introduction Text.* McGraw-Hill Book Company Australia Private Limited.

Cameron, T.A. and James, M.D. (1987). "Efficient estimation methods for use with 'close-ended' contingent valuation survey data," *Review of Economics and Statistics,* 69: 269-276/

Cameron, T.A. and Quggin, J. (1994). "Estimation using contingent valuation data from a 'dichotomous choice with follow-up' questionnaire", *Journal of Environmental Economics and Management*; 27:218-234.

Canon, J. R. (1992) "El Nino 92: Data and fishery-biological effects," *Chile. Pesq.*,69: 51-54

Cantera K., Jaime R., Thomassin, Bernard A. and Arnaud, Patrick M. (1999). "Faunal zonation and assemblages in the Pacific Colombian mangroves," *Hydrobiologia*, 413:17-33.

Carson, Richart T.; Hanemann, W.M.; Kopp, R.J.; Mitchell, R.C.; Presser S. and Rudd, P.A. (1992). A contingent valuation study of lost passive use values resulting from Exxon Valdez oil spill. Report to the Attorney General of the State of Alaska. Natural Resource Damage Assessment, Inc.

Carson, Richard T. and Mitchell, Robert Cameron (1995) "Sequencing and nesting in contingent valuation surveys," *Journal of Environmental Economics and Management,* 28(2):155-73.

Carlson, J. L. (2000) "Hypothetical surveys versus real commitments: further evidence," *Applied Economics Letters*, 7(7):447-450.

Carter, J. (1959) "Mangroves succession and coastal change in Southeast Malaysia," *Transactions and Papers,* Inst. British Geography, 26:79-88

CIESIN (2002) OECD: The Implementation of the Polluter-Pays Principle. Center for International Earth Science Information Network Available on-line at http://www.sedac.ciesin.org/pidb/texts/oecd/OECD-4.09.html 30 October 2002.

Chalmers, Neil and Parker, Phil (1989). *The OU project guide.* Dorchester-Dorset: Field Studies Council.

Chesapeake Biological Laboratory (2002): Contingent Valuation Method. Available on-line at http://www.cbl.umces.edu/~dkingweb/contingent_valuation.htm dated July 5,2002.

Chilton, S. M., and Hutchinson, W. G. (1999) "Do focus groups contribute anything to the contingent valuation process?," *Journal of Economic Psychology*; 20(4), 465-483.

Chin, Chan Shick (2003). "Liability under the rule in Rylands and Fletcher in Malaysia,". *Malayan Law Journal Article*, 3 (1).

Choo, P.S. (1996) *The Utilization of mangroves Areas For Aquaculture-Can It be Sustainable?* Department of Fisheries Malaysia ,Kuala Lumpur

Choo, P. S. and Raihan, S. H. A. (2003). About mangroves: Country report- Malaysia. SEAFDEC Aquaculture Department. Available on-line at http://www.mangroveweb.net/html/country.htm dated 18 September 2003

Christensen, Bo (1983). Mangroves: what are they worth? Unasylva no.139. 35. Rome: Food and Agricultural Organization.

Chuan, Gan Chin (1999).A Review of Post- *UEM Developments.* 26 JMCL 119,at p155. CIA (2003). Available on-line at http://www.cia.gov/cia/publications/factbook/geos/my.html dated 14 April 2003.

Clark, R.B. (2002). *Marine Pollution.* New York: Oxford University Press.

Clerk, John Frederic (1947). *Clerk and Lindsell on the law of torts.* London: Sweet & Maxwell.

Clawson, Marion and Jack L. Knetsch (1966) *Economics of Outdoor Recreation.* Baltimore: The John Hopkins Press

Cole, Daniel (2002). *Pollution and property: Comparing ownership institutions for environment protection.* Cambridge: Cambridge University Press.

Common, Michael (1996) *Environmental & Resource Economics, An Introduction.* Singapore: Longman.

Constanza, R., d'Arge, R., de Groots, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. and Belt, M.V.D. (1997). 'The value of the world's ecosysytem services and natural capital'. *Nature* Vol. 387.

Cordato, Roy E. (2002) "The impossibility of harming the environment," *The Freeman: Ideas on Liberty,* Vol.52, no.5.

Couch, John A.(1979). Shrimps (Arthropoda: Crustacea: Penaeidae). In: C.W. Hart, Jr. and L.H. Samuel (eds.) *Pollution Ecology of Estuarine Invertebrates.* EPA-600/J-79-083. New York: Academic Press, Inc.

Cox, George W. (1968) *Laboratory Manual of General Ecology.* Dubuque, Iowa: WM. C. Brown Company

Crawford, Bruce A. and Johnson, Laura E. (2003). Procedure for monitoring effectiveness of fish passage projects (culverts, bridges, fishways, logjams, dam removal, debris removal) (MC-1). Washington Salmon Recovery Funding Board.

Cummings, R. G., and L. O. Taylor (1998) "Does realism matter in contingent valuation surveys?" *Land Economics,* 74(2), 203-215

Czaja, Ronald and Blair, Johnny (1996) *Designing Surveys.* Pine Forge Press, California.

Dale, M.R.T. (1999). *Spatial pattern analysis in plant ecology.* Cambridge: Cambridge University Press.

Dames & Moore, Inc. (2000). Applicability of biodiversity indices to FKCCS species and ecosystem. A paper prepared by Dames & Moore, Inc., for the U.S. Army Corps of Engineers and the Florida Department of Community Affairs. September 2000.

Deakin, S.; Johnston,A. and Markesinis, B. (2003). *Makesinis and Deakin's tort law.* New York: Oxford University Press Inc.

Department of Fisheries Malaysia (2000) *Fisheries resources survey in the exclusive economic zone (EEZ) of Malaysia 1997-1999 – The status of demersal and pelagic resources.* MFRDM, Ministry of Agriculture Malaysia

Department of Fisheries (2004) Objectives. Available on-line at http://agrolink.moa.my/dof/newdof/fmaklumat/objektif.htm dated 11 December 2004

Department of Statistics Malaysia (2000) Unpublished paper presented at Workshop on Key Economic Indicators . Bangkok,Thailand, 22-25 May 2000.

Desvousges, W.H.; Smith, V.K. and Fisher, A (1987) "Option price estimates for water quality improvements: A contingent valuation study of the Monongahela River," *Journal of Environmental Economics and Management,* 14: 248-267.

Diemont, W. H. and Von Wijngaarden (1975) Sedimentation patterns, soils, mangrove vegetation and land-use in the tidal area of West Malaysia. In G. E. Walsh, S. C. Snedaker and H.J. Teas (eds.) *Proceedings of international symposium on biology and management of mangroves, 8-11 October 1974, Hawaii.* Gainesville: Univ. Florida.

Dixon, R. G. (1959) A working plan for the Matang mangrove forest reserve (first revision, 1959). Perak, Malaysia, Forest Dept.

Dixon, B. R., Bouma, G. D. and Atkinson, G.B.J. (1992) *A handbook of Social SciencResearch* . Oxford: Oxford University Press

Dobson, S.; Maddala, G.S. and Miller, E. (1998) *Microeconomics.* UK: McGraw- Hill Book Company

DOE (2004) National Policy on the Environment. Available on-line at http://www.jas.sains.my/jas/NPOTE/content_intro.htm dated 11 April 2004.

DOF (1987). Cost structure and profitability of small scale fisheries in Peninsular Malaysia (Fisheries Extension Paper no.126). Kuala Lumpur: Department of Fisheries Malaysia.

DOF (1990). Kajian kos dan pulangan perkakas-perkakas tradisional di semenanjung Malaysia (Fisheries Extension Paper no. 154). Kuala Lumpur : Department of Fisheries Malaysia.

DOF Annual Statistical Report (2001).Department of Fisheries, Perak.

Dougherty, C. (2002) *Introduction to Econometrics.* New York: Oxford University Press

Dubourg, R. (1998). The Value of Morbidity Effects From Air Pollution in Kuala Lumpur. Institutional Strengthening and Capacity Building Project. Economic Planning Unit,Prime Minister's Department.

Duverger, M. (1964) *Introduction to the Social science.* London: George Allen & Unwin Ltd

Dytham, C. (2003) *Choosing and using statistics - a biologist's guide.* UK: Blackwell Publishing

Dziegielewska, D. A. P. and Mendelsohn, R. (2005) "Valuing air quality in Poland," *Environmental and Resource Economics,* 30: 131-163.

Ecosystem Valuation (2002) Market price method. Available on-line at http://www.ecosystemvaluation.org/market_price.htm dated 7 May 2002.

Edwin, C. (2003) "About assignment," *Malayan Law Journal Articles,* 1 (129).

Ellis, F. (1992) *Agricultural Policies in Developing Countries.* Cambridge: Cambridge University Press

Energy Information Administration, May 2001

Environmental Quality Act (Amendment) Act 1985 (Malaysia)

Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order, 1987 (Malaysia)

EPA (2002A). Methods for evaluating wetlands condition #4, study design for monitoring wetlands (EPA 822-R-02-015. Washington: United States Environmental Protection Agency.

EPA (2002B) CERCLA overview. Available on-line at http://www.epa.gov/cgi-bin/epaprintonly.cgi dated 30 October,2002.

EPA (2002C) Oil pollution act. Available on-line at http://www.epa.gov/cgi- bin/epaprintonly.cgi dated 30 October 2002.

EPU (1993) National conservation strategy. Volume 2: Administration. Economic Planning Unit, Department of Prime Minister (Malaysia), Kuala Lumpur.

ESCAP (2004) Role of various environment-related measures. Available on-line at http://www.unescap.org/drpad/vc/orientation/M5_anx_1.htm dated 12 June 2004.

Estelle, V.B. (2003). Employing a BACIPS experimental design to examine the effects of an introduced crab on shorebirds and their prey. Proceedings of the Third International Conference on Marine Bioinvasions, La Jolla, California, March 16-19, 2003, pp. 39.

FAO(1980). Available on-line at http://www.fao.org/fi/glossary/spec-termn.asp?id_glo=1364&id_lang=TERMS_E dated January 24, 1980.

FAO (1994) *Mangrove forest management guidelines.* FAO Forestry Paper No.117.Rome.

FAO (1995) *Code of conduct for responsible fisheries.* FAO of UN publication.

FAO (2001). Report of the bio-economic modeling workshop on the small pelagic fisheries of the west coast of peninsular Malaysia (GCP/INT/648/NOR, Field Report F-19(En).ROME: Food and Agriculture Organization.

FAO (2002A). Report of the expert consultation on identifying, assessing and reporting on subsidies in the fishing industries (FAO Fisheries Report No. 698). Rome: Food and Agriculture Organization, 3-6 December 2002.

FAO (2002B). The state of world fisheries and aquaculture (ISBN 92-5-104842-8). Rome: Food and Agriculture Organization, 2002

FAO (2003A). Glossary. Available on-line at http://www.fao.org/fI/glossary/default.asp dated 22 October 2003

FAO (2003B) Review of the state of world aquaculture. FAO Fisheries Circular No.886 FIRI/C886(Rev. I).

FAO Fisheries glossary and encyclopedia Britannica (2001). Available on-line at http://www.fao.org/documents/show_cdr.asp?url_file=/docrep/007/y5424e/y5424e06.htm dated 21 September 2003.

Fauzi Abdullah (2001) Unpublished report on the coral inventories of Pulau Sembilan, Perak prepared for the presentation to the Perak's government of the proposal to establish a marine park. Department of Fisheries, Perak.

Ferguson, Ken (2002) *Essential economics- A guide for business students.* Basingstoke: Palgrave

Fiedler, P. C.; Methot, R. D. and Hewitt, R. P. (1986) "Effects of California El Nino 1982-1984 on the northern anchovy," *J.Mar. Res.,* 44(2): 317-338.

Field, B. C. (1994). *Environmental economics - An introduction.* New York: McGraw-Hill, Inc.

Fisheries Act 1985 (Malaysia)

Fletcher, W.J., Chesson, J., Fisher, M., Sainsbury K.J., Hudloe, T., Smith A.D.M., and B. Whitworth (2002): National ESD reporting framework for Australian fisheries: The "How To" guide for wild capture fisheries. FRDC Project 2000/145. Canbera,Australia.

Ghatak, S., Healey, N., and Jackson, P. (1992). *The macroeconomic environment.* London: Weidenfeld and Nicolson

Gilham, B. (2001) *Case study research methods.* London: Continuum

Gilpin, A. (1995) *Environmental impact assessment: cutting edge for the twenty-first century.* Cambridge, UK: Cambridge University Press.

Glasson, J., Therivel, R. and Chadwick, A. (1995) *Introduction to environmental impact assessment.* London: UCL Press

Goldsmith,B. (ed). (1992). *Monitoring for conservation and ecology*. London: Chapman & Hall.

Goodman, S.L.; Seabrooke, W. and Jaffry, S.A. (1998) "Considering conservation value in economic appraisals of coastal resources," *Journal of Environmental Planning and Management,* 41(3): 313-36.

Gravelle, H. and Rees, R. (1990) *Microeconomics*. London and New York: Lomgman

Green, R.H. (1979). *Sampling design statistical methods for environmental biologist.* Chichester:Wiley.

Green, W. H.(1990).*Econometric analysis.* Englewood Cliff, NJ: Prentice Hall.

Greenwood, J. J. D. (1997). Basic techniques. In W. J. Sutherland (ed.), *Ecological census technique- a handbook*. Cambridge: Cambridge University Press. p. 11-110

Gregerson, H.M.; Brooks, K.N.; Dixon, J.A.; and Hamilton, L.S. (1987) *Guidelines for appraisal of watershed management projects.* Rome: FAO

Griffiths, A. and Wall, S. eds. (1999) *Applied Economics: An Introductory Course. Pearson Education* Singapore: Asia Pte. Ltd.

Griffiths, William E.; Hill, R. Carter and Judge, George G. (1993) *Learning and Practicing Econometrics.* New York: John Wiley & Sons, Inc.

Gross, M. G. (1977) *Oceanography - a view of the earth.* New Jersey: Prentice-Hall, Inc., Englewood Cliff

Gujarati, D. N. (1995). *Basic econometrics*. Singapore: McGraw-Hill, Inc.

Guillemette, M.; Larsen, J. K. and Clausager, Ib (1999). Assessing the impact of the Tuno Knob wind park on sea ducks: the influence of food resources. National Environmental Research Institute, Denmark. Pp.21- NERI Technical Report No.263).

Gulland, J.A. (1969) Manual of methods for fish stock assessment: Part 1. Fish population analysis. FAO Manual. Fish. Sci. 4.

Gulland, J.A. (1983) *Fish Stock Assessment.* New York: John Wiley & Sons

Gummesson, E. (2000) *Qualitative methods in management research.* U.S.A: SAGE Publication, Inc.

Hall, D.J. and Hall, I. M. (1996) *Practical social research: Project work in the community.* Baingstoke: Macmillan.

Hammann, M. G.; Nayar, J. S. P. and Nishizaki, O.S. (1995) "The effects of the 1992 El Nino on the fisheries of Baja California, Mexico," *Calcofi. Rep.,*36: 127-133

Hanemann, W.M. (1984) "Welfare evaluations in contingent valuation experiments with discrete responses," *American Journal of Agricultural Economics* 66:332-341.

Hanemann, W.M. (1985) "Some issues continuous- and discrete-response contingent valuation Studies," *Northeastern Journal of Agricultural Economics*, 14: 5-13.

Hanemann, W.M., Loomis, J.B. and Kaninnen, B.J. (1991) "Statistical efficiency of double-bounded dichotomous choice contingent valuation", *American Journal of Agricultural Economics,"* 73: 1255-1263.

Hanemann, W. M.(1994) "Valuing the environment through contingent valuation," *Journal of Economic Perspectives*, 8(4): 19-43.

Hannesson, R. (1993) *Bioeconomic Analysis of Fisheries.* Rome: FAO

Haralambos, M. ed. (1987) *Sociology : A new approach.* Lancasshire: Causeway Press Ltd.

Harnett, D. L. and Murphy, J. L.(1980) *Introductory statistical analysis.* U.S.A.: Addison-Wesley Publishing Company

Harper, W. M. (1991) *Statistics.* U.K.: The M & E Handbook Series

Hartley, K. and Tisdell, C. (1981) *Micro-economic policy.* U.S.A.: John Wiley and Sons

Hausman, J.A. (1993). *Contingent valuation: a critical assessment.* Amsterdam: North Holland.

Henderson, P.A. (2003) *Practical methods in ecology.* U.K.: Blackwell Publishing

Henry, C. (1989) *Microeconomics for public policy, helping the invisible hand.* U.K.: Clarendon Press Oxford

Herriman, M. (2004) Malaysia marine resource valuation, and integrated coastal and marine area management. Malaysia ICZM Policy 2004 Project. APEC Oceans Forum, Easter Island, October 2004.

Hilborn R. and Walters, C. J. (1992) *Quantitative fisheries stock assessment: Choice, dynamics and uncertainty.* New York: Chapman and Hall

Hogarth, P. J. (1999) *The biology of mangroves.* New York: Oxford University Press

Honore, T. (1999). *Responsibility and fault.* Oregon: Hart Publishing.

Hope, S. (1999) *Applied microeconomics.* U.K.: John Wiley & Sons Ltd

Hotelling, Harold (1947) The economics of public recreation. The Prewitt Report, Washington: National Park Service. Original Proposal for TCM; 6; OR.

House of Lords Select Committee on EC. The polluter pays principle (10 th Report) HL 131, Session 1982-83.

Hudloe, T.J. (1984) Economic studies. In R.A. Kenchington and B. E. T. Hudson (eds.) *Coral Reef Management Handbook.* UNESCO.

Humpries, C.J., Williams, P.H., & Vane-Wright, R.I. (1996). "Measuring biodiversity value for conservation," *Annual Review of Ecology and Systematics,*, 26: 93-111.

Hurlbert, S. H. (1984) "Pseudoreplication and the design of ecological field experiments," *Ecological Monographs,* 54 (2): 187-211

Huston, M.A. (1994). *Biological diversity. The Co-existence of species in changing landscapes.* Cambridge: Cambridge University Press.

Hydec Engineering (1998). Preliminary environmental impact assessment for proposed sand mining off Pulau Pangkor, Perak Darul-Ridzuan. Kuala Lumpur: Desa Kilat Sdn. Bhd.

Idris, S.M.M. (2000) Comments by the Consumers' Association of Penang and Sahabat Alam Malaysia on the detailed EIA of proposed thermal waste treatment plant for solid waste management in Kg. Bohol, MUkim Sungai Besi, Kuala Lumpur. Available in-line at http://surforever.com/sam/pressrelease/kgbohol.html dated 21 September 2005.

IMO (2004). International convention on the establishment of aninternational fund for compensation for oil pollution damage (FUND). International Maritime Organization. Available on-line at http://www.imo.org/Conventions/mainframe.asp?topic_id=256&doc_id=661#2 dated 25 November 2004.

Info Perikanan Perak 2001, Department of Fisheries Perak Publication.

Ingles, J. and Pauly, D. (1984) An atlas of the growth, mortality and recruitment of Philippines fishes. ICLARM Tech. Report 13.

IOC (1997) Workshop report N0.141, International Oceanographic Commission/WESTPAC workshop on co-operative study in the Gulf of Thailand: A science plan. Bangkok, Thailand, 25-28 February 1997.

Isa, M.M. (1988) Population dynamics of *Nemipterus japonicus* (Pisces: Nemipteridae) off Kedah State, Malaysia. In S. Venema, J. M. Christensen and D. Pauly (eds.) Contribution to tropical fisheries biology: papers by participants of FAO/DANIDA follow-up training courses. FAO Fisheries Report 389. Rome: FAO. p.142-152.

Isarankura, A.(1971) Assessment of stocks of demersal fish off the west coast of Thailand and Malaysia. Rome, FAO, IOFC/DEV/71/20.

Israngkura, A. (1996). "The polluter-pays principle : so who pays?" *TDRI Quarterly Review,* 11(3), 12-15.

Israngkura, A. (2000). Malaysian palm oil pollution tax. In J. Rietbergen-McCracken and H. Abaza (eds.), *Economic instruments for environmental management* London: UNEP Earthscan Publications Ltd. p. 65-71

Ishak, Haji Omar (1994). *Market power, vertical linkages, and government policy- The fish industry in Peninsular Malaysia.* Kuala Lumpur: Oxford University Press.

Ishak, S. and Shafie, F. (1998) "Keperluan dan corak tempat tinggal bagi warga tua," *Jurnal Kebajikan,* 20 (1)

ITLOS (2003) A case concerning land reclamation by Singapore in and around the Straits of Johor held from 25 to 27 September 2003 at the International Tribunal for the Law of the Sea, Hamburg. Verbatim record.

Jaafar, M. Z. and Mohamad, R. A.(2001). Is there a need for energy subsidy reform? A Malaysian perspective. A paper presented at Asia Workshop Energy Subsidy Reform , Bangkok 16 - 17 January 2001. Available on-line at http://www.uneptie.org/energy/act/pol/wokshops/bangkok/docs/amran.doc

Japar, S. B. (1994) Mangrove plant resources in the Asean region. In C. Wilkinson, S. Sudara and C. L. Ming (eds.) *Proceedings- Third ASEAN- Australia symposium in living coastal resources* Townville: Australian Institute of Marine Science. p. 101-104

Jedamus, P., Frame, R. and Taylor, R. (1976) *Statistical analysis for business decisions.* U.S.A.: McGraw-Hill Book Company

Jansen, N. (2004) "Duties and rights in negligence: A comparative and historical perspective on the European law of extra contractual liability," *Oxford Journal of Legal Studies,* 24(443).

Jones, G. P. and Kaly, U. L. (1996) Criteria for selecting marine organisms in biomonitoring studies. In R.J. Smith and C.W. Osenberg (eds.) *Detecting ecological impacts.* U.S.A.: Academic Press. p. 29-48

Jordan, S. R. (1985) "Ecological changes and economic consequences of El Nino Phenomenon in the southeastern Pacific," *Bol. Erfen/Erfen Bull.,* 12: 27-33

Jordan, J. L. and Ehnagheeb, A. H. (1994) "Differences in contingent valuation estimates from referendum and checklist questions," *Journal of Agricultural and Resource Economics,* 19 (1): 115-28.

Kamaruzaman, H. S. (1997) A socio-economic assessment of collective choices in the coastal trawl fisheries of Malaysia. PhD thesis, University of Hull.

Kameri-Mbote, A. P. and Cullet, P. (1999). "Agro-biodiversity and international law- a conceptual framework," *Journal of Environmental Law,* 11 (257).

Kane, E. (1991) *Doing your own research: How to do basic descriptive research in the social sciences and humanities.* London and New York: Marion Boyars

Kanniah, R. (2000). "Public participation in the environmental impact assessment process in Malaysia," *Malayan Law Journal Articles,* 3 (134)

Kaplowitz, M. D., and Hoehn, J. P. (2001) "Do focus groups and individual interviews reveal the same information for natural resource valuation?" *Ecological Economics*; 36(2): 237-247

Karasin, L. (2003) The travel cost method, background, summary, explanation and discussion. Available on-line at http://www.ulb.ac.be/ceese/PAPERS/TCM/TCM.html dated 12 May 2003.

Kathiresan, K. and Rajendran, N. (2002) "Fisheries resources and economic gain in three mangrove areas on the South-east coast of India," *Fisheries Management and Ecology,* 9:227-283.

Keay, A. and Prez, P. de (2001). "Insolvency and environmental principles: a case study in a conflict of public interests,". *Environmental law Review,* 3.2 (90).

Kee, C. P. (1992) "Profail penuaan penduduk Malaysia." *Jurnal Kebajikan,* 14 (2)

Klein, L. R. and Young, R. M.(1980). *An introduction to econometric forecasting and forecasting models.* Massachusetts: Lexington Books.

Kline, J. D. and Wichelns, D. (1998) "Measuring heterogeneous preferences for preserving farmland and open space," *Ecological Economics,* 26 (2):211-224

Kling, C.L. (1988) " The reliability of estimates of environment benefits from recreation demand models," *American Journal of Agricultural Economics*; 70(4): 892-901.

Kotchen, M.J. Reiling, S.D. (2000) "Environmental attitudes, motivations, and contingent valuation of non-use values: A case study involving endangered species," *Ecological Economics*; 32(1): 93-107.

Koutsoyiannis, A. (1979) *Modern microeconomics.* London: Macmillan Publishers Ltd.

Knetsch, J. L.(1994) "Environmental valuation: Some problems of wrong question and misleading answers," *Environmental Values*; 3 (4): 351-68.

KPDNHEP(2004).Subsidi diesel . Available on-line at http://www.kpdnhep.gov.my/index.php?ch=16&pg=77&ac=365 dated 30 September 2004.

Krassula, N. (2001). Choice of methodology for marine pollution monitoring in intertidal soft-sediment communities. CBM: Skriftserie 3:131-148.Uppsala 2001.

Laevastu, T. and Hayes, M. L. (1981) *Fisheries oceanography and ecology*. England: Fishing News Books Ltd.

Laevastu, T.; Alverson, D. L. and Marasco, R. J. (1996) *Exploitable marine ecosystem: Their behaviour and management*. England: Fishing News Books Ltd.

Laidler, D. and Estrin, S. (1989) *Introduction to microeconomics*. U.K.: Philip Allan

Lalli, C. M. and Parsons, T. R. (1979) *Biological Oceanography: An Introduction*. U.K.: Butterworth – Heinemann

Lambshead, P. J. D., Platt, H. M., and Shaw, K. M. (1983) "The detection of differences among assemblages of marine benthic species based on an assessment of dominance and diversity," *Journal of Natural History*, 17:859-874.

Langford, I.H., Bateman, I.J., Jones, A.P. Langford, H.D. and Georgiou, S. (1998) "Improved estimation of willingness to pay in dichotomous choice contingent valuation studies," *Land Economics*, 74(1): 65-75.

Laws, E. A. (1981) *Aquatic pollution*. New York: John Wiley and Sons

Lee, R. M. (2000) *Unobtrusive methods in social research*. Buckingham: Open University Press

Leng, Ter Kah (1992) "Economic loss - current principles of recovery," *Malayan Law Journal Articles*, 1 (178).

Levin, R. and Wilson, M. (1980) "Ecological theory and pest management," *Annual Review of Entomology*, 11:287-309.

Levin, J. and Fox, J. A. (1988) *Elementary statistics in social research*. New York: Harper & Row, Publishers

Lewis, L.J., Davenport, J. and Kelly, T.C. (2002) "A study of the impact of a pipeline construction on estuarine benthic invertebrate communities," *Estuarine, Coastal and Shelf Science*. 55: 213-221.

Lindberg, K. and Huber, Jr. R. (1993). Economic issues in ecotourism management. In K. Lindberg and D.E. Hawkins (eds.). *Ecotourism: Guide for planners & managers*. North Bennington: The Ecotourism Society, pp. 82-115.

Linke, S., Norris, R and Faith, D.P. (2002). Australian river assessment system: Improving AusRivAS analytical methods- DDRAM and E-Ball (Phase 1 Final Report). Inland

Waters, National River Health Program, Australian Government, Department of the Environment and Heritage.

Lin, N. (1976) *Foundation of social research.* New York: McGraw-Hill

Lipsey, R. G. and Chrystal, K. A. (1995) *An introduction to positive economics.* Oxford: Oxford Press University

Liu, J. T.; and Chen, Y. T. (1996) "Estimation of willingness to pay to avoid illness: A comparison of urban areas and areas near petrochemical complexes in Taiwan," *Academia Economic Papers*; 24 (3):397-431.

LKIM (1998). Laporan kajian sosioekonomi nelayan 1995. Kuala Lumpur: Lembaga Kemajuan Ikan Malaysia, Kementerian Pertanian Malaysia.

Lobegeiger, R. and Hoang, T. (2001) Banana prawn survey. *Aquaculture News, issue 19.* Queensland; Dept. of primary industries and Fisheries

Looi, J. (2002) "Major case law and environmental management," *The Malayan Law Journal Articles,* 3 (287).

Loomis, J.; Gonzalez-Caban, A. and Gregory, R. (1994) "Do reminders of substitutes and budget constraints influence contingent valuation estimates?" *Land Economics*, 70 (4): 499-506.

Ludwig, J.A. and Reynolds, J.F. (1988). *Statistical ecology* . New York: Wiley and Sons.

Lumsden, K., Attiyeh, R. and Bach, G. L. (1974) *Microeconomics - A Programmed books.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc

Luzar, E. J. and Cosse, K. J. (1998) "Willingness to pay or intention to pay: The attitude behavior relationship in contingent valuation," *Journal of Socio Economics,* 27 (3): 427-44.

Lynn, P. (1996) Principles of sampling. In T. Greenfield (ed). *Research methods: Guidance for postgraduates.* London; Arnold. p-132.

Mabry, R. H. and Ulbrich, H. H. (1994) *Economics.* U.S.A.: Houghton Mifflin Company

Macnae, W. (1968) Mangrove forests and fisheries. Indian Ocean Programme Pub. N0.34. Rome: Indian Ocean Fishing Commission.

Maddala, G.S. (2001) *Introduction to econometrics.* Chichester: John Wiley & Sons Ltd.

Mahmood, R.; Fong, L. C. and Baharuddin, Z. (1989). Perusahaan perikanan laut dalam di Malaysia dari segi kos dan pulangan bot 70 Grt ke atas (Fisheries Extension Paper no. 146). Kuala Lumpur: Department of Fisheries Malaysia.

Malaysian Nature Society, 6 October 1996.

Manjung District Office (2003) Statistical information. Available on-line at http://pdt-manjung.perak.gov.my/BM/Indeks.html dated 30 September 2003

Mankiv, N. G. (2001)*Principles of Economic*. U.S.A.: Harcourt College Publishers

Mapstone, B. D. (1995) "Scalable decision criteria for environmental impact assessment; effect size, Type I and Type II errors," *Ecological Applications*, 5: 401-410.

Magurran, A.E. (1988) *Ecological diversity and measurement*. Princeton: Princeton University Press

Margalef, R. (1969) "Diversity and stability: A practical proposal and a model of interdependence," *Brookhaven Symp. Biol.*, 22: 25-37

Marsh, I. ed. (1996) *Making sense of society – An introduction to sociology*. New York: Addison Wesley Longman Limited

Marshall, A. (1920)*Principles of economics (8 th edition)*. London: Macmillan

Marshall, C. and Rossman, G. B. (1989) *Designing qualitative research*. Newbury Park, U.S.A: SAGE Publication

Matta, A. M. (2003) "Claimability of economic loss: Malaysia takes a stand amid inconsistencies," *Malaysian Law Journal*, 4 (178).

Menhinick, E. F. (1964) "A comparison of some species-individuals diversity indexes applied to samples of field insects," *Ecol*ogy, 45: 859-861

Mendenhall,W., Reinmuth, J. E. and Duhan, D. (1986) *Statistics for management and economics*. Boston: Duxbury Press

Mendoza, A. B. and Alura, D. P. (2001). Mangroves structure on the eastern coast of Samar Island, Philippines. In D.E. Stott, R.H. Mohtar and G.C. Steinhardt (eds.), *Sustaining the global farm*. Selected papers from the 10 th. International Soil Conservation Organization Meeting held May 24-29 1999 at Purdue University and the USDA-ARS National Soil Erosion Research Laboratory.

MFRDM (2000) Fisheries resource survey in the exclusive economic zone (EEZ) of Malaysia 1997-1999 (ISBN 983-9819-18-6). Kuala Lumpur: Marine Resource Development and Management, Department of Fisheries, Ministry of Agriculture Malaysia.

MIDA (2004).Economic strength. Kuala Lumpur: Malaysian Industrial Development Authority. Available on-line at http://www.mida.gov.my/beta/view.php?cat=1&scat=16 dated 25 December 2004.

Miles, E. L. (1996) Consultant's report on an integrated national ocean policy. Kuala Lumpur: Maritime Institute of Malaysia

Miller, D. C. (1991) *Handbook of research design and social measurement.* Newbury Park, U.S.A.: SAGE Publications

Miller, R.L., Acton, C. Fullerton, D.A. and Maltby, J. (2002) *SPSS for social scientists.* U.K: Palgrave Macmillan

MIMA (1995) MIMA report on the establishment of the National Institute of Oceanography. Unpublished paper by Maritime Institute of Malaysia, Kuala Lumpur.

Ministry of Agriculture (2003) Message from the Prime Minister of Malaysia. Available on-line at http://agrolink.moa.my/dpn/dpn3/dpn/pm.html dated 15 September 2003

Ministry of the Environment, Japan (2004). Available on-line at http://www.env.go.jp/en/lar/blaw/index.html dated 17 December 2004.

Ministry of Foreign Affairs, Singapore(2003). Available on-line at http://app10.internet.gov.sg/scripts/mfa/sections/press/report_press.asp?3564 dated 8 November 2003.

Ministry of Foreign Affairs, Singapore (2003). Available on-line at http://app.mfa.gov.sg/internet/press/view_press.asp?post_id=900 dated 18 December 2004.

Mishan, E.J. (1975) *Cost-benefit analysis, An informal introduction.* London: George Allen & Unwin Ltd.

Mitchell R.C. & Carson R.T. (1989) *Using surveys to value public goods: The contingent valuation method.* Washington, DC: Resources for the Future.

Mitchell, R.C. and Carson, R.T. (1995). Current issues in the design, administration and analysis of contingent valuation surveys. In P.O. Johansson, B. Kristom. and K. G. Maler (eds.), *Current issues in environmental economics.* Manchester: Manchester University Press.

Mitsch, W. J. and Gosselink, J. G. (2000) *Wetlands.* New York: John Wiley & Sons,Inc

MMS (2004). El-Nino-its impact on weather in Malaysia. Malaysia Meteorological Services. Available on-line at http://www.kjc.gov.my/english/education/weather/elnino.html dated 6 September 2004.

Modell, Martin (1996) *A professional's guide to systems analysis.* New York: McGraw-Hill Book Company

Mohr, P.; Fourie, L. and associates (1997) *Economics for South African students.* Pretoria: J.L.van Schaik

Morrison, M. D., Blamey, R. K. and Bennett, J. W. (2000) "Minimizing payment vehicle bias in contingent valuation studies," *Environmental & Resource Economics,* 16(4): 407-422.

MOSTE (2000). Malaysia 'initial national communication' submitted to the United Nations framework convention on climate change. Malaysia: Ministry of Science, Technology & Environment. July 2000.

MOSTE (2004). National policy on the environment. Malaysia: Ministry of Science, Technology & Innovation

Mourato, S. and Day, B. (1998). A contingent valuation study of solid waste management in Kuala Lumpur and Petaling Jaya. Institutional Strengthening and Capacity Building Project. Malaysia: Economic Planning Unit, Prime Minister's Department

Mulholland, H. and Jones, C.R. (1977) *Fundamentals of statistics.* London: The English Language Book Society and Butterworths

Munprasit, A., Theparoonrat, Y., Sae-Ung, S., Soodhom, S., Matsunaga, Y., Chokesanguan, B. and Siriraksophon, S. (1989). Fishing gear and methods in Southeast Asia: Malaysia (TD/RES/24, Reprinted October 1994, May 1995). Bangkok: Training Department Southeast Asian Fisheries Development Center.

National Research Council (US)(1995) *Understanding Marine Biodiversity.* Washington, D.C.: National Academy Press

New Straits Times, 9 February 2004

Neuman, W. L. (1997) *Social research methods: Qualitative and quantitative approaches.* Boston, U.S.A.: Allyn and Bacon

Nik M., Nik A. K. and Yaqin, A. (2003). "Reasons in administrative decision-making : The reach of judicial reviewability in Malaysia," *Malayan Law Journal Articles,* 4 (96).

Ng, P. K. L. and Sivasothi, N. eds. (2001) *A guide to mangroves of Singapore.* Singapore: Singapore Science Center

NOAA (2004). Salmon recovery review panel- Report for the meeting held on July 21-23, 2003 at Northwest Fisheries Science Center, National Marine Fisheries Service, Seattle, WA. National Oceanic and Atmospheric Administration Fisheries, U.S.A. Available on-line at http://www.nwfsc.noaa.gov/trt/rsrp_docs/Hatchery_Experiments_Final_Report.pdf dated 6 September, 2004.

Noakes, D. S. P. (1952) A working plan for the Matang mangrove forest reserve, Perak. Kuala Lumpur: Forest Dept.

Noordin, M. N. (1988) *Ternakan rerang Anadara granosa L di Malaysia.* Fisheries Bulletin No.28, Department of Fisheries Malaysia.

Norlida, H. and Jamal, O. (2000). Evaluation of forest recreational resource: Case of Taman Negara Malaysia. Paper presented at the First Conference for Resource and Environment Economists. Paradise Malacca Village Resort, Ayer Keroh, Malacca 29-31 July 2000.

Nybakken, J. W. (1997) *Marine biology: An ecological approach.* U.S.A.: Addison Wesley Longman

Odum, E. P.(1993) *Ecology and our endangered life- support systems.* Sunderland, Massachusetts: Sinauer Associates, Inc. Publishers

OECD (1989). Economic instruments for environmental protection. Paris: Organization for Economic Co-operation and Development.

Ong, J.E. (1995) "The ecology of mangrove conservation and management," *Hydrobiologia;*295: 343-351

Ong, D. M. (2001) "The impact of environmental law on corporate governance: International and comparative perspective," *European Journal of International Law,* 12 (685).

Ortacesme, V., Ozkan, B. and Karaguzel, O. (2002) "An Estimation of the recreational use value of Kursunlu Waterfall Nature Park by the individual travel cost method," *Turk J. Agric. For,* 26: 57-62.

Padmavathi, M. (1991) Proceedings of National symposium on remote sensing on environment. Chennai: Anna University.

Pallant, J. (2001) *SPSS survival manual.* Buckingham: Open University Press

Palys, T. (1997) *Research decisions: Quantitative and qualitative perspectives.* Canada: Harcourt Canada Ltd.

Parkinson, S. (2004) Corporate influence on science and technology. Available on-line at http://www.sgr.org.uk/SciencePolicy/SpeechGreenParty2004.htm dated 21 September 2005.

Parliamentary debate, Question number 85, dated 26 June,2002. Available on-line at http://www.parlimen.gov.my/Hansard/2002/DR26062002.pdf dated 17 May 2004

Pate, J. and Loomis, J. (1997) "The effect of distance on willingness is to pay values: A case study of wetlands and salmon in California," *Ecological Economics*; 20(3), 199-207.

Pauly, D. (1980) *A selection of simple methods for the assessment of tropical fish stocks.* FAO Fish. Circulation.

Pauly, D. (1984) Fish population dynamics in tropical waters: A manual for use with programmable calculators. ICLARM Studies and Reviews 8.

PDT Manjung (2002) Statistiks pejabat daerah dan tanah Manjung, Perak Darul Ridzuan,Malaysia. Available on-line at

http://pdt- manjong.perak.gov.my/BM/isirumah.html dated 22 November,2002.

Pearce, D.W. and Nash C.A. (1981) *The social appraisal of projects, a text in cost-benefit analysis*. Hong Kong: The Maxmillan Press Ltd.

Pearce, D.W. and Turner, R.K. (1990). *Economics of natural resources and the environment*. London: Harvester Wheatsheaf.

Penang people's Report (1999) Fisheries yield. Available on-line at www.seri.com.my/spi/economy.pdf dated 1 dated 16 November 2003.

Perkins, F. (1994) *Practical cost benefit analysis.* Melbourne: Macmillan Education Australia Pty. Ltd.

Perunding Utama (1997) *Detailed environmental impact assessment for proposed Lekir coastal development.* Kuala Lumpur: Desa Kilat Sdn.Bhd.

PETRONAS Dagangan Berhad (2004). PDB: share price unchanged despite costlier petrol. Available on-line at http://www.mymesra.com.my/index.php?ch=41&pg=121&ac=378 dated 30 September 2004.

Piltz, F. M. (1996) Organizational constraints on environmental impact assessment research. In R.J. Smith and C.W. Osenberg (eds.) *Detecting ecological impacts.* U.S.A.: Academic Press. p. 317-328

Pindyck, R. S. and Rubinfeld, D. L.(1998) *Econometric models and economic forecasts.* U.S.A.: Irwin/McGraw-Hill

Pong, L. Y.; Ean, Chee P. and Seng, Y. T. (1994) *Major commercial marine fishes of Malaysia.* Penang: Department of Malaysia and SEAFDEC

Portney, P.R. (1994). "The contingent valuation debate: why economist should care," *Journal of Economic Perspective,* 8(4): 3-18.

Power Technology (2003) Manjung coal-fired power plant, Malaysia. Available on-line at http://www.power-technology.com/projects/manjung/ dated 7 July 2003.

Pugh, C. and Day, M. (1991). "Toxic torts," *New Law Journal,* Vol. 141, no.6528, p.1549.

Quang, T.T. (1996) Buddhism and environmental protection. Available on-line at http://www.saigon.com/~anson/ebud/ebdha006.htm dated 23 December 2004.

Quiggin, J. (1998) "Individual and household willingness to pay for public goods," *American Journal of Agricultural Economics,* 80(1) 58-63.

Radhakrishnan, S. (2002) "Medical negligence," *Malayan Law Journal Articles,* 4 (5).

Rahman,M. M.,Daud, M., Bbardaie , M.Z. and Hassan,M..N. (2002) Sustainable approach for developing quality EIA reports. Available on-line at http://www.eric.chula.ac.th/GIN-Asia/abstract/128.doc dated October 31,2002

Ramanathan, Ramu (2002) *Introductory econometrics with applications.* U.S.A.: Harcourt College Publishers

Ramli, M.F.S.(1983) Unpublished project paper for the fulfillment of Bachelor of Science (Fisheries) degree, University of Agriculture, Malaysia.

Ravera, O. (2001). "A comparison between diversity, similarity and biotic indices applied to the macroinvertebrate community of a small stream: the Ravella river (Como Province, Northern Italy)," *Aquatic Ecology,* 35: 97-107.

Rennolls, K. (1997). Statistical aspects of inventory design, methodology and procedures used in IFRIS (FIMP-INTAG Technical Series No.6).Jakarta: Ministry of Forestry, Indonesia.

Rennolls, K. and Laumonier, Y. (1999). "Tree species-area and species-diameter relationships at three lowland rain-forest sites in Sumatra," *Journal of Tropical Forest Science,* 16: 253-270

Report of the NOAA Panel on Contingent Valuation, 11 January, 1993 .

Richmond, R. H. (1995). Coral reef health: Concerns, approaches and needs (Coral Reef Symposium- January 26-27, 1995). U.S. Environmental Protection Agency.

Ricker, W.E. (1975) Computation and interpretation of biological statistics of fish population. Bulletin of the Fisheries Board of Canada, 191:2-6.

Rio Declaration on Environment and Development, June 14, 1992, 31 ILM 874.

Ritchie, J. and Lewis, J. eds. (2003) *Qualitative research practice: A guide for social science students and researchers.* London: SAGE Publication

Rodéhn, J.(2002) Mangroves ecosystem, ecological basis for evaluation. Available on-line at http://www.evp.slu.se/trop_ecology/JohanR_proj.htm dated May 17,2002.

Rohlf, W. D. Jr. (2002) *Introduction to economic reasoning.* New York: Addison Wesley, Rose, D. (2003) *Officialsocial classification in the UK.* Available on-line at www.soc.surrey.ac.uk/sru/SRU9.html dated 7 April, 2003.

Royce, W. F. (1972) *Introduction to fisheries science.* U.S.A.: Academic Press

Ruff, L. E. (1993). The economic common sense of pollution. In R. Dorfman and N. S. Dorfman (eds.), *The economics of the environment-selected readings.* New York: W.W. Norton and Company. p. 20-36

Rumbold, D.G., Davis, P. W. and Perreta, C. (2001) "Estimating the effect of beach nourishment on *Caretta caretta* (Loggerhead sea turtle) nesting," *Restoration Ecology,* 9(3), 304.

Ryan, M., and Miguel, F. S. (2000) "Testing for consistency in willingness to pay experiments," *Journal of Economic Psychology,* 21(3): 305-317.

Rybczyk, John M., Day, John W. and Conner, William H. (2002) "The impact of wastewater effluent on accretion and decomposition in a subsiding forested wetland," *Wetlands,* 22(1): 18-32.

Saeger, J., Martosubroto, P. and Pauly, D. (1976) First report of the Indonesian - German demersal fisheries projects/results of a trawling survey in the Sunda Shelf area. Contributors of the demersal fisheries project No. 1: 3-46. Jakarta: Marine Fisheries Research Institute

Said, R. M. (2000) NAP3-A Comprehensive Approach Towards Agricultural Development in Malaysia. The 8th MANCO Annual Conference on 'Opportunities in Agriculture', 23-24 November 2000, Ministry of Agriculture, Malaysia

Saenger, P., Hegerl, E. J. and Davie, J. D. S. (1983) *Global status of mangrove ecosystems.* Commission on Ecology papers Number 3, IUCN.

Santos, T., Cunha, I. and Weber, M. (2002). A "beyond BACI" study of Agunsa's breakwater in North Portugal. Littoral 2002, The Changing Coast. EUROCOAST/EUCC, Porto-Portugal, ed. EUROCOAST- Portugal, ISBN 972-8558-09-0.

Sasekumar, A. and Lai, J.J. (1983). "Litter production in three mangroves forest zones in the Malay Peninsular," *Aquatic Botany,* 17: 283-290

Sasekumar, A and Lim, K.H. (1994). Compatible activities and mangroves forest. In C. Wilkinson, S. Sudara and C. L. Ming (eds.), *Proceedings- Third ASEAN-Australia symposium in living coastal resources.* Townville: Australian Institute of Marine Science. p. 101-104

Schwarz, C.J. (1999) *Intermediate sampling and experimental design.* Department of Statistics and Mathematics, Simon Fraser University.

Scura, L. F., Chua, T. E., Pido, M. D. and Paw, J. N. (1992) lessons for integrated coastal zone management : The ASEAN experience. In T. E. Chua and L. F. Scura (eds.) *Integrative framework methods and for area management,* ICLARM Conference Proceedings 37. International Centre for Living Aquatic Marine Resource, Manila.

Second Long-Term Planning Framework Year 1991-2000 (2004). Available on-line at http://www.pmo.gov.my/RancanganWeb/rancangan_frameset.htm dated 18 March 2004 dated 16 June 2004.

Seri (2002). Briefing to the Penang state government (Volume 4, issue 10). Penang:Socio-Economic & Environmental Research Institute.

Seri (2004).Penang's manufacturing competitiveness by Anna Ong Cheng Imm. Penang:Socio-Economic & Environmental Research Institute.

Schmitt, R. J. and Osenberg, C. W. (1996) *Detecting ecological impacts: Concepts and applications in coastal habitats.* U.S.A.: Academic Press

Shabman, L., and Stephenson, K. (2000) "Environmental valuation and its economic critics," *Journal of Water Resources Planning and Management*, 126(6) 382-388

Sharp, Ansel M., Register, Charles A. and Leftwich, Richard H. (1994) *Economics of social issues.* U.S.A.: Irwin

Shyamsundar, P., Kramer, R. A (1996) "Tropical forest protection: An empirical analysis of the costs borne by local people," *Journal of Environmental Economics and Management* ; 31(2), 129-44.

Sien, C. L., ed.(1987) *Environmental management in South East Asia.* Singapore: National University of Singapore

Silvius, M. J., Chan, H. I. and Shamsudin, I. (1986) *Evaluation of wetlands of the West Coast of Peninsular Malaysia and their importance for natural resource conservation.* Kuala Lumpur: WWW Malaysia

Sime Darby Group News (2001) 'Sime engineering to construct largest steam turbine generator In Malaysia." Available on-line at http://www.simenet.com/ dated 12 February 2001

Singh (2003). "A comparative study of approaches to public interest ligitation (*Government of Malaysia/UEM V Lim Kit Siang* revisited)," *Malayan Law Journal Article.* 3 (1).

Sloman, J. (2004) *Essentials of economics.* Pearson Education Limited, England.

Smith, T. J. (1992) Forest structure in tropical mangrove ecosystem. In A. I. Robertson, D. M. Alongi (eds.) *Coastal and estuarine studies No. 41.* Washington D. C.: American Geophysical Union. p. 101-136

Smith, E. P. (2002). Ecological statistics. In A. H. El-Shaarawi and W. W. Piegorsch (eds.) *Encyclopedia of environmetrics*. Chichester: John Wiley & Sons Ltd. p. 589-602

Solberg, E. J. (1982) *Intermediate microeconomics*. Plano, Texas: Business Publication Inc.

Southwood, T.R.E. (1978). *Ecological methods*. London: Chapman and Hall.

Sparre, Per and Venema, S. C.(1992) *Introduction to tropical fish stock assessment.* Rome: FAO

Spellerberg, I. F. (1991). *Monitoring ecological change*. Cambridge: Cambridge University Press.

Staerdahl, J. (2002) Joint EIA research program on EIA and roads. DUCED-SACUDE-I &UA.

Statistical Dept. Malaysia (2003) Yearbook of Statistics Malaysia 2003, Kuala Lumpur: Department of Statistics Malaysia

Stewart-Oaten, A., Murdoch, W. R. and Parker, K. R. (1986) "Environmental impact assessment "pseudoreplication" in time?" *Ecology*, 67:929-940.

Stewart-Oaten, A., Bence, J. R. and Osenberg, C. W. (1992) "Assessing effects of unreplicated perturbations: No simple solution," *Ecology,* 73:1396-1404.

Stewart-Oaten, A. (1996A) Goals in environmental monitoring. In R.J. Smith and C.W. Osenberg (eds.) *Detecting ecological impacts.* U.S.A.: Academic Press. p. 17-28

Stewart-Oaten, A. (1996B) Problems in the analysis of environmental monitoring data. In R.J. Smith and C.W. Osenberg (eds.) *Detecting ecological impacts.* U.S.A.: Academic Press. p. 109-132

Stewart-Oaten, A. and Bence, J. R. (2001). "Temporal and spatial variation in environment impact assessment," *Ecological Monographs*, 71(2), 305-339.

Stiglitz, J. and Driffill, N. (2000) *Economics*, W W Norton, New York

Stiling, P. (1999) *Ecology : Theories and application.* Upper Saddle River, New Jersey: Prentice Hall

Strauss, A. and Corbin, J. (1990) *Basics of qualitative research - grounded theory, procedures and technique.* Newbury Park, U.S.A.: SAGE Publication

Studenmund, A.H. (1997) *Using econometrics: A practical guide.* U.S.A.: Addison-Wesley

Sugden, R. and Williams, A.(1978) *The principles of practical cost-benefit analysis.* U.K.: Oxford University Press

Surrey (2002) Environmental tax reform: What does Britain think? Available on-line at http://surrey.ac.uk/news/releases/02-0117environmental_tax.html dated 30 October 2002.

Tai S. Y. (2001)*Bio-economic modeling of alternative management policies for the small pelagic fishery in Northwest Peninsular Malaysia.* A paper presented and discussed at the Bio-economic Workshop on Small Pelagic Fisheries on the West Coast of Peninsular Malaysia on 12-16 February 2001 in Penang, Malaysia.

Tan, A. K. J. (2004) Preliminary assessment of Malaysia's environmental law. Available on-line at http://law.nus.edu.sg/apcel/dbase/malaysia/reportma.html#Top dated 10 February 2004.

Taylor, S. J. and Bogdan, R. (1984) *Introduction to qualitative research methods - the search for meanings.* Toronto, Canada: John Wiley & Sons

Teal, G. A., and Loomis, J. B. (2000) "Effects of gender and parental status on the economic valuation of increasing wetlands, reducing wildlife contamination and increasing salmon populations," *Society & Natural Resources,* 13(1): 1-14.

Teong, P. T. O. (2004). "Marine pollution in Malaysia," *Malayan Law Journal.* Available on-line at http://www.mlj.com.my/free/articles/philipteoh.htm dated 11 October 2004.

Tenaga Nasional (1997) *Detail environmental impact assessment study for proposed 2100MW coal-fired power station at Manjung, Perak Darul-Ridzuan.* Selangor: TNB Janamanjung Sdn. Bhd.

Thampanya, U. & Vermaat, J. E. (2001). Impact of sedimentation on mangroves dynamics along Thai coastlines (European Tropical Forest Research Network No.33).Netherlands: Netherlands Foundation for the Advancement of Tropical Research (WOTRO).

The Independence (Thursday, 25 March 2004)

Thong, K.L. and Sasekumar, A. (1984). The tropic relationship of the fish community of the Angsa Bank, Selangor, Malaysia. In E. Soepadmo, A. N. Rao and D. J. Macintosh (eds.) *Proceeding of the UNESCO/Asian symposium on mangroves environment:Research and management.* Kuala Lumpur: University Malaya. p. 385-399.

Thrush, S. F. Pridmore, R.D. and Hewitt, J. E. (1994) "Impacts on soft-sediment macrofauna: The effects of spatial variation on temporal trends," *Ecological Applications,* 4(1): 31-41.

Thye, C. C. (2002) "The role of article 8 of the federal constitution in the judicial review of public law in Malaysia," *Malayan Law Journal Articles,* 3 (104).

Tietenberg, T. H.(2000) *Environmental and natural resource economics.* Reading, Mass.: Addison-Wesley

TJSB (2003) Operations: Site choice. Available on-line at
http://www.penjanabebas.com.my/tnbj/operation.htm dated 11 September 2003

TNB (2002) Top 20 shareholders of TNB. Available on-line at
WWW.tnb.com.my/tnb/TNB.inv_sp_top20s.jsp dated 28 October,2002

Treasury Circular No. 5 Year 1990. Available on-line at
http://www.treasury.gov.my/design/web/b_pekeliling.htm dated 24 August 2004

Trice, A. H. and S. E. Wood (1958) " Measurement of recreation benefits," *Land Economics*, 34(3): 195-207.

Tumin, M. M. (1973) *Patterns of society; identities, roles, resources.* Boston: Little, Brown and Company

Tuoo, H. M.(1999) , Kaedah sampling pengutipan data merin: Satu tinjauan semula (Paper no. SMPP 15/99). Kuala Lumpur: Department of Fisheries Malaysia.

Turner, R.K.; Pearce, D. and Bateman, I. (1994). *Environmental economics- an elementary introduction.* London: Harvester Wheatsheaf.

Ualberta (2005). Land reclamation, remediation and restoration. University of Alberta, California. Available on-line at
http://www.rr.ualberta.ca/Research/Index.asp?page=LRRR dated 3 January 2005.

Underwood, A.J. (1992) "Beyond BACI: The detection of environment impacts on populations in the real, but variable, world," *J. Experimental Marine Biology and Ecology*, 161: 145-178.

Underwood, A. J. (1994) "On beyond BACI: sampling designs that might reliably detect environmental disturbances," *Ecological Applications*, 4:3-15

UNEP (2000) Guidelines for the intergrated management of the watershed - phytotechnology and ecohydrology (Freshwater Management Series No.5). United Nations Environment Programme, Division of Technology, Industry, and Economics.

United Nation (UN) (2002) Malaysian track for 2020 vision. Available on-line at
http://unpanl.un.org/intradoc/groups/public/documents/apcity/unpanoo3222.pdf
dated 11 October,2002.

U.S. Department of Defense (2004). Defense procurement and acquisition policy- contract pricing reference guides. U.S.A. Department of Defense. Available on-line at
http://www.acq.osd.mil/dpap/contractpricing/vol2chap1.htm.
dated 6 June 2004

USM (2003) Public speech by Professor Ahyaudin Ali in commemoration with his professorial appointment at the Universiti Sains Malaysia. Available on-line at http://www.lib.usm.my/press/SSU/Ahyaudin/ dated 16 September 2003.

Vanclay, J.K. (1998). Towards more rigorous assessment of biodiversity. In P. Bachmann, M. Koehl and R. Paivinen (eds.) *Assessment of biodiversity for improved forest planning*. Dordrecht: Kluwer Academic Publishers. Forestry Science Series 51. p. 211-232

Varian, H. R. (1990). *Intermediate microeconomics- a modern approach.* New York: W.W. Norton & Company.

Ward, F. A. and Beal, D. (2000) *Valuing nature with travel cost models.* U.K.: Edward Elgar Publishing Limited

Watson, J.G. (1928) Mangrove forests of the Malay Peninsular. Malay Forest Record No.6. Singapore, Fraser and Neave

Weinstein, M.P. (1979) Shallow marsh habitats as primary nursery for fishes and shellfish, Cape Fear River, North Carolina, *Fish. Bull.* 77:339-358

Welch, S. and Comer, J. (1988) *Quantitative methods for public administration.* Chicago, Illinois: The Dorsey Press

Werner, M. (1999) "Allowing for zeros in dichotomous-choice contingent-valuation model," *Journal of Business & Economic Statistics.* 17(4) 479-486.

Westlund, L. (2004) *Guide for identifying, assessing and reporting on subsidies in the fisheries sector.* FAO Fisheries Technical Paper 438. Rome: Food and Agriculture Organization of the United Nation

Westra, L. (2000) "The disvalue of 'contingent valuation'; and the problem of the 'expectation gap," *Environmental Values,* 9(2): 153-171.

Wetterstein, P. (1997). *Harm to the environment: The right to compensation and the assessment of damages.* Oxford: Clarendon Press

Wheater, C. Philip and Cook, Penny A. (2003). *Using statistics to understand the environment.* London: Routledge, Taylor & Francis Group.

Winpenny, J.T. (1991) *Values for the environment – A guide to economic appraisal.* overseas London: Development Institute (ODI)

Whittaker, R.H. (1972). "Evolution and measurement of species diversity," *Taxon,* 21: 213-251.

Whitehead, Peter (1977) *How Fishes Live*. England: Galley Press

Whittington, D. (1998) Administering contingent valuation surveys in developing countries. *World Development* 26(1): 21-30.

World Bank (1991) *Environmental assessment sourcebook, Volume 1: Policies, procedures, and cross-sectoral issues.* Washington, D.C.: The World Bank

World Bank (2002) Available on-line at www.worldbank.org/eapsocial/ASEM/region/malay.htm dated 21 October 2002.

Wright, Sonia R. (1979) *Quantitative methods and statistics.* London: SAGE Publications, Beverly Hills

Wu, P. I., and C. L. Huang (2001) "Actual averting expenditure versus stated willingness to pay," *Applied Economics,* 33(2): 277-28 3.

WWFM(2002) Mangroves Forest. Available on-line at http://www.wwfmalaysia.org/features/spaces/mangrove.htm dated 17 May 2002.

WWF Press Release, 30 November 2000

Xavier, G. (1998) "Dr Abdul Hamid Abdul Rashid & Anor V Jurusan Malaysia Consultants (sued as a firm) & Ors [1997] 3 MLJ 546: Breakthrough for recovering in pure economic loss?" *Malayan Law Journal Articles,* 3 (26).

Xavier, G. (2001) "Donoghue V Stevenson. A new façade for the construction industry?" *Malayan Law Journal Article,* 2 (65).

Yeo, B.H. (1998). The Economic Valuation of Protected Area in Malaysia. A Case Study on Pulau Payar Marine Park, Kedah, Malaysia. M.A. Dissertation, University College, London.

Yoo, S.H., S.J. Kwak and T.Y.Lim (2000) "Dealing with zero responses data from contingent valuation surveys: Application of least absolute deviations estimator," *Applied Economics Letters*, 7(3): 181-184.

Yoklavich, M. M.; Loeb, V. J., Nishimoto, M; and Daly, B.(1996) "Nearshore assemblages of larval rockfishes and their physical environment off Central California during an extended El Nino event, 1991-1993," *Fish Bull.*, 94(4): 766-782.

Appendix 1

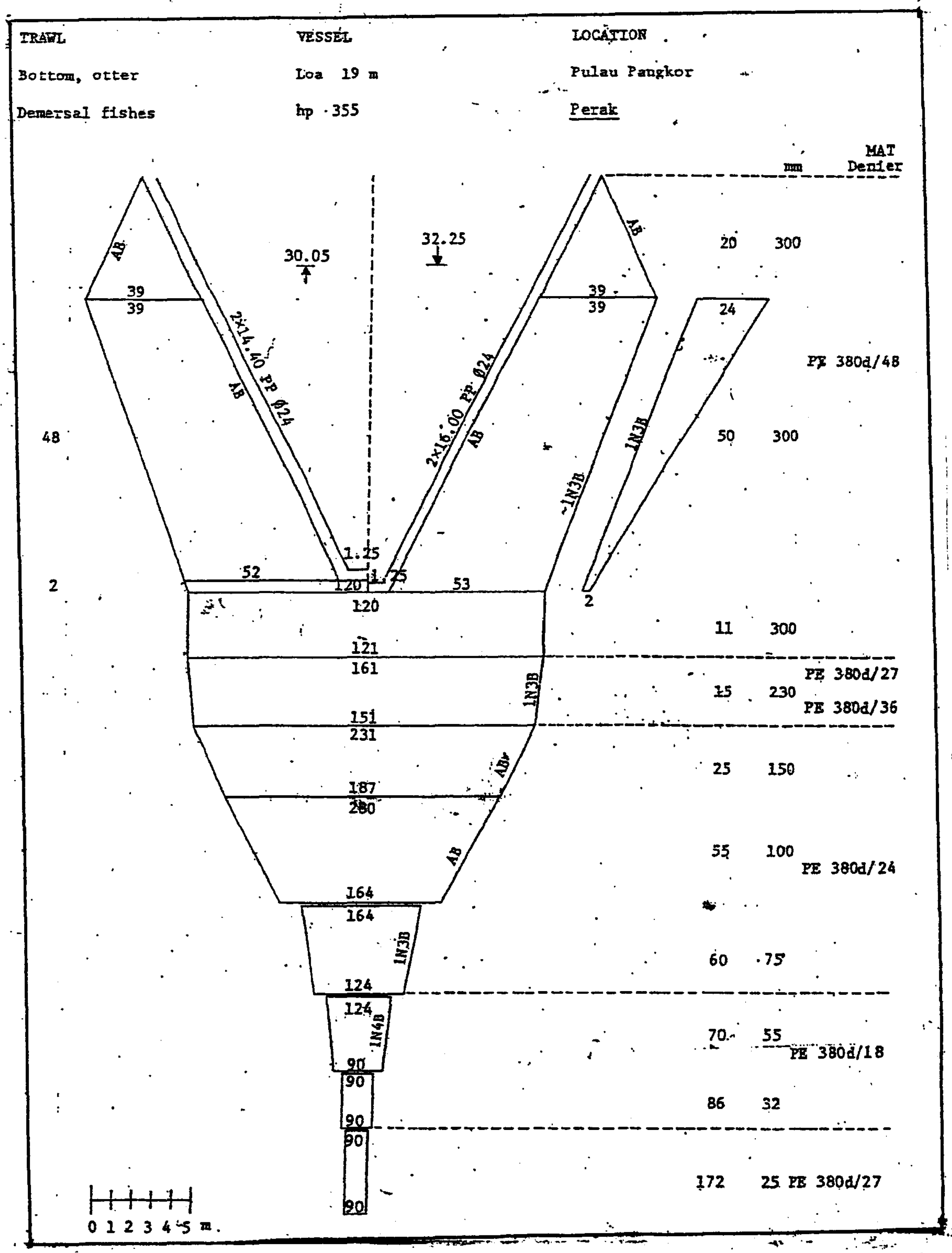

Figure 2A: trawl net design and specification

Table 2A: Fishing information of swept area method on 17 August 2002 (research vessel No. PKFB 1042)

FISHING INFORMATIONS

Survey type:	swept-Area	Date of arrival:	17/08/02		
Date of departure:	17/08/02	Fishing base:	Kpg Acheh	Tide: neap	
Names of technical staff:		1 Mr. Abdul Rahman bin Majid Senior Lab-Assistant, Fisheries Research Institute,Penang,Malaysia 2 Mr.Chi Soon Chung Fisheries Assistant, Fisheries District Office of Manjung, Sitiawan, Perak, Malaysia			
Names of fishing vessel's crew		1 Mr. Hoo Sing Hook Skipper 2 Mr. Hoo Sing Yew Deckhand 3 Mdm. Hoo Sing Mooi Deckhand			
Vessel informations:	Registration number:	PKFB 1042	Length(m):	12.93	
	Hull :	Wood	Width(m):	4.57	
	Base:	Kpg Acheh	Depth(m):	1.17	
	Tonnage(Gross Registered Tonnage): 19.56		Horse Power: 190		
			Engine's make: CUMMINS		
	Engine's type:	Diesel	Sailing speed: 9.5 Knots		
	Trawling speed: Refer to Trawling log				
Gear informations:	Type:	trawl net	Length of trawl net:	50meters	
	Material:	PE	codend:	25mm(I inch)	
	Headrope length:	30.05meters	Wing rope:	216 inch.	
	Otter board measures:	64 ins.X 47 ins.	Weight of each otter board: 300 Kg		
Other informations:	GPS's make:	Advanced AE 688			
	Echosounder:	KODEN CVS-108			
	Net Drum:	Upper/lower (2)			
	Refrigerated sea water(RSW):	SSB Midland			

Table 2B: Fishing information of swept area method on
17 August 2002 (research vessel No. PKFB 1075)

FISHING INFORMATIONS

Survey type:	swept-Area	Date of arrival:	17/08/02	
Date of departure:	17/08/02	Fishing base:	Kpg Acheh	Tide: neap

Names of technical staff:	1.Mr .Amir bin Mat Azah, Fisheries Asst. Fisheries District Office of Manjung, Sitiawan ,Perak,Malaysia. 2.Mr. Hamdan bin Abd. Rahman, Deckhand. Fisheries Enforcement Unit, Kpg Acheh,Perak,Malaysia. 3. Mr. Arshad bin Mohammad,Deckhand. Fisheries Enforcement Unit, Kpg Acheh,Perak,Malaysia.
Names of fishing vessel's crew	1 Mr. HooSing Huat Skipper 2 Mr. Ding Koon Chai Deckhand 3 Mr. Hoo Sing Kok Deckhand

Vessel informations:	Registration number:	PKFB 1075	Length(m):	16.1
	Hull :	Wood	Width(m):	5.65
	Base:	Kpg Acheh	Depth(m):	1.22
	Tonnage(Gross Registered Tonnage): 19.56	28.07	Horse Power: 250	
	Engine's type:	Diesel	Engine's make: CUMMINS	
	Trawling speed: Refer to Trawling log		Sailing speed: 11.0 Knots	

Gear informations:	Type:	trawl net	Length of trawl net:	50meters
	Material:	PE	codend:	25mm(I inch)
	Headrope length:	30.05meters	Wing rope:	216 inch.
	Otter board measures:	64 ins.X 47 ins.	Weight of each otter board: 300 Kg	

Other informations:	GPS's make:	Advanced AE 688
	Echosounder:	KODEN CVS-108
	Net Drum:	Upper/lower (2)
	Refrigerated sea water(RSW):	SSB Midland

Table 2C: Trawling log of trawl survey in South Manjung fishing ground on 17 August 2002 (research vessel No. PKFB 1042)

TRAWL-SURVEY IN SOUTH MANJUNG FISHING GROUND
(TRAWLING LOG)

Vessel number:	PKFB 1042	Fishing Leader: Mr. Abdul Rahman bin Majid	
Skipper:	Mr. Hoo Sing Hook	Assisted by:Mr. Chi Soon Chung	
Date and time of departure:	August 17,2002/0815	Date and time of arrival:	August 17,2002/ 1730

Date		17/8/02		17/08/02		17/08/02		17/08/02	
Station no.		1A		2A		3A		4A	
Trawling Positions	Began(1)	4°.08.18	100° 37.17	4° 06.46	100° 37.56	4° 07.99	100° 36.97	4°10.68	100° 35.58
	30 minutes position(2)	4° 06.10	100° 37.5	4° 07.6	100° 38.9	4° 09.02	100° 34.99	4° 09.14	100° 36.92
	Ended(3)	4° 05.57	100° 39.16	4°07.91	100° 37.29	4°10.46	100° 34.76	4° 08.27	100° 37.77
Trawling Directions (degrees)	1	157		17		276		114	
	2	150		3		320		166	
	3	150		285		330		97	
Water Depth (meters)	1	26.4		12.3		27.2		6.5	
	2	10.9		8.8		21.7		20.3	
	3	9.7		25.6		24.3		18.8	
Length of Warp rope		120meters		120meters		120meters		120meters	
Trawling Speed (knots)	1	4		3.8		3.8		3.4	
	2	4		3.8		3.8		3.2	
	3	3.7		3.7		3.7		3.3	
Trawling Time	1	948		1130		1255		1428	
	3	1048		1230		1355		1528	
Trawling Duration (minutes)		60		60		60		60	
Distant Travelled (nautical miles)		4.2		4.01		4.3		3.88	

Table 2D: Trawling log of trawl survey in South Manjung fishing ground on 17 August 2002 (research vessel No. PKFB 1075)

TRAWL-SURVEY IN SOUTH MANJUNG FISHING GROUND
(TRAWLING LOG)

Vessel number:	PKFB 1075	Fishing Leader: Mr. Amir bin Mat Azah	
Skipper:	Mr. Hoo Sing Huat	Assisted by:Mr. Hamdan bib Abd Rahman and Mr. Arshad bin Mohammad	
Date and time of departure:	August 17,2002/0815	Date and time of arrival:	August 17,2002/ 1730

	#	1B	2B	3B	4B
Date		17/8/02	17/08/02	17/08/02	17/08/02
Station no.		1B	2B	3B	4B
Trawling Positions	Began(1)	4° 4.88', 100° 37.9'	4° 1.8', 100° 38.68'	4° 4.38', 100° 37.0'	4° 0.42', 100° 35.93'
	30 minutes position(2)				
	Ended(3)	4° 1.1', 100° 39.57'	4° 3.93', 100° 37.6'	4° 0.41', 100° 37.0'	4° 4.32', 100 36.3'
Trawling Directions (degrees)	1	156	344	180	5
	2				
	3				
Water Depth (meters)	1	36	17.3	32	28
	2	15	28	40.3	56
	3	12.9	34.1	48.7	48.7
Length of Warp rope		120meters	120meters	120meters	120meters
Trawling Speed (knots)	1	4.3	3.8	3.7	4.1
	2	4.3	3.8	3.9	3.7
	3	3.9	4.05	4.1	3.7
Trawling Time	1	1000	1144	1317	1457
	3	1100	1244	1417	1557
Trawling Duration (minutes)		60	60	60	60
Distant Travelled (nautical miles)		4.17	3.88	3.9	3.83

Table 2E: Fishing information of swept area method on 21 August 2003 (research vessel No. PKFB 8908)

FISHING INFORMATIONS

Survey type:	swept-Area	Date of arrival:	21/08/2003		
Date of departure:	21/08/2003	Fishing base:	Kpg Acheh	Tide:	Neap

Names of technical staff:	1.Mr Chi Soon Chung, Fisheries Asst. Fisheries District Office of Manjung, Sitiawan ,Perak,Malaysia. 2.Mr. Ismail, Deckhand. Resource Protection Unit,Dept.of Fisheries,Kpg Acheh

Names of fishing vessel's crew	1 Mr. Lim Geok Kwong Skipper 2 Mr. Hoo Sin Yen Deckhand

Vessel informations:	Registration number:	PKFA 8908	Length(m):	13.81
	Hull :	Wood	Width(m):	4.42
	Base:	Kpg Acheh	Depth(m):	1.44
	Tonnage(Gross		Horse Power:	275
	Registered Tonnage	24.87	Engine's make:	CUMMINS
	Engine's type:	Diesel	Sailing speed:	11.5 Knots
	Trawling speed: Refer to Trawling log			

Gear informations:	Type:	trawl net	Length of trawl net:	50meters
	Material:	PE	codend:	25mm(I inch)
	Headrope length:	30.05meters	Wing rope:	216 inch.
	Otter board measures:	64 ins.X 47 ins.	Weight of each otter board:	300 Kg

Other informations:	GPS's make:	Advanced AE 688
	Echosounder:	KODEN CVS-108
	Net Drum:	Upper/lower (2)
	Refrigerated sea water(RSW):	SSB Midland

Table 2F: Fishing information of swept area method on
21 August 2003 (research vessel No. PKFB 716)

FISHING INFORMATIONS

Survey type:	swept-Area	Date of arrival:	21/08/2003	
Date of departure:	21/08/2003	Fishing base:	Kpg Acheh	Tide: Neap

Names of technical staff:	1 Mr. Shamsul Kamal b. Ariffin Fisheries Assistant, Resource Protection Unit,Dept.of Fisheries,Kpg Acheh 2 Mr.Nor Ahmad bin Sasad Engineman, Resource Protection Unit,Dept.of Fisheries,Kpg Acheh

Names of fishing vessel's crew	1 Mr. Goh Aian Hook Skipper 2 Mr. Goh Cheng Ming Deckhand

Vessel informations:	Registration number:	PKFB 716	Length(m):	12.74
	Hull :	Wood	Width(m):	5.13
	Base:	Kpg Acheh	Depth(m):	1.54
	Tonnage(Gross Registered Tonnage): 38.54		Horse Power: 335	
			Engine's make: CUMMINS	
	Engine's type:	Diesel	Sailing speed: 12.5 Knots	
	Trawling speed: Refer to Trawling log			

Gear informations:	Type:	trawl net	Length of trawl net:	50meters
	Material:	PE	codend:	25mm(I inch)
	Headrope length:	30.05meters	Wing rope:	216 inch.
	Otter board measures:	64 ins.X 47 ins.	Weight of each otter board: 300 Kg	

Other informations:	GPS's make:	Advanced AE 688
	Echosounder:	KODEN CVS-108
	Net Drum:	Upper/lower (2)
	Refrigerated sea water(RSW):	SSB Midland

Table 2G: Trawling log of trawl survey in South Manjung fishing ground on 21 August 2003 (research vessel No. PKFA 8908)

TRAWL-SURVEY IN SOUTH MANJUNG FISHING GROUND
(TRAWLING LOG)

Vessel number:	PKFA 8908	Fishing Leader: Mr. Chi Soon Chung	
Skipper:	Mr. Lim Geok Kwong	Assisted by:Mr. Ismail and Hoo Sin Yen	
Date and time of departure:	August 21,2003/0815	Date and time of arrival:	August 21,2003/ 1730

Date		21/08/2003		21/08/2003		21/08/2003		21/03/2008	
Station no.		1BB		2BB		3BB		4BB	
Trawling Positions	Began(1)	4° 04.3'	100° 39.11'	4° 0.51'	100° 39.0'	4° 4.75'	100° 37.3'	4° 0.58'	100° 35.36'
	30 minutes position(2)								
	Ended(3)	4° 0.8'	100° 39.29'	4° 3.65'	100° 37.35'	4° 1.35'	100° 36.5'	4° 3.91'	100° 36.46'
Trawling Directions (degrees)	1	177.8		331		192		19.2	
	2	177.8		331		192		19.2	
	3	177.8		331		192		19.2	
Water Depth (meters)	1	36		17.3		32		28	
	2	15		28		40.3		56	
	3	12.9		34.1		48.7		48.7	
Length of Warp rope		120meters		120meters		120meters		120meters	
Trawling Speed (knots)	1	4.3		3.8		3.7		4.1	
	2	4.3		3.8		3.9		3.7	
	3	3.9		4.05		4.1		3.7	
Trawling Time	1	1000		1144		1317		1457	
	3	1100		1244		1417		1557	
Trawling Duration (minutes)		60		60		60		60	
Distant Travelled (nautical miles)		4.17		3.88		3.9		3.83	

Table 2H: Trawling log of trawl survey in South Manjung fishing ground on 21 August 2003 (research vessel No. PKFB 716)

TRAWL-SURVEY IN SOUTH MANJUNG FISHING GROUND
(TRAWLING LOG)

Vessel number:	PKFB 716	Fishing Leader: Mr. Shamsul Kamal b. Ariffin
Skipper:	Mr. Goh Aian Hook	Assisted by:Mr.Nor Ahmad bin Sasad
Date and time of departure:	August 21,2003/0815	Date and time of arrival: August 21,2003/ 1730

Date		21/08/2003		21/08/2003		21/08/2003		21/08/2003	
Station no.		1AA		2AA		3AA		4AA	
Trawling Positions	Began(1)	4° 07.8'	100° 36.25'	4° 05.34'	100° 40.4'	4° 07.9	100° 36.97'	4° 10.25'	100° 35.28'
	30 minutes position(2)								
	Ended(3)	4° 05.4'	100° 39.37'	4° 07.85'	100° 37.3'	4° 10.5'	100° 34.2'	4° 07.42'	100° 38.1'
Trawling Directions (degrees)	1	128		309		312		135.5	
	2	128		309		312		135.5	
	3	128		309		312		135.5	
Water Depth (meters)	1	26.4		12.3		27.2		6.5	
	2	10.9		8.8		21.7		20.3	
	3	9.7		25.6		24.3		18.8	
Length of Warp rope		120meters		120meters		120meters		120meters	
Trawling Speed (knots)	1	4		3.8		3.8		3.4	
	2	4		3.8		3.8		3.2	
	3	3.7		3.7		3.7		3.3	
Trawling Time	1	948		1130		1255		1428	
	3	1048		1230		1355		1528	
Trawling Duration (minutes)		60		60		60		60	
Distant Travelled (nautical miles)		4.2		4.01		4.3		3.88	

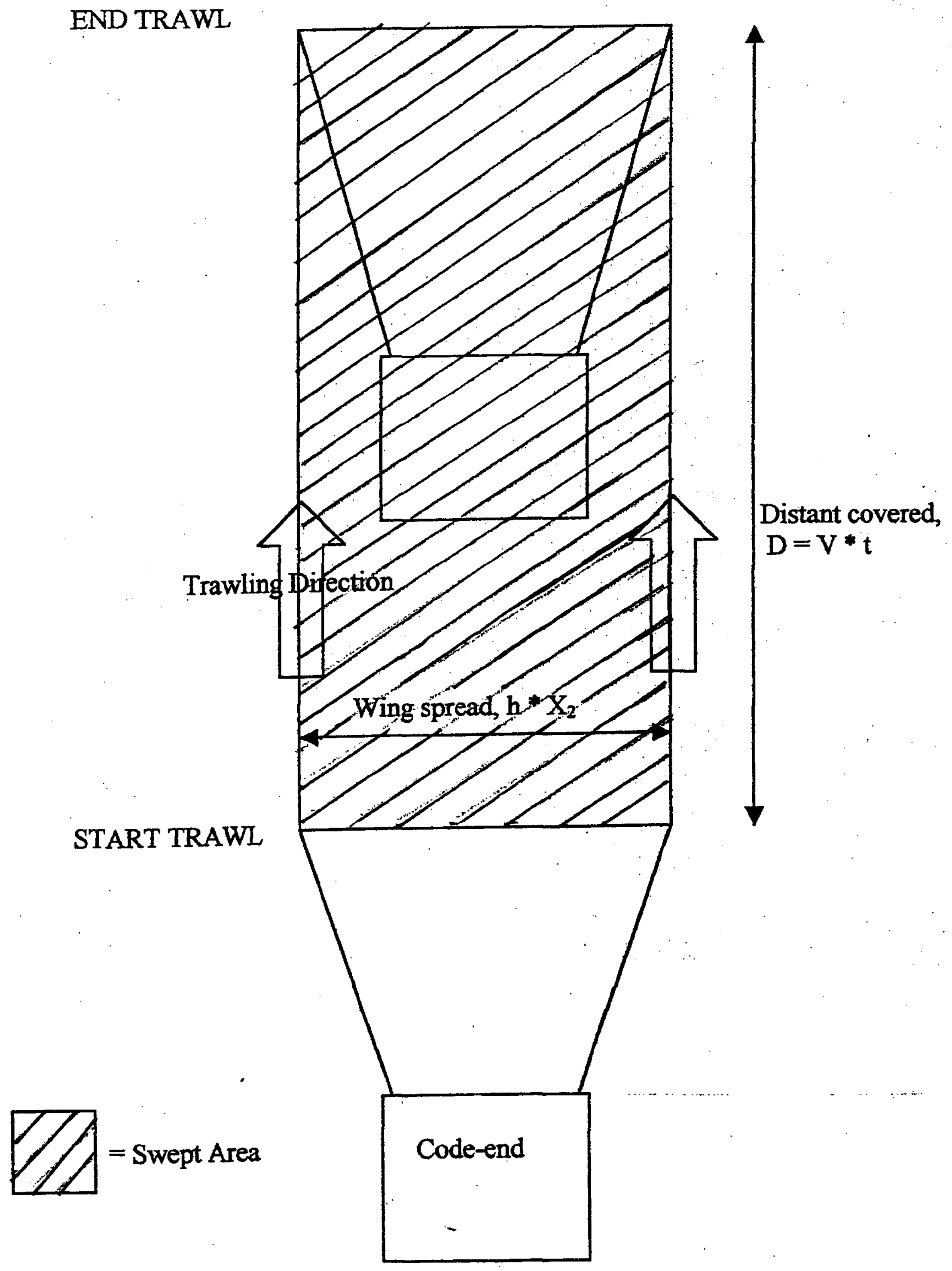

Figure 2B: The swept area

Table 2I: List of fish caught by Tenaga Nasional (1997) within 3 km radius of the project site during two surveys.

Local Name	Scientific name	F1	F2	F3	F4	F5	F6	F7	TOTAL
Baji-baji	*Platyce sp*	1	-	-	-	-	-	-	1
Bedukang	*Arius sagor*	-	-	1	1	-	2	-	4
Belanak Biji Nangka	*Liza melanoptera*	4	1	-	-	6	6	-	17
Duri Putih	*Arius maculates*	44	1	6	6	4	3	10	74
Gelama	*Johnius dussumieri*	15	3	5	5	-	1	7	36
Gelama Jarang Gigi	*Otolithes rubberi*	-	-	1	-	-	-	-	1
Kekek Labu	*Leoignathus splendens*	5	3	2	3	-	5	6	24
Ketuka	*Dasyatis poecilura*	1	-	1	1	-	3	-	6
Puntung Damar	*Sillago sihama*	1	-	-	-	-	-	-	1
Sebelah	*Pseudorhombus malayanus*	1	-	-	-	-	-	1	2
Selangat	*Anadontostoma chacunda*	-	2	-	-	-	-	-	2
Sembilang	*Plotosus canius*	-	-	-	-	1	-	-	1
Senangin	*Polynemus sextarius*	-	-	-	-	1	-	-	1
Tamban	*Lupea fimbriata*	9	-	-	-	-	-	-	9
Timah	*Trichiurus savala*	-	-	-	1	-	-	-	1
Ketam Batu	*Scylla serrata*	-	-	-	-	-	-	-	0
Ketam Renjong	*Portunus pelagicus*	1	2	2	-	3	-	2	10
Udang Lipan	*Parapenaeopsis sp*	1	-	-	-	-	-	1	2
Udang Putih	*Panaeus sp*	1	1	1	-	-	-	1	4
	Fish Species	9	5	6	6	4	6	4	
	Crab Species	1	1	1	0	1	0	1	
	Prawn Species	2	1	1	0	0	0	2	

Source: Tenaga Nasional (1997)

Table 2J: List of commercially important fish present within 3 km radius of the project site.

Fish Species	English Name	Local Name
Anodontostoma chacunda	Gizzard shad	Ikan Selangat
Arius maculates	Spotted catfish	Duri Putih
Arius sagor	Sagor catfish	Bedukang
Arius sp	Catfish	Mayong
Caranx djeddaba	Djeddaba crevalleq	Ikan Pelata
Chirocentrus dorab	Wolf herring	Ikan Parang
Chorenimus lysan	Queenfish	Ikan Talang
Chiloscyllum indicum	Catshark	Ikan Yu Cicak
Cynoglossus lingua	Tounge sole	Ikan Lidah Pasir
Cynogglossus bilineatus	Tounge sole	Ikan Lidah
Dasyatis poecilura	Ray fish	Ikan Ketuka
Dasyatis zugei	Ray fish	Ikan Pari
Decapterus russeli	Scad	Ikan Selayang
Drepane punctata	Spotted sicklefish	Ikan Daun Baharu
Eleutheronema tetradactylum	Fourfinger treadfin	Ikan Senangin
Epinephelus bleekeri	Bleeker's grouper	Ikan Kerapu
Epinephelus tauvina	Greasy grouper	Ikan Kerapu
Ilisha elongata	Elongate ilisha	Ikan Beliak Mata
Ilisha megaloptera	Bigeye ilisha	Ikan Beliak Mata
Ilisha sp	Ilisha	Ikan Beliak Mata
Johnius belangeri	Belanger's croaker	Ikan Gelama Batu
Johnius carouna	Croaker	Ikan Gelama
Johnius dussumieri	Bearded croaker	Ikan Gelama
Leiognathus brevirostris	Shortnose ponyfish	Ikan Kekek
Leiognathus equulus	Common ponyfish	Ikan Kekek
Leiognathus splendens	Splendid ponyfish	Ikan Kekek Labu
Liza melanoptera	Mullet	Belanak Biji Nangka
Liza subviridis	Greenback grey mullet	Ikan Loban
Sardinella fimbriata	Fringescale sardinella	Tamban
Lutjanus argentimaculatus	Snapper	Ikan Siakap Merah
Lutjanus johni	John's snapper	Ikan Jenahak
Lutjanus malabaricus	Malabar red snapper	Ikan Tanda
Lutjanus russelli	Russel's snapper	Ikan Tanda
Megalaspis cordyla	Hardtail scad	Ikan Cencaru
Muraenesox cinereus	Dagger-toothed pike conger	Ikan Malong
Nematolosus nasus	Gizzard shad	Ikan Perang
Nibea soldadu	Soldier croaker	Ikan gelama Papan
Otolithes rubber	Tiger-toothed croaker	Gelama Jarang Gigi
Pampus argentus	Silver pomfret	Ikan bawal Putih
Pampus chinensis	Chinese pomfret	Ikan Bawal Tambak
Panna macrodon	Panna croaker	Ikan Gelama
Parastromateus niger	Black pomfret	Ikan Bawal Hitam
Pennahia macropthalmus	Bigeye croaker	Ikan Gelama Pisang
Platycephalus indicus	Flatheads	Ikan Baji-baji
Platycephalus scaberg	Flatheads	Ikan Baji-baji
Plotosus canius	Catfish eel	Ikan Sembilang
Polynemus sextarius	Blackspot threadfin	Ikan Senangin
Pomadasys hasta	Lined silver grunt	Ikan Gerut-gerut
Pseuorrhombus malayanus	Malayan flounder	Ikan Sebelah
Rastrelliger kanagurta	Indian mackerel	Ikan kembong
Saurida tumbil	Lizardfish	Ikan Mengkarong
Scoliodon sorrakawah	Shark	Ikan Yu Pasir
Selaroides leptolepis	Yellowstrip trevally	Ikan Selar
Setipinna taty	Hairpin anchovy	Ikan Kasai Janggut
Sillago sihama	Silver silago	Ikan Puntung Damar
Sphyraena jello	Banded barracuda	Ikan Alu-alu
Sphyraena obtusa	Obtuse barracuda	Ikan Kacang
Stolephorus commersonii	Commerson's anchovy	Ikan Bilis Tembaga
Stolephorus tri	Spined anchovy	Ikan Bilis
Stolephorus sp	Anchovy	Ikan Bilis
Thryssa hamiltoni	Hamilton's thryssa	Ikan Bilis
Thryssa mystax	Moustached thryssa	Ikan Kasai
Trichiurus savala	Smallhead hairtail	Ikan Timah

Source: Tenaga Nasional (1997)

Note: Fish caught by artisanal fishers using gill-nets

Table 2K: List of commercially important prawns caught within 3 km radius of the project site.

Prawn Species	English Name	Local Name
Acetes sp	Belacan shrimp	Udang Belacan
Metapenaeus affinis	Pink prawn	Udang Merah Ros
Metapenaeus brevicornis	Yellow prawn	Udang Kuning
Metapenaeus ensis	Pink prawn	Udang Merah
Metapenaeus lysianassa	Small white prawn	Udang Putih Kecil
Parapenaeopsis coromandelica	Sharp rostrum prawn	Udang Minyak
Parapenaeopsis hardwickii	Sharp rostrum prawn	Udang Minyak
Parapenaeopsis hunger fordii	Banded sharp rostrum prawn	Udang Minyak Jalur
Parapenaeopsis sculptilis	Rainbow prawn	Udang Kulit Keras
Penaeus indicus	Indian white prawn	Udang Putih
Penaeus merguiensis	Banana prawn	Udang Putih
Penaeus monodon	Tiger prawn	Udang Harimau
Penaeus penicellatus	Banana prawn	Udang Putih

Source: Tenaga Nasional (1997)
Note: Prawns caught by artisanal fishers using trammel nets or gill-nets

Table 2L: List of commercially important Chephalopod caught within 3 km radius of the project site.

Species	English Name	Local Name
Loligo uyii	Little squid	Sotong Cumit=cumit
Loligo cinensis	Mitre squid	Sotong Torak
Loligo edulis	Sword Tip squid	Sotong Biasa
Sepiella inermis	Spineless cuttlefish	Sotong Katak
Sepia sp	Cuttlefish	Sotong Katak

Source: Tenaga Nasional (1997)

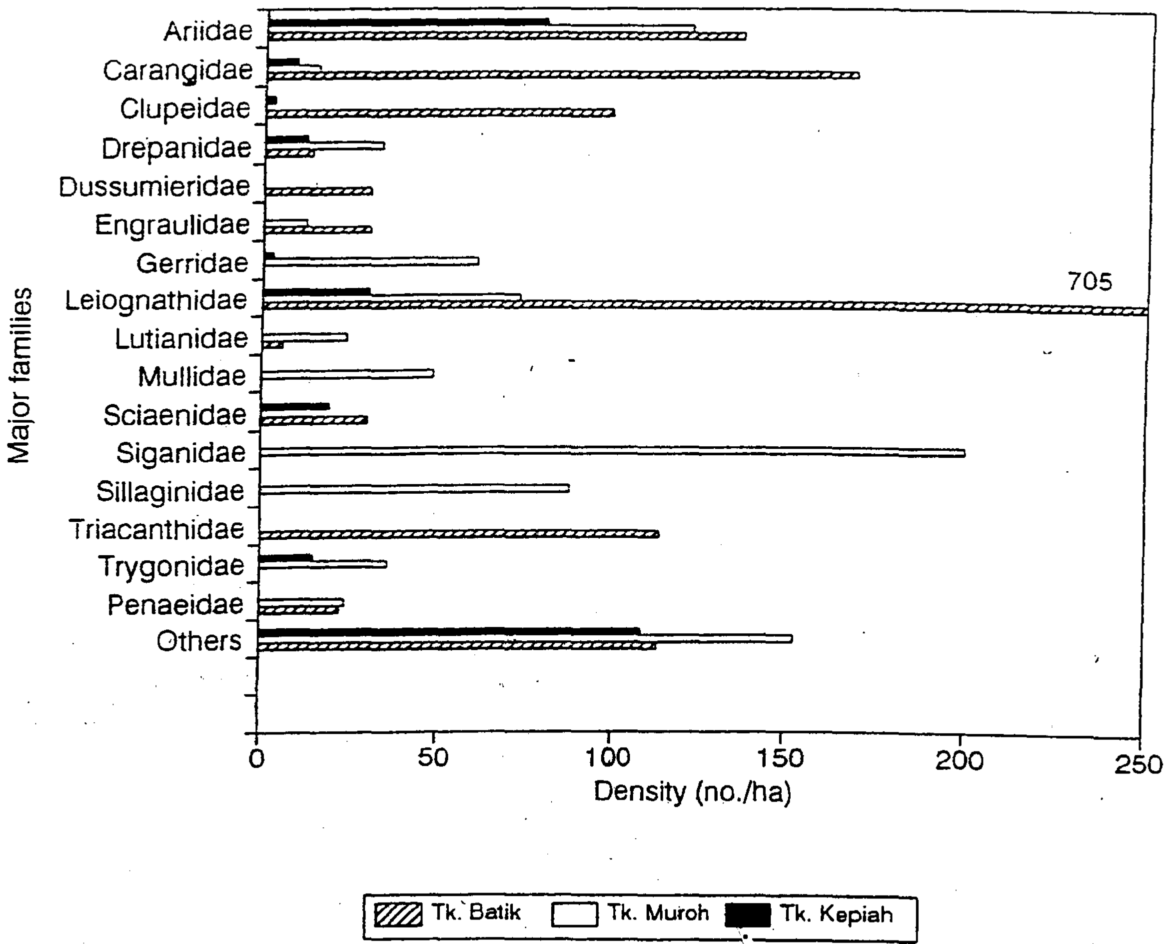

Figure 2C: Relative abundance of the major families of fish and prawns as sampled by the beach seine in Dinding Channel, Perak.
Source: Perunding Utama (1997)

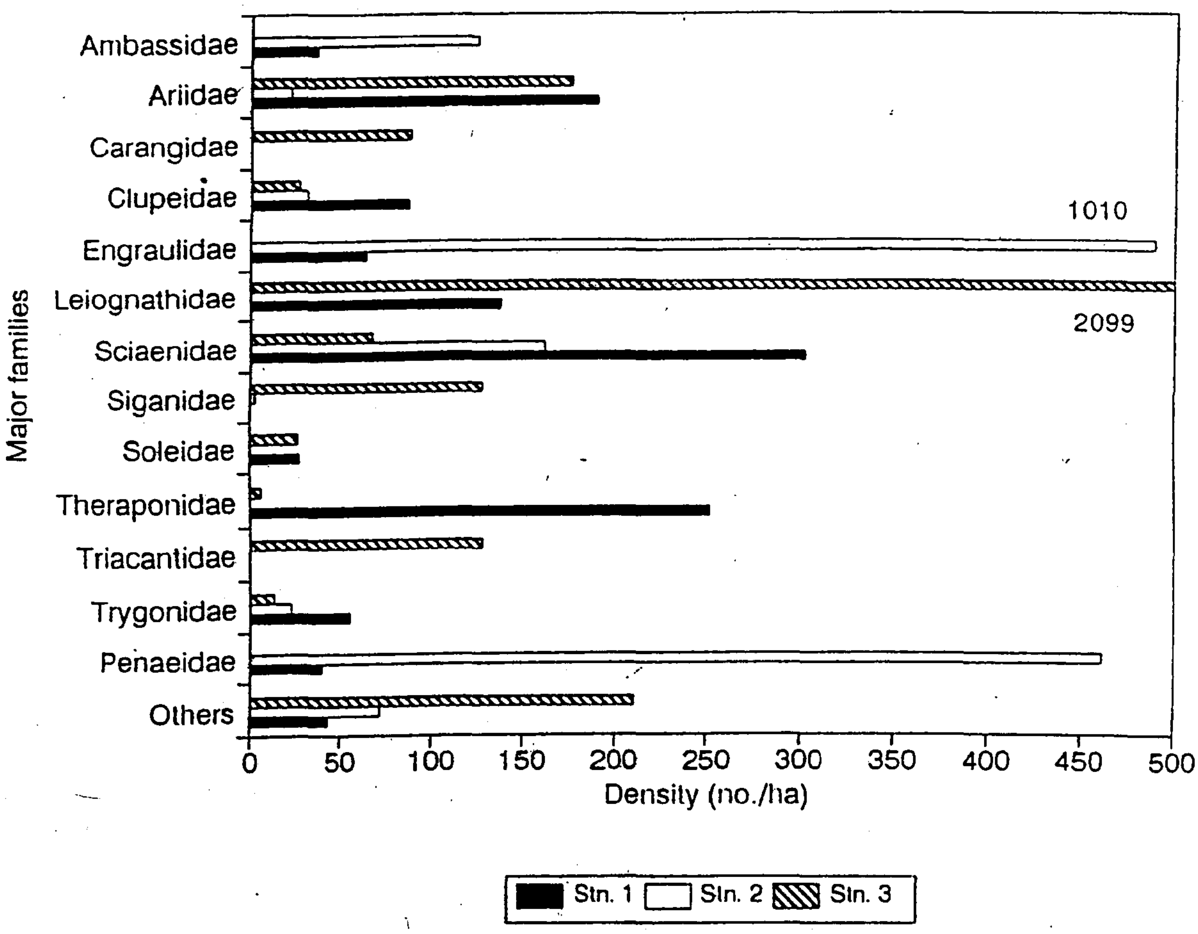

Figure 2D: Relative abundance of major families of fish and prawns as sampled by the trawl net off Lekir's coast, Perak.
Source: Perunding Utama (1997)

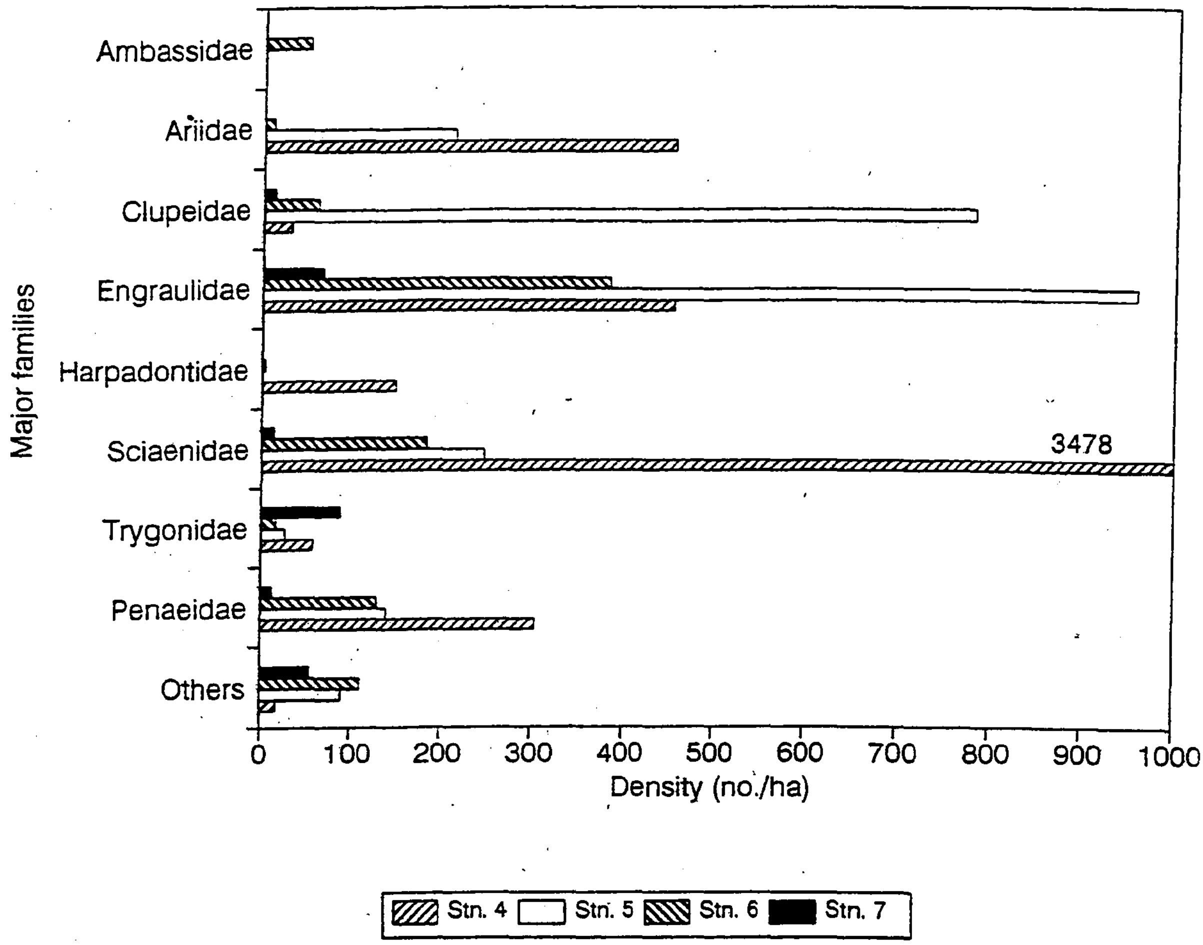

Figure 2E: Relative abundance of major families of fish and prawns as sampled by the trawl net off Lekir's coast, Perak.
Source: Perunding Utama (1997)

Appendix 2

A QUESTIONNAIRE FOR THE SOCIAL-ECONOMIC STUDY OF THE POPULATION IN MUKIM LEKIR , MANJUNG DISTRICT, MALAYSIA.

AIMS: The purpose of this questionnaire is to study the effect of the coastal land reclamation and the construction of the 2000MW power-plant on the livelihood of the fishers and other stake holders living in the vicinity of the project.

CONDITIONS : Information given by the respondent will not be revealed to anybody except for the above purposes and for the use of the Department of Fisheries Malaysia in planning and implementation of the government policy.

The Department of Fisheries Malaysia is assuring the respondent that this questionnaire will not be used for the enforcement of the Fisheries Act 1985.It is no way that this questionnaire to be handed over to other government agencies for the same purposes or for the enforcement of other laws.

The identity of the respondent in this exercise will be kept secret and discreet so as to safeguard the safety and welfare of each respondent.

OUR HOPE: We appeal the respondent to give full cooperation for this exercise. The achievement of our aims is solely on your interest to participate and dedicate your utmost commitment.

REMINDER: This interviewer is a government officer working with the Department of Fisheries Malaysia. Please ask for the official identification before giving any information. You must report to us if you suspect unauthorized individual attempting to carry out this exercise. Please call: 05-2554061 or 05-2554062.

CASE NUMBER:

PART 1 (for the fishers only)

1	1

1. Village Name :______________________________

2	2

2. Name :______________________________

A. Respondent's Profile

A.1	3

A.1 Age :________

A.2	4

A.2. Sex: (1) male (2) female

A.3	5

A.3. Race (1) Malay (2) Chinese (3) Indian (4) Others

A.4. Highest education level :

Primary School :	1
Lower certificate of Education:	2
Malaysian certificate of Education:	3
Higher School of Education :	4
Diploma :	5
University degree :	6
Non of the Above :	7

A.4	6

B. Employment Status/ Fishing Activities

B.1	7

B.1. Full-time: (1) Yes (2) No

B.2. In your spare time, do you have other type of occupation?
If you have, what is it? : ____________________

B.2	8

B.3	9
B.4	10
B.5	11
B.6	12
B.7	13
B.8	14
B.9	15
B.10	16
B.11	17
B.12	18
B.13	19

B.3. Number of years as fisher :________year(s)

B.4. Are you a member of Fisheries Association of South Manjung? (1) Yes (2) No

B.5. Number of fishing days per month:____day(s)

B.6. Are you a boat owner? (1) Yes (2) No

B.7. If Yes, do you have a fishing license? (1) Yes (2) No

B.8. If Yes, what is your boat's registration number?:________________

B.9. If you do not own a boat, are you working as a member crew of a licensed boat? (1) Yes (2) No

B.10. If Yes, what is the boat's registration number?: ________________

B.11. What is the type of boat you own or work in: (1) Canoe with outboard engine
(2) Canoe without engine
(3) Boat

B.12. What is your canoe/boat's engine horsepower: ______________

B.13. What is your canoe/boat's tonnage :________________

B.14. Type of fishing gear used :

B.14	20

drift net	1
trawl net	2
purse-seine	3
long-lines	4
cockles (and other shellfish) collecting	5
others (please specify):____________	6

B.15. If you are using drift net, what is the mesh size? ________ (inches/centimeters)

B.15	21

B.16. Total number of other fishers on the canoe/ boat: ______person(s)

B.16	22

B.17. Please point your present fishing area in general:
(A chart no: B 17 is shown dividing the fishing areas into four zones)

zone A (0 – 5 nautical miles)	1
zone B (5- 12 nautical miles)	2
zone C1(12 – 30 nautical miles)	3
zone C2(above 30 nautical miles)	4

B.17	23

B.18. Please point your previous fishing area in general:
(A chart no: B 18 is shown dividing the fishing areas into four zones)

zone A (0 – 5 nautical miles)	1
zone B (5- 12 nautical miles)	2
zone C1(12 – 30 nautical miles)	3
zone C2(above 30 nautical miles)	4

B.18	24

B.19. Fishing Costs (to be answered by boat owner):

(a)Capital costs:

Value of canoe/boat : RM________
Value of engine : RM________
Value of gears : RM________
License fee :RM________
TOTAL : RM________

B.19a	25

(b) Operating costs per day :

Fuel :RM_________

Ice :RM_________

Food and other provisions :RM_________

Maintenance and repair : RM_________

Wages for crews: RM_______

TOTAL :RM_________

B.19b	26

B.20. On the average, how much fish did you catch per day? : _____________Kilograms

B.20	27

B. 21. In what months are your best catch ? _________ through __________ and
_________ through __________ and
_________ through __________.

B.21	27

B.22. In what months are your worse catch?_________ through __________ and
_________ through __________ and
_________ through __________.

B.22	28

B.23. Please list down your 5 most important catch of species:
(arranged in term of importance)

species no. 1 _______________
species no.2 _______________
species no.3 _______________
species no.4 _______________
species no.5 _______________

B.23	29

B.24. Normally, how much did you sell the fish to the buyers?
(the price is per Kg basis).

species no. 1 RM____________
species no.2 RM____________
species no. 3 RM____________
species no.4 RM____________
species no.5 RM____________

B.24	30

B.25. Do you think your catch is better than before?

Very much better	1	
Much better	2	
Somewhat better	3	
Worse	4	B.25 31
Very much worse	5	
No change	6	
I don't know	7	

B.26. What do you think of the price of fish lately?:

Very high	1	
High	2	
Somewhat high	3	
Low	4	B.26 32
Very low	5	
No change	6	
I don't know	7	

B.27. If your catch is unsatisfactory, what do you think the most probable cause(s)? : B.27 33

____

____

____

(go to Part 3)

PART 2 (for other stakeholders) 1 1

1. Village Name :______________________________

2. Name :________________________________

2	2

C. Respondent's Profile

C.1	34

C.1. Age : __________

C.2	35

C.2. Sex : (1) Male (2) Female

C.3	36

C.3. Race : (1) Malay (2) Chinese (3) Indian (4) others

C.4. Highest education level :

Primary School :	1
Lower certificate of Education:	2
Malaysian certificate of Education:	3
Higher School of Education :	4
Diploma :	5
University degree :	6
Non of the Above	7

C.4	37

D. Employment status :

D.1	38

D.1. Occupation :________________________

D.2	39

D.2. Employer (do not fill if self-employed): ________________________

D.3	40

D.3. Job location :________________________

D.4. Full-time : (1) Yes (2) No

D.4	41

D.5. In your spare time do you have other type of occupation?
If you have, what is it? ____________________

D.5	42

D.6. Number of working years :_______

(go to Part 3)

D.6	43

Part 3

(to be completed by both categories of Part 1 and Part 2)

E. Continuation of Respondent's Profile

E.1. Marital status : (1) Married (2) single parent/divorced (3) single

E.1	44

E.2. Children :

order of children	sex	age(years)	Level of education	level of education
first child				
second child				
third child				
fourth child				
fifth child				
sixth child				
seventh child				

E.2	45

(level of education : non-schooling (n.s.), Primary School (p.s.) Secondary School (s.s.), College (coll.), University(uni.), Drop-out/unemployed (d.o.) and working (w.k.))

E.3. Total income per month :

Income from employment : RM____________

Income from other sources: RM___________

TOTAL : RM___________

E.3	46

E.4	47

E.4. Social status : house (1) Owner (2) Renting

E.5	48

E.5. Do you own other houses, and how many?_______

E.6	49

E.6. What is the value of your house(s) :RM_________

E.7	50

E.7. If you are renting, how much is the rent?: RM___________

E.8. Please tick if you possess any of the items below:

- car ☐
- motorcycle ☐
- bicycle ☐
- television radio ☐
- stereo system ☐
- ASTRO(cable channels) ☐
- washing machine ☐
- refrigerator ☐
- air conditioner ☐
- telephone ☐

E.8	51

E.9. Land ownership in Mukim Lekir. (1) Yes (2) No

E.10. How many acres ? ____________

E.11.Land ownership in other area (1) Yes (2) No

E.12 How many acres? ____________

E.9	52
E.10	53
E.11	54
E.12	55

F. Utilities:

F.1. Where do you get your water supply?
(1) Perak's Water Board (piped water)
(2) river
(3) well
(4) any combination of the above

F.2. Is your house supplied with electricity? (1) Yes (2) No

F.3. Do you have telephone in your house? (1) Yes (2) No

F.4. If No, how do you communicate long distance: ________________________

F.5. Solid waste disposal : Disposed by Town Council (1) Yes (2) No

F.6. If No, how do you dispose your solid waste: ____________________

F.1	56
F.2	57
F.3	58
F.4	59
F.5	60
F.6	61

G. Infrastructure :

G.1. Is there a road access to nearest town? (1) yes (2) No

G.2. If yes, do you think it ought to be improves? (1) Yes (2) No

G.3. In what way it should be improved:
____
____
____

G.4. If no, do you need such road? (1) Yes (2) No

G.1	62
G.2	63
G.3	64
G.4	65

(for fishers only- Questions G.5. – G.8.)

G.5	66

G.5. Are there fishing bases/ports in this village? (1) Yes (2) No

G.6	67

G.6. If Yes, do you think it ought to be improved? (1) Yes (2) No

G.7. If Yes, in what way it should be improved:

G.7	68

G.8. If your village has no fishing base/port, do you need one? (1) Yes (2) No

G.8	69

H. Amenities :

H.1. Do you know the existence of the following government agencies and community facilities in your area?

Government Agencies and Community Facilities	Yes (1)	No (2)	Quantity
Headman office			
Agriculture Training Center			
MARA Skills Training Center			
Health Center			
Hospital			
Maternity Clinic			
Police Station			
Kindergarten			
Primary School			

H.1	70- 87

Secondary School					
Religious School					
College/University					
Mosque					
Surau					
Community hall					
Post Office					

Others:

____

____

H.2. Generally, how do you rate the above amenities in your village?

Very satisfied	1	
Satisfied	2	H.2 88
Somewhat satisfied	3	
Dissatisfied	4	
Very dissatisfied	5	

H.3. If you rated the above amenities as somewhat satisfied, dissatisfied or very dissatisfied, please state reason(s):

H.3 89

____

____

____

H.4. How are you rating the public transportation such as bus services?

Very satisfied	1
	2

Satisfied

Somewhat satisfied 3

Dissatisfied 4

Very dissatisfied 5

H.4	90

H.5. If you rated the bus services as somewhat satisfied, dissatisfied or very dissatisfied, please state your reason(s):

____

____

____

H.5	91

H.6. How about public telephones(pay-phones); do you think it is adequately supplied?

Very adequate 1

Adequate 2

Somewhat adequate 3

Inadequate 4

Very inadequate 5

H.6	92

H.7. If you rated the public telephones supply as somewhat adequate, inadequate or very adequate, please suggest the number of public telephones should your village has:

____

H.7	93

I. Awareness of the Reclamation project

I.1. Do you know there is a reclamation project in your area? (1) Yes (2) No

I.1	94

I.2. If yes, how you come to know about it?

Observation 1

Television news 2

Radio news	3
Newspaper	4
From other residents	5
From the Headman	6
Others: ______________________ ______________________	7

I.2	95

I.3. Do you know what is the purpose of that reclamation project? :

____

____

____

I.3	96

I.4. What is your reaction to the reclamation project?:

Very supportive	1
Supportive	2
Somewhat supportive	3
Unsupportive	4
Very unsupportive	5

1.4	97

I.5. What is your reaction to the purpose of the reclamation project?

Very supportive	1
Supportive	2
Somewhat supportive	3
Unsupportive	4
Very unsupportive	5

I.5	98

J . Perception Towards Development:

J.1. Employment opportunity:

Are you satisfied with your present job?:

Very satisfied	1	
Satisfied	2	J.1 99
Somewhat satisfied	3	
Unsatisfied	4	
Very unsatisfied	5	

J..2. If your answer is somewhat satisfied, unsatisfied or very unsatisfied, please give your reason(s): ______________________ — J.2 100

____

____

J.3. Do you, if given a chance, switch job to a better one? (1) Yes (2) No — J.3 101

J.4. If Yes, what kind of job do you prefer:______________________ — J.4 102

J.5. Do you think you can get that job in your village? (1) Yes (2) No — J.5 103

J.6. If No, are you willing to look for the job somewhere else? (1) Yes (2) No — J.6 104

J.7. Have you ever tried applying job to the reclamation project?(1) Yes (2) No — J.7 105
(there is no need to answer this question if you are already employed by the reclamation project)

J.8. If Yes, what is the reason of your failure to secure the job?

No vacancy	1		
No qualification	2	J.8	106
Irrelevant qualification	3		
Others:	4		

____

____

____

J.9	107

J.9. Have you ever tried getting other job in this area? (1) Yes (2) No

J.10. If Yes, what is the reason of your failure to secure the job?

No vacancy	1		
No qualification	2	J.10	108
Irrelevant Qualification	3		
Others:	4		

____

____

____

J.11. If other members of your family are working, please specify :

relationship with you	type of occupation	location	employee (if any)
Spouse			
1 st children			
2 nd children			

J.11	109

J.12. If your members of the family are unemployed, please give reason(s):

____
____
____

J.12	110

K. Enhancement of property value:

(for tenant only)

K.1 If you are renting a house, is there an increase of rent over the past few years? (1) Yes (2) No

K.1	111

K.2. If yes, how much is the rent previously?: RM__________

K.2	112

K.3.Are you planning to buy a house in near future? (1) Yes (2) No

K.3	113

K.4. If Yes, what is the value range that you can afford?:RM__________to RM__________

K.4	114

K.5. If No, please select the reason(s):

- No money at all [1]
- Not enough money [2]
- Unable to get loan [3]
- Cheaper to rent a house [4]
- Planning to move out soon to other area. [5]
- Others: [6]

____
____

K.5	115

(for house owner only)

K.6. Are you willing to sell your house?

- Yes, if the price is right [1] (there is no guarantee that you can buy or built another house in the same area)

K.6	116

Yes, so long as I can built or buy another house as good as or better than the present one in this area. [2]

No, at all cost. [3]

K.7. What is the right price for your house? RM______________

K.7	117

K.8.Do you think the house value has gone up lately?:

Very high [1]

High [2]

Affordable [3]

No change [4]

Low [5]

Very low [6]

I don't know [7]

K.8	118

(for land owner only)

K.9. Are you willing to sell your land?

Yes, if the price is right (there is no guarantee that you can buy another piece of land in the same area) [1]

Yes, so long as I can buy another piece of land in this area. [2]

No, at all cost. [3]

K.9	119

K.10. What is the right price for your land? RM______________per acre

K.10	120

K.11. Do you think the land value has gone up lately?:

Very high	1	
High	2	
Affordable	3	K.11 121
No change	4	
Low	5	
Very low	6	
I don't know	7	

K.12. What are other properties that you think have gone up in value:

__________ __________ __________
__________ __________ __________

K.12 122

L. Increase of standard of living:

L.1. Can you please state what kind of food, goods and services that have gone up in price :

__________ __________ __________
__________ __________ __________
__________ __________ __________
__________ __________ __________
__________ __________ __________

L.1 123

M. Relocation :

M.1 124

M.1.Are you been relocated somewhere else because of the project? (1) Yes (2) No

M.2.If Yes, from where to where: from______________to______________

M.2 125

N. Losing land ownership (for land owner only):

N.1.Are you loosing land to the reclamation project? (1) Yes (2) No

N.1	126

N.2. If Yes, how many acres involved?:____________

N.2	127

N.3. In what manner that you lose ownership of the land:

By force (no compensation)	1
Voluntarily (no compensation)	2
By force (compensated)	3
Voluntarily (compensated)	4
Forced to sell	5
Volunteered to sell	6

N.3	128

N.4. How much is the compensation value?:RM__________

N.4	129

N.5. How much is the selling price?:RM_____________

N.5	130

N.6. Are you satisfied with the compensation value?

Very satisfied	1
Satisfied	2
Somewhat satisfied	3
Unsatisfied	4
Very unsatisfied	5

N.6	131

N.7. Are you satisfied with the selling price?

Very satisfied	1
Satisfied	2

Somewhat satisfied	3	N.7	132
Unsatisfied	4		
Very unsatisfied	5		

O. Disturbance/ Inconveniences

O.1. Please tick the following :

Rate	Increase (1)	Decrease (2)	No Change (3)	I don't know (4)
Crime				
Traffic				
Traffic accidents				
Sexual offences				
Fire				
Immigrants				
Illegal immigrants				
Outsiders				
Noise pollution				
Smoke pollution				
Dust pollution				
Water pollution				
Tranquility				

O.1	133 - 145

P. Perception Towards TNB Janamanjung Sdn. Bhd. Social Responsibility

P. Level of agreeable	**1**	**2**	**3**	**4**	**5**
Environmental friendly	☐	☐	☐	☐	☐
Providing infrastructure	☐	☐	☐	☐	☐
Tourism center	☐	☐	☐	☐	☐
Shopping complexes	☐	☐	☐	☐	☐
Social services	☐	☐	☐	☐	☐
Employment opportunity	☐	☐	☐	☐	☐
Local people involvement in the activities.	☐	☐	☐	☐	☐

P.1	146 - 152

1= Very agreeable, 2= Agreeable, 3= Somewhat agreeable, 4= Disagreeable
5= Very disagreeable

Thank You: The Department of Fisheries Malaysia wishes to thank you for your kind cooperation .

FORM A

Events	WEEK 1	2	3	4	5	6	7
crime							
traffic							
traffic accident							
sexual offences							
fire							
immigrants							
illegal immigrants							
outsiders							
noise pollution							
smoke pollution							
dust pollution							
water pollution							
tranquillity							
Others:							

FORM B

Events	OBSERVATIONS
source of pollutions	
new infrastructures	
rate of tourism	
new shops or shopping complexes	
social services provided by the power plant management	
social activity organized by the power plant management involving the locals	
Others	

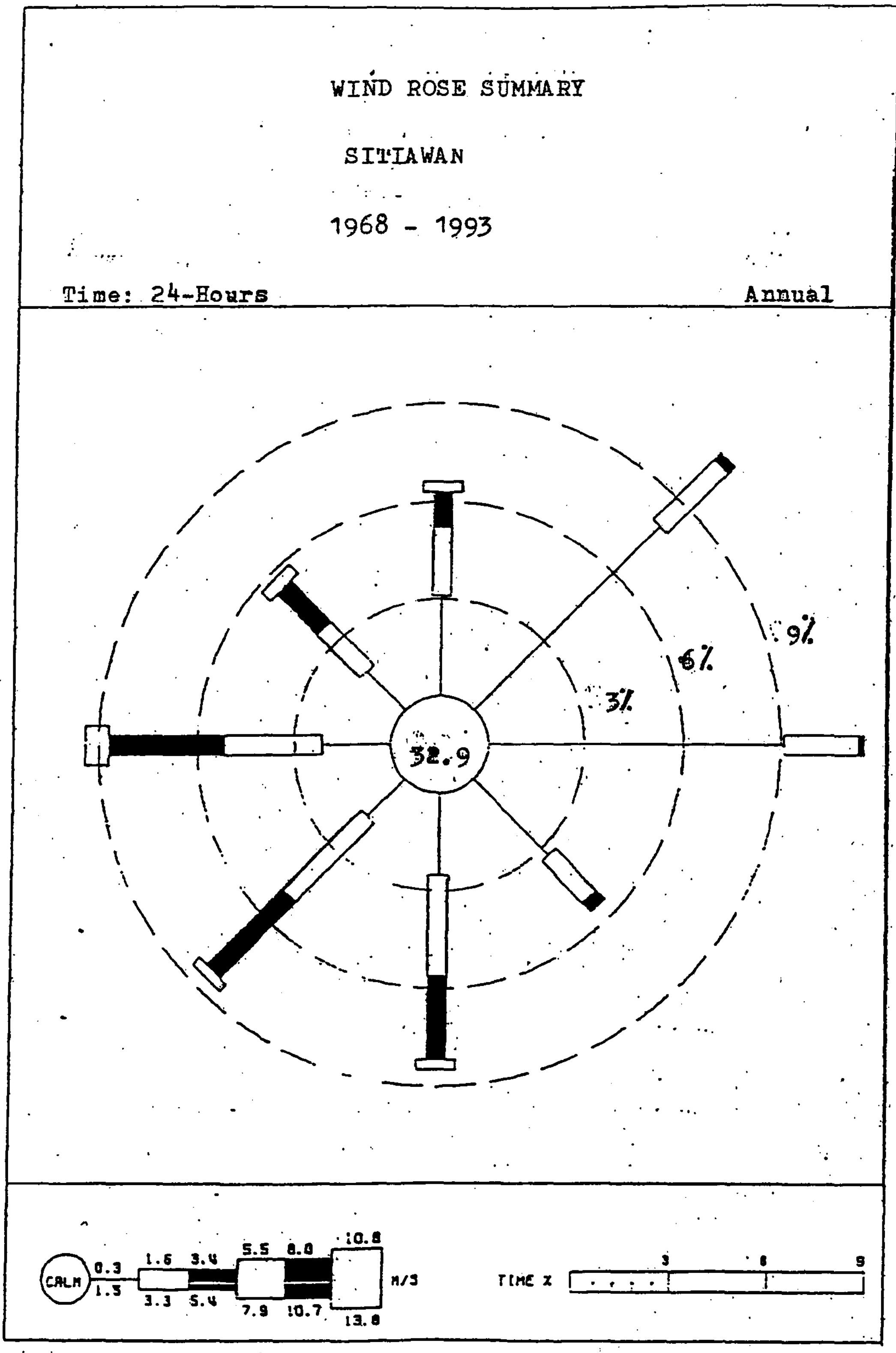

Figure 3A: Wind rose summary (1968-1993) for Sitiawan
Source: The Meteorological Department, Manjung.

Interview transcript of two respondents in Mukim Lekir

First Interview

The respondent is a traditional fisher, aged about 56 years old. He had been a fisher since 1979 at the age of 25 years old. He lives in Kg Dato Seri Kamaruddin, situated about 500 metres from the power plant. He has seven children aged between 7 - 26 years old. The monthly income from fishing is RM 750.00 and educated at primary school level.

After explaining the reasons of the interview to him, the questions and answers session began which were recorded as *verbatim* as possible (due to Malay-English translation).
INT = Interviewer , MAN = Respondent

INT: How is your living now?

MAN: I don't really understand what has actually happened to us, the fishers. Last time I used to bring back home fishes enough to feed my family. I sold some of them to get the money and some for my family consumption. It was not that good in the old days but we can manage our living. Of course sometime I had to borrow from someone when the catches were bad but I repaid him once I got more fish. We were poor then but I think worst right now.

INT: Why is that?

MAN: Look at the 'island' over there. Why they are reclaiming whilst there still plenty of land to build the power plant?

INT: It is cheaper, I think.

MAN: Cheap is one thing, but did they think about us? Now when I go out to catch the fish, most of the time I couldn't break even. Few days ago, I went out to catch fish with RM50 fuel cost. Do you know how much fish I caught? I got few fishes only, about RM15, the value. It is ridiculous.

INT: Why don't you look for another job?

MAN: It is easy for you. You are government officer, high ranking too. I only has primary school certificate. Nobody wants it. I'm old too. What can I do? I can still borrow from 'tauke' and repay him when I have the money.

INT: Do you know why fishes now become scarce?

MAN: Firstly, the 'island'. Last time, before the 'island', that was our fishing grounds. We caught a lot of pomfret, threadfin, mackerel and many more. I tell you, the pomfret, especially the Chinese pomfret, they were large. Twice my palm.

INT: Now?

MAN: Forget about it. I have to travel further up to catch fish. Even that, I caught less fish. Our fuel cost has risen up as well.

INT: Other reason?

MAN: Trawlers. When they encroached, we are sure to catch less fish.

INT: But which one do you think the main culprit?

MAN: Of course, the 'island'. I noticed the change. No 'island, I caught more fish than now. It must be it.

INT: Do you notice any mangroves being destroyed?

MAN: Not around here. But at Tangjung Kepah, all were gone.

INT: Do you know why?

MAN: Sedimentation. The mangroves over there were fertile before the coming of the 'island'. But slowly there was sedimentation. Now you can see, all trees are dead.

INT: Are you sure because of the 'island'?

MAN: Yes, I'm sure.

INT: Do you know the purpose of mangroves?

MAN: Somebody told me, if there are mangroves, fish will be plenty. Prawns too.
Yes, another thing, is that, the mangroves can protect houses from big storm.

INT: Do you own a house or land.

MAN: I have a house but no land. Well, a bit of extra land surrounding my house. I planted coconut trees.

INT: People say that the villagers will get some benefits when the power plant project has been completed. They say land value will raise up, or rent rate will raise up. This will benefit those owning lands or being landlords. Is that true?

MAN: I don't think so. Maybe for those living in Sitiawan. Why they want to buy houses here? Better for them to buy in Sitiawan. Plenty of houses to choose and the rent is cheap. Who said that, anyway?

INT: Well, some people. Anyway, what other benefits you think there are that you or other people have obtained?

MAN: Not me. It is a nuisance.

INT: How about jobs?

MAN: Nobody here been employed by the power plant.
INT: During the making of 'island' and the power plant?

MAN: No. There was a sub-contractor, a local one, but he hired outsiders.

INT: There is a fisher's Association, the South Manjung Fisher's Association. Do you think they will help you?

MAN: Not a chance.

INT: Why is that?

MAN: The officials are more interested to look after themselves.

INT: How about the Fisheries Department?

MAN: You look at their project. The one that suppose to help us. The persons taking care of it are not really fishers. They are called the 'corporate' fishers.

INT: What do you mean by that?

MAN: 'Corporate' fishers are not really fishers. They are the well-to-do part time fishers. There school teachers, navy guys and all kind of workers. They do not bother if their catch is less. They have other incomes. Good too.

INT: Could be, the project needs people with higher education?

MAN: Could be.

INT: You caught less fish but the price of fish has risen up tremendously.

MAN: Yeah, It is good thing, but still, not enough because we caught too little fish.

INT: I was told that some fishers agreed to the 'island' and power plant when they were asked earlier on by people making the survey.

MAN: Were they asking to the right person? Or they asked the 'corporate' fishers instead. I think every fisher would not agree if someone tries to 'throw sand into his rice pot'.

INT: Non-fishers like teachers, Navy, farmers all agreed?

MAN: Of course they had agreed because not of their 'rice pots'. It is not fair. Unjust. Rich people become richer and poor people become poorer.

INT: Don't do that. You must think of your wife and children. If you get caught, who will take care of them?

MAN: An oppressed person can do many wild things.

INT: Calm down, now. I hope you are joking. There is law here and there is god. Be patient. Maybe things can be better in the future.

MAN: It is already five years since they built the 'island'. I didn't see any good change. It is worst, I agree.

INT: This used to be a quiet area. Don't you agree?

MAN: Used to be. Not anymore. Traffic is heavy especially in the morning and afternoon. That is when the workers come to work and going back from work.

INT: Pollution?

MAN: Smoke pollution, noise pollution and water pollution. Last time I saw a greenish water coming out from the power plant. It must be some kind of pollution. I don't know what. Do you?

INT: No, I don't. Other disturbances?

MAN: Not anymore. Last time, immigrants, now no more.

INT: What kind of benefits that the power plant people had given the villagers?

MAN: What kind, what?

INT: Social things, for example they donate money to the villagers or build roads.

MAN: I'm not sure about that. But I know, personally, I have not received anything. They only built road to the power plant. Our village has already a good road built by government.

INT: Have you heard anything like somebody wants to build shopping complexes here?

MAN: No.

INT: Do you know anything about the RM I million, that the government or the power plant people or the 'island' contractor had contributed?

MAN: Yes, I heard that. But nothing until now.

INT: Do you think compensation will do?
MAN: It is good if they give us money but something must be done to improve our living.

INT: Few moment ago, I visited the power plant and I saw the channel between the 'island' and the mainland was blocked by sand. Do you know that.

MAN: Yes, I know. Now some fishers will have to use other longer route. They told us the sand will be removed soon.

INT: I thank you for your kind cooperation. Now, for the last time, have you got anything else to say? Don't be afraid, this is only a research.

MAN: I hope the government or somebody must help us. Everyday I catch less and less fish. If we no longer can become fishers, then the government must offer us other jobs, suitable with our qualification. If there are projects for fishers, only genuine fishers are selected, not the 'corporate' fishers. Don't do so many surveys like this one, we got bored. Many people came and asked us many questions but nothing comes out. For the projects people, I hope they come and visit us .Let them know how we live. They are very rich people. Compensation is good but how much? At least they give us some money. That will reduce our burden. My friend, this morning, went out to sea, he brought back three kilos of fish. That was about RM25. Even fuel cost is not enough. Ridiculous. I don't know how long we can survive. You look at those 'sampan'. Mostly belonged to 'corporate' fishers. They compete with us. What are government doing? They are illegal fishers. I have a license. Not like them. Lastly, I hope the government build new jetties for us or subsidize our fuel or free electricity for us. That's all.

INT: I thank you once again. Maybe we can see each other next time.

(The interview took about 20 minutes)

Second Interview

The respondent is a government servant, aged 36 yrs old and working with the Department of Public Works in Seri Manjung. He owns a house in Kpg Permatang which the distant is less than 500 metres from the power plant and had been living there for about 16 years. However, I met him at Tg.Kepah beach on the 23 February 2004 while he was beach-angling. He is married with three children, educated at SPM level and earning RM 1,000.00 per month. Since he claimed to be an avid angler and familiar with the Lekir beaches, I interviewed him.

After explaining the reasons of the interview to him, the questions and answers session began which were recorded as *verbatim* as possible (due to Malay-English translation).
INT = Interviewer , GOV = Respondent

INT: How are your living now?

GOV: Well, I think I'm doing fine. But not too good. Just barely enough. You know, we are the same. I hope our government will be doing fine. Economy will raise then I hope our pay as well.

INT: Please state, maybe you have some difficulties, financially, I mean.

GOV: Most of the prices of the foods have risen. They raised faster than my salary. Petrol price as well.

INT: How about fish price?

GOV: Oh, yes. I forgot. This is the number one item had increased in price. My family now rely on chicken. But now we afraid of disease. Chicken disease, mad-cow disease. For Chinese, the 'Nipah' virus disease in pigs. I don't know what next.

INT: Do you agree that if there is plenty of fish, the price will fall?

GOV: Certainly. I hope fishers catch more fish.

INT: Where do you buy your fishes?

GOV: Kg Permatang, most of the time. Sometime in fish market in Sitiawan or Lumut. But fresh fish in Kg. Permatang.

INT: Do you know why there is less fish now at sea?

GOV: I heard the fishers blaming the land reclamation project.

INT: How about you own inference?

GOV: I think it could be true that land reclamation caused something bad to the fish. No more fishing ground, pollution and dead mangroves.

INT: Are mangroves important to the fish?

GOV: Of course. People say; no mangroves, no prawns. I think fish will be affected more.

INT: Do you know where mangroves had been destroyed in Mukim Lekir?

GOV: Here in Tg Kepah. The other place is right in front of the power plant.

INT: Do you agree if we destroy mangroves?

GOV: No. But depend on the purpose. It become a dilemma. If we don't destroy mangroves, then there will be no development. If I oppose, then people might brand me as anti-development. So, for the power plant, I have to agree.

INT: Suppose you are a fisher. What say you.

GOV: I will not agree. Unless they give me other job.

INT: But you are an angler.

GOV: Yes, but this is only recreational.

INT: Fishers told me. their livelihood is badly hit by the power plant. What is your feeling about it.

GOV: I pity them. But, I think the government must do something to help them.

INT: Do you own a house or land?

GOV: I have a house bought on government loan. No land.

INT: Do you think the price of your house will be higher if you want to sell it?

GOV: I think so.

INT: Why is that?

GOV: I think it is normal for a house price to be higher a little bit.

INT: Could be because of the power plant? Demand for houses has risen. Many new workers over there.

GOV: I don't think so. If they want to buy houses, better in Sitiawan. Plenty of houses to choose. Nearer to their working place.

INT: Somebody told me, the price of houses and land will be raised because of the projects.

GOV: I think the project is not that big to trigger big economic change here.

INT: Basically, do you happy with your work?

GOV: Yes, I'm.

INT: Tell me what makes you happy.

GOV: My salary is not that high but compare to fishers, it is constant. I know every month, there will be money in my account. I can afford a decent house through the government loan. I'm quite happy.

INT: I want to measure satisfaction now. You say your salary is not high, but you are happy because you own a house. What else makes you happy.

GOV: I think I have what most people have; car, television, refrigerator and many more. But most of the goods I bought through hire-purchase scheme. Still I can afford . I pay bit by bit every month.

INT: Do you agree that most people are satisfied living because they possessed what they desire.

GOV: Absolutely.

INT: Now, we talk about development. You seem to agree about the power plant. Tell me what do you know about the power plant and its benefits.

GOV: Power plant produces electricity. Electricity is for houses, factories, train, batteries and many more. We need electricity to develop.

INT: But do you agree about the land reclamation? You know that the power plant can be built on land as well, without destroying fishing grounds.

GOV: If there is alternative, yes, I think the power plant should be built on land. But, otherwise, I agree for them to build on reclaimed land.

INT: But reclamation destroys fishers.

GOV: I know that, but government must find other ways to help.

INT: Now the power plant is in operation. Tell me any benefit you get from them?

GOV: Nothing directly. Electricity, maybe. But, I observed the electrical lines so long away from this area. Probably, the electricity produced here for other places.

INT: Do you wish to change to other job?

GOV: Only if the pay is higher.
INT: Have you heard about the power plant wanting new workers?

GOV: I don't know about that. I don't think they advertised. I read the newspaper almost everyday. I heard from somebody, the power plant boss hired a sub-contractor to recruit new workers and that sub-contractor chose only his 'cronies'. Most works go to his cronies. I think that boss should think about the welfare of fishers. Let them have the jobs. Locals should be his main concern.

INT: Maybe the fishers or their sons/daughters are not qualified?

GOV: Maybe. But, how about menial jobs. I'm sure some of them could do it.

INT: Tell me frankly, are you affected or not by the projects?

GOV: No. Except the fish price, otherwise, my life runs as usual.

INT: How about pollution?

GOV: Oh yes, I had overlooked. I saw a very large pile of coal in front of the power plant. I don't really know what it is, but I observed during strong wind, there was some kind of small black particles flying around. The air became polluted. But I don't know the real effect of it. Smoke too, from the two towers.

INT: Other kind of pollutions?

GOV: Maybe, water pollution. But, it is not affecting me or my family.

INT: Other disturbances?

GOV: Traffic is quite heavy in the morning and afternoon. People coming to work or going back home. But I do not use the same road. Maybe for other people living nearby. They might get irritated.

INT: Please think deeply of other disturbances.

GOV: I think, that about it.

INT: For the last time, I want you to tell me freely your opinion on the whole matter concerning the land reclamation and the power plant projects in your area. Please be sincere and do not be afraid because this is only a survey.

GOV: I support the projects because it gives us electricity. If this country is serious about developing further, more of the power plant is needed. However, as much as they could, they should avoid destroying fishing grounds, mangroves and other wild-life habitats. If they couldn't, I have to agree with them. Fishers should change. They must move away to other places. Maybe we will get fish from Thailand. Singapore survives without fishers. They import fish from us and Thailand. We must copy their methods as well. I'm not selfish, but it is the way the world now moving. I heard the actual project is very large. It covers the whole Mukim Lekir. Then we must think carefully. Is it worth or not? What benefits they can give to us especially to fishers. I think we must use the land, not the sea. People like myself are not affected. We can always move to better place to live. That is all I want to say.

INT: I thank you. You have been very cooperative. Maybe we can see each other later.

(This interview took about 25 minutes).

Appendix 3

CARD A. BACKGROUND INFORMATION ON MANGROVE BIODIVERSITY

Mangrove Biological Diversity (or 'biodiversity') refers to the total **NUMBER** and **VARIETY** of plants, animal and fish species found in the mangroves. These mangrove plants, animals and fishes live and interact within different types of mangrove environments. Mangroves are trees and shrubs of the genera Rhizophora, Brugiera, Sonneratia and Avicennia or, more generally, communities dominated by these genera. They are among few emergent woody plants that tolerate the salinity of the open sea .It is subtropical and tropical coastal ecosystem dominated by halophytic trees, shrubs, and other plants growing in brackish to saline tidal waters. The word "mangrove" also refers to the dozens of tree and shrub species that dominate mangrove wetlands. There are 15 true mangrove species present in Lekir. On average, there are 37 true species present in South East Asian countries. It means in Lekir alone, about 40 % of the species are found here. Lekir mangroves are also a home to crabs, shellfish and other invertebrates, and mammals. On the terrestrial fauna, 113 and 101 vertebrate species consisting of amphibians, reptiles, mammals and birds were identified respectively. Referring to Wildlife Act 1972 (Malaysia), two mammalians; *Nycticebus coucang* (Slow Loris) and *Manis javanica* (Pangolin) are protected under the Act while 13 others are partially protected. Only 15 avifauna species are not accorded by any legal status by the Act which means majority of the species identified are endangered and hence protected by the law. To protect the individual plant and animal species diversity it is necessary to protect mangrove environment.

In Malaysia, there are 104 mangrove species of which 38 are categorized as true (exclusive) species, 57 are non-exclusive species and nine associated biota. The exclusive mangroves are species which are restricted to the mangrove habitat; the non-exclusive may be important in the mangrove habitat but not restricted to it; and the associated or correlated biota which include, for example, bryophytes and pteridophytes.

CARD B. BACKGROUND INFORMATION ON LEKIR MANGROVES

Mangroves are trees and shrubs that grow on sheltered coastlines, mudflats and riverbanks. They are part of a rich coastal ecosystem, which provide a range of natural products and services. Currently, mangrove habitats in Malaysia, including the mangroves of Lekir, are being lost due to industrial and urban development, and conversion to fishponds and agricultural land. Particularly in Lekir, the recent coastal land reclamation is seemed to deteriorate the mangroves condition. With the exception of Matang mangroves in Perak, other mangrove areas are not protected by law.

Lekir mangroves are situated between Perak river at the southern part and Batu Tiga at the northern part. The area has been estimated to about 97 hectares (240 acres).

Fishing is important to people living near the mangroves. It has been well established that mangroves are important feeding and nursery grounds for many species of prawns and fish fry. Prawns are so dependent on mangroves that the size of a shrimp population (or annual catch statistics as a substitute for a population estimate) is determined by the area of contributing mangroves. **Without mangroves, there could be no fishing.**

Should Lekir mangroves be protected, the benefit would be:

- Conservation of the important wildlife and habitat
- Maintenance of a substantial inshore fishing industry
- Provision of a sustainable harvest of mangrove products
- Protection from strong wing and storm, and land erosion

CARD C. MANAGEMENT SCENARIOS

SCENARIO 'A': PRESENT STATE OF AFFAIRS - NO PROTECTION

- Mangroves between Perak river and Batu Tiga are deteriorating due to land reclamation works
- Loss of mangrove areas to coastal development
- Potential loss of commercial and recreational fishing
- Reduction in the natural protective functions against strong wind, storm and land erosion.
- Increased pollution and loss of fish productivity
- Deterioration of recreational facilities and aesthetic beauty

SCENARIO 'B': PROPOSED MANAGEMENT PLAN: PROTECTION OF MANGROVES

BETWEEN PONTIAN AND RENGIT AS A PROTECTED FOREST LAND

- Protection of significant birds and other wildlife and habitat currently under threat
- Maintenance of fish stocks and shell fish of benefit to local communities
- Increased protection of houses and lands from bad weather (strong wind, storm and land erosion).
- Improved recreational and educational facilities for residents and tourists
- Reduced pollution

CONTINGENT VALUATION METHOD (CVM) FOR EVALUATING THE MANGROVE USES FOR NON-MARKETED GOODS/SERVICES OF LEKIR MANGROVES IN THE STATE OF PERAK, MALAYSIA.

SECTION 1

INSTRUCTION FOR INTERVIEWERS:

Before starting the interview procedures, please introduce yourself to the respondent. The elements of introduction are laid down below. It can be commenced in any way you think fit for the situation but normal practice is as suggested:

- Assalamualaikum (greeting)/ good morning/good evening Encik (Mr.)/ Puan (Madam)....................................My name is........................I am working with the Department of Fisheries Perak (show your official card).
- Tell him/her that you are involved with a survey to find out how much households value the mangroves in Lekir area. and would like to ask him/her a series of questions.
- All answers are confidential and there are no right or wrong answers. Their opinion is what count.
- Tell him/her how much you appreciate their cooperation in the survey and reminding them that the time taken for the interview will be kept as short as possible and if they are busy right now, it can be done at other time (note down their names, addresses and phone numbers).
- If he/her is not interested to participate, thank them and search for another person.

• NOTE SOME QUESTIONS DEPEND UPON PREVIOUS ANSWERS
• IN THE CASE OF A REFUSAL TO RESPOND NOTE THIS WITH A CAPITAL 'R'. DO NOT MERELY LEAVE BLANK.
• RESPONDENTS MUST BE THE HEAD OF A HOUSEHOLD (Decision makers).

SECTION 2

Name of respondent:______________________________________

Address :____

Telephone number:______________________

A. GENERAL ATTITUDES TOWARDS THE ENVIRONMENT

A.1. Suppose that the Malaysian government or the State of Perak is going to invest money to help with one of the problems listed below . Which of these problems do you consider to be the most important one to solve in Perak State? And which of the problems do you consider the second most important to solve?

CIRCLE ONE ANSWER FOR MOST IMPORTANT AND ANOTHER FOR SECOND MOST IMPORTANT

Problem	**Most important**	**Second most important**
Increasing fisheries productivity	1	1
Increasing agricultural productivity	2	2
Reducing water pollution	3	3
Protecting natural habitats & wildlife	4	4
Providing more employment opportunity	5	5
Other, specify_______________________	6	6

A.2. What problems concerning the natural environment are you most worried about?

CIRCLE ONE ANSWER FOR MOST IMPORTANT AND ANOTHER FOR SECOND MOST IMPORTANT

Problem	**Most worry about**	**Second worry about**
Air pollution	1	1
Water pollution	2	2
Destruction of fishing ground	3	3
Land erosion	4	4
Wildlife preservation	5	5
Other, specify__________	6	6

A.3. I will like to read you some statements concerning the protection and conservation of our natural environment . Please think carefully and give your frank responds.

SHOW CARD FOR EACH QUESTION

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
Everybody has the duty to protect the environment from development regardless of the cost (*intrinsic value/overall duty to protect)*	1	2	3	4	5
We should reduce our use of the environment now, so that our grand children may benefit from it (*Bequest value)*	1	2	3	4	5
Malaysia needs to develop her forest, seas, and land to increase jobs and incomes, regardless of the environmental damage (*role of environmental assets in development)*	1	2	3	4	5
Because birds depend on the mangroves, they should be protected regardless of the costs (*existence value)*	1	2	3	4	5

I should pay for the protection of the mangroves even though I do not visit them *(selfish use value motive)*	1	2	3	4	5
Even I don't use the mangroves now, I am prepared to pay to protect them in case I want to use them in the future*(option value)*	1	2	3	4	5
It is worth spending money to protect the mangroves because they help to protect fisheries activity in the area (indirect use motivations)	1	2	3	4	5
We have more important things to think about than the loss of the mangroves *(putting issue in context)*	1	2	3	4	5

SECTION 3

B. USES OF LEKIR THE MANGROVES

B.1. Have you ever heard of Lekir's mangroves area?

Yes	1
No	0

B.2. Have you ever visited Lekir mangroves?

Yes	1
No	0

B.3. Do you think you will be visiting Lekir mangrove in the next 5 years?

Yes	1
No	0

B.4. Do you think the mangroves in Lekir are significantly important to the people of Lekir in respect of its size?

Figure 5.3 : It shows the mangroves area of Lekir with respect to other types of vegetations.

Very important	1
Important	2
Somewhat important	3
Unimportant	4
Very unimportant	5
I don't Know	6

B.5. Now you are shown a list of some major physical uses of the mangroves. Please indicate Yes or No answer if you agree or don't agree that Lekir mangroves can offer.

Uses	**Yes**	**No**
Timber	1	2
Poles	1	2
Fuel wood and charcoal	1	2
Building dwellings	1	2
Medicines ingredients	1	2
'Sagu', 'nipa' liquid and other edible products	1	2
Agriculture	1	2
Prawn/fish culture	1	2

B.6. Now you are shown a list of some major non-physical/environmental uses of the mangroves. Please indicate Yes or No answer if you agree or don't agree that Lekir mangroves can offer.

Uses	Yes	No
Fish nursery ground	1	2
Birds sanctuary	1	2
Wildlife protection	1	2
Eco-tourism	1	2
Protection from strong wind and storm	1	2
Preventing erosion	1	2
Possibility of national park	1	2
Possibility of forest/mangrove reserve.	1	2

B.7. At present, do you extract anything from the mangroves or its natural resources for your own use or for trading to get money? If No, go to next question. If Yes, please specify the products or services:

____

____

I am now going to introduce the concept of biodiversity.

SHOW INFORMATION CARD A AND READ INFORMATION ON MANGROVE BIODIVERSITY.

I am now going to give you some information about the mangroves of Lekir and introduce you to some of the environmentally sensitive issues that these mangroves face today.

SHOW INFORMATION CARD B AND READ BACKGROUND INFORMATION ON THE MANGROVES OF LEKIR. SHOW PHOTOGRAPHS ON SHEETS (a) through (d).

B.8. Is this information new to you?

Yes, very new	1
Only some of it is new	2
I know all of this already	3

PRESENT SHOWCARD C:

READ SCENARIO A

B.9. After you have been shown card A and Card B and some of the photographs relating to mangroves, how are you expressing your feeling towards the whole situation?

Very unhappy	1
Unhappy	2
A little bit unhappy	3
No feeling	4
Couldn't care less	5

B.10.Do you think Lekir mangroves are now in bad condition?

Very, very bad. Unrecoverable.	1
Very bad, but recoverable in long time.	2
Bad, recoverable quite sometime.	3
Not so bad, recoverable soon	4
No bad at all.	5

SECTION 4

READ SCENARIO B

C. WILLINGNESS TO PAY SECTION

The objectives of managing and protecting the Lekir mangroves are :

- To rehabilitate the mangrove areas into sustainable uses;
- To protect the areas from further damages;
- To ensure continuous uses of mangroves particularly in fisheries, eco-tourism and other recreational facilities.

The implementation of the above objectives will surely involve a lot of money. Since you and the people of Lekir mostly receive the benefits that will be incurred by this management and protection scheme, the management and protection costs will have to be paid by everybody on a continuing basis if they want to enjoy the benefits protection of the mangroves will offer.

As such, suppose that in order to protect the mangroves, your household would be asked to pay a monthly fee to A LEKIR MANGROVES FUND (LMF), which will be established and managed by the government to help protect the mangroves in Lekir..
Please think for a second about how much this would be worth to you and your household.
(IF RESPONDENTS EXPRESS DOUBTS ABOUT THE MANAGEMENT PLANS EFFICIENCY, TELL THEM TO ASSUME THAT THE SYSTEM WILL WORK WELL).
[IF NECESSARY SHOW CARD D WHICH LISTS POSSIBLE PROJECTS WHICH COULD IMPROVE BIODIVERSITY].
Please keep in mind:
1. The issues discussed here are only a few among many other environmental problems Perak and Malaysia faces.
2. This interview is on the mangroves of Lekir only, not on other environmental issues or other mangrove areas around the country that you may be concerned about.
3. Your own personal income is limited and has important alternative uses.
4. There is no right or wrong answers and you should answer for your household.

ELICITATION FORMAT
(Referendum Followed by Single-Bounded Dichotomous Choice)

C.1 Are you now willing to pay a monthly fee to the LMF?

Yes	1
No	0

(If No, please go to questions C.2 and C.3)

C.1 (a). Are you willing to pay RM__________ (Show the card value).

Yes	1
No	0

TO BE ANSWERED BY THE RESPONDENT WHO STATED ZERO WTP.

C.2. I am sure there is a good reason why you are undecided right now (no-answer option). Please be free to state you reason because we believe everybody has his/her own reason for such an act.

Now, you please read the statements below and choose only one that really suits your judgment:

CIRCLE ONLY ONE ANSWER

I have no spare income but would otherwise contribute	1
I feel that environmental protection of Lekir Mangroves is unimportant	2
I'd rather have the current situation than pay more	3
The user should pay	4
I believe that this improvement will take place without my contribution	5
I don't believe the system would bring the changes you describe	6
It is the government's responsibility	7
I fail to understand the question	8
We cannot place a monetary value on bio-diversity	9
No-response	10

C.3. Contribution to make the mangroves better and well protected is not only in monetary term. It can be contributed through other means, for example, by doing volunteering works. The LMPPPF is also designing some job descriptions for volunteers to work on the mangroves management and protection plan. Among other things, the job will include (a) keeping away unwanted people from the mangroves areas, (b) preventing unauthorized individuals from taking anything out of the mangroves areas (e.g. woods and hunting animals) and (c) planting and nursing new plants. This job will of course unpaid and consume your precious leisure hours. Think careful about it. Now, are you willing to become a volunteer ?

Yes	1
No	0

If Yes, please go to C.3.a,
If No, please go to C.7.

C.3.a. How many hours you will like to work as a volunteer for the LMF?

None	0
Hours per Month	
I cant make up my mind now	999

C.3.b. Please state why are you willing to spend your time in Lekir mangroves?

____

____

C.4. Why did you vote no ?

____

____

(Please go to question C.7)

TO ANSWER ONLY IF THE RESPONDENT STATED A POS1T1VE WT P

C.5. Why did you vote yes ?

____

____

C.6. There are also other mangrove areas in Perak that need attention. Will you also willing to pay anything for the betterment of those mangroves?

Yes	1
No	0

C.6.a. If Yes, what is your maximum WTP ? RM ________________.

C.6.b. If No, what is your reason?

____

____

C.7. Suppose you are no more living in this area in the future, will you still be paying to the LMF ? (assuming your income remain the same)

Yes	1
No	0

C.7.a. If Yes, how much you will be WTP.

Same as before	1
Other amount, specify __________	2

C.7.b. if No, why are you not WTP ?

____

____

TO BE ANSWERED BY ALL RESPONDENTS

C.8. Do you think the LMF which is managed by the government is the best method of saving the mangroves?

Yes	1
No	0

C.8.a. if No, do you have any other suggestion? (specify, if you have)

____

C.9. S. Do you think that there would be any direct benefits to you from this project?

Yes	1
No	0

C.9.a. If Yes, do these direct benefits relate to your current use of the Lekir mangroves as listed earlier in B.7 or are there other benefits to you?

Direct benefits as listed in B.7	1
Other additional benefits , List as described:____________ ____________ ____________	2

C.10.). We are now near completion of the most important part of this survey. I will like to know if what has been told and explained to you bears any meaningful experience to you. You choose the best statement below that suites your general view of the whole processes:

This survey tells me that it is important to spend some money to protect mangroves so that it can be beneficial in short and long run to everybody	1
This survey has given me opportunity to know more about the importance of mangroves to mankind	2
This survey merely adds a little bit of knowledge than what I already knew	3
This survey means nothing to me	4

D. SOCIO-ECONOMIC BACKGROUND

D.1. State sex of respondent:

Male	0
Female	1

D.2. Please state your age group (in Years):

Less than 21	1
21 – 30	2
31 – 40	3
41 – 50	4
51 – 60	5
61 – 70	6
More than 70	7

D.3. Please state your race :

Malay	1
Chinese	2
Indian	3
Others , specify:____________________	4

D.4. What is the highest level of education you have obtained?

No formal education	1
Primary school	2
SRP/PMR	3
SPM/SPVM	4
STPM	5
Diploma/Professional certificate	6
University degree	7

D.5. What is your occupation ? ____________________________

D.6. How far is your house from Lekir mangroves? ___________ Km

D.7. How many members are there in your household? _______________

D.8. I am going to ask you about your total income per month. You might have a steady monthly income from your occupation and other incomes from various sources. Please add them together and tell me. Remember, this information is strictly confidential.

No income	0
Less than RM350	1
RM351 – RM450	2
RM451 – RM550	3
RM551 – RM600	4
RM601 – RM700	5
RM701 – RM800	6
RM801 – RM900	7
RM901 – RM1,000	8
RM1000 – RM1,500	9
More than RM1,500	10

D.9. Finally, we come to the end of this survey. One last question, please.
Just say Yes or No to the statements I am going to read to you:

	Yes	No
Interesting , if you are doing another survey please look for me		
Boring, regret talking to you		
Interesting, but I cant grasp most of what you are talking about		
Give me a lot of new knowledge		
Ridiculous, if I see you again, I chase you out.		
Other, specify________________________		

THE END. THANK YOU VERY MUCH. YOUR KIND COOPERATION IS VERY MUCH APPRECIATED.

CARD D: POSSIBLE PROJECTS TO INCREASE BIODIVERSITY BETWEEN PERAK RIVER AND BATU TIGA

- Rehabilitation of mangroves (e.g. in front of bunds in order to protect agriculture)
- Establishment of visitors centre / information centre
- Promotion of environmental sensitive tourism activities (e.g. bird watching, boat trips)
- Monitoring of fish, plant life and mangroves
- Encouragement of proper disposal of garbage and other waste to reduce pollution