The Ecological, Economic and Social Profile of Boat Based Recreational Fisheries of Port Dickson

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Abstract

This thesis examines the social, economic and environment aspects of boat based recreational fishery in the marine district of Port Dickson, Negeri Sembilan, Malaysia. It identifies the primary fishing techniques used and species and volumes harvested and compared with the artisanal fishermen who also fished in the same waters. The Port Dickson District's waters supported an important recreational fisheries industry, with 30 landing points utilised for that purpose. Anglers fished from boats rented from fishermen and commercial boat operators, *kelong* (privately owned fishing platforms*)*, purpose built public jetties and breakwaters. Data was collected at these recreational fishing landing points indicated that activity was dominated by shore angling and boat angling. A wide range of species were caught include some such as the cobia (*Rachycentron canadum*) that did not appear in official fisheries statistics. The main bait types that were used included live prawn, squid, small fish and *pumpum (*polychete worms*)* as bait. The use of artificial bait or lures was almost non-existent. The paper describes a method for estimating the value of recreational fishery in Port Dickson based on fishing effort derived from interviews and discussions with recreational fishes. The investigation indicated that boat fishing in Port Dickson involved 10,066 anglers with a total fishing effort of 23,048 person-day with expenditures that amounted to RM1,490,062. Annualised catch volume, the total boat-based recreational fisheries catch is estimated to have amounted to 592 tonnes, which is not far from 2018 artisanal fisheries catch of 670 tonnes. In many landing points, recreational fisheries was found to be a major contributor to the local economy. The relationship of existing recreational fishing patterns in relation to the Port Dickson District's natural capital was explored and discussed, especially in relation to the ability of the fishers to identified hitherto unknown habitats. The uptake by boat based recreational fisheries undermines the assumptions on which existing fisheries management regimes, which is based entirely on artisanal fishing catch, is also discussed.

However, it is important to note that the findings of the under-represents the economic value of off this activity as the research does not investigate the value generated through a range of related economic supply chain activities. The study described the potential value of less visible activities in coastal areas, the need to develop appropriate modelling tools with which take account of this value and the significant role of novel approaches to measuring this value.

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CHAPTER 1: BACKGROUND TO RECREATIONAL FISHERIES – THE ULTIMATE PARTICIPANT SPORT

1.1 Recreational Fisheries – The Global Sport

The capture of fish for food and animal feed has a major global dimension, with total landings in 2018 amounting to 96.4 million tonnes (FAO, 2020). On the other hand, recreational fishing, (often called sports fishing, angling, and game fishing to distinguish it from commercial/artisanal fishing) is one of humanity's principal recreational activities and is, in many countries, the most popular participant (non-spectator) sport (Pitcher and Hollingworth, 2002). While the economic value of recreational fisheries has been commonly recognized in developed countries (Ihde et al., 2011, Pitcher and Hollinsworth, 2002), in developing countries it has largely not been assessed or understood. Gupta et al. (2015), in a review of recreational fisheries in India, indicated the success of recreational fisheries programmes in relation to the mahseer (*Tor* sp.) but bemoaned the fact that little was known of the status and value of marine recreational fisheries.

This chapter attempts to provide some historical and global context to the issue, leading up to what it means to Malaysia as a developing nation with ambitions of being a developed nation (Mahmoud and Mitkees, 2017). Clearly, recreational fisheries would be expected to play as an important role in its tourism and recreation industry as it does in developed nations.

Recreational Fisheries – What is It?

There is a significant degree of confusion over the various terms used in recreational fishing, mainly because the lack of a standardised nomenclature for the activity and the very localised nature of some of the activities that comes under its ambit.

The Food and Agriculture Organisation defines recreational fishing as… *the fishing of aquatic animals (mainly fish) that do not constitute the individual's primary need to meet basic nutritional needs and are not generally sold or otherwise traded on export, domestic or black markets* (FAO, 2012). Though acceptable as a whole, this definition is driven by its relationship to personal consumption and distances itself from the economic accrual arising from the activity.

Member states of the European Union also struggled to standardise the definition of recreational fisheries. In a comprehensive review, Pawson et al. (2008) pointed out that though the EU commission defined recreational fisheries as …*all fishing activities not conducted for commercial fishing purposes*…, others (Roberts et al., 1996; EAA,

2004) defined it as an activity….*not involving sale of catch*… or an activity …*not deemed commercial fishing….*

The US takes a slightly different stand. The National Marine Fisheries Service defines recreational fishing as a …..*form of fishing where the primary reward is the challenge of finding and catching the fish rather than the culinary or financial value of the fish's flesh.* (Pawson et al., 2008). Pitcher and Hollingsworth (2002) define it more simply as "..fishing for fun" pointing out that while commercial and artisanal fisheries may find fishing "fun" from an occupational standpoint, that is not their primary motivation.

Another issue of contention is the nomenclature used in literature to describe the activity. The term "recreational fishing" is used interchangeably with terms such as "sports fishing", "angling" and "game fishing". "Angling" is a term that is limited to the use of the rod-and-line (Jones, 1995). The use of cast nets, for instance, does not qualify as angling. Angling should, therefore, should be considered a sub-set of recreational fishing activities. Sport fishing, as a general term, appears to be a misnomer since *"…fishing as a sport is closed to no one, a sport with no fans, only participants."* (Jones, 1995). "Sports fishing", together with "game fishing" better relates to competitive exhibitions of the activity, rather than a general term for the activity. Game fishing is regulated by the International Game Fish Association (IGFA), which sets rules and maintains records. A sports fishing programme that seeks IGFA endorsements would be required to comply with its rules. However, even the IGFA mixes up the nomenclature, calling its rules as International Angling Rules (IGFA, 2015).

Scuba diving is regarded as part of recreational fishing, especially when it involves spearfishing in Australia (DELWP, 2019) and South Africa (Mann et al., 1997) or collection in Australia (DELWP, 2019). The rationale of covering spearfishing and collection as part of recreational fishing is, of course, the potential impact of these activities on resource health since both represent extractive activities. However, neither of these are undertaken (or are supposed to be undertaken) in Malaysia at recreational level. Spear guns are regarded as "guns" and need to be licensed by the police. Spearfishing is specifically prohibited in Malaysian marine parks under Section 44 of the Fisheries Act, 1985 (Amended 1991).

While collection is unlicensed, observation by the author indicates it is primarily undertaken as artisanal fishing activity. In the context of this thesis, therefore, recreational diving is not included as part of recreational fisheries.

However, given the close nexus between the health of habitats such as coral reefs (which are the target of most recreational diving) and that of commercial fish stocks (Sadovy and Domeier, 2005), it clear that the management of recreational fisheries may need to consider the impacts of recreational diving at one point of time or another.

Recreational Fisheries – How old is it

Fishing for fun has an ancient origin. The term “angler” has its root in ancient Aryan root ank, which means bend or hook, while fishing from dedicated fish tanks have known from Egyptian times (Pitcher and Hollingsworth, 2002). Kearny (2002), in historical review of the activity, points to an Egyptian mural dated 2400 BCE that show fishing as a recreational activity. Modern big game fishing, made feasible by powered boats, was thought to have pioneered in 1898 by C.R Holder in Santa Catlina island, California, USA (Pitcher and Hollingsworth, 2002). Other studies also indicate an ancient tradition where recreational fisheries are concerned. Gupta et al. (2015) reported that recreational fisheries was described in early texts (Matsyavinoda) as early as 1127AD, suggesting the activity was prevalent even then.

Recreational Fishers – How many are there

The numbers involved in recreational fishing are unclear and are tricky to estimate since, unlike commercial and artisanal fishermen, recreational fishermen undertake the activity on an occasional and opportunistic basis (Kearny, 2002). Pitcher and Hollingsworth (2002) reported recreational fisheries to amount to 2 – 4% of the population in Germany, USA and UK while Toivonen (2002) that reported 12 – 50% of Scandinavian populations are involved in the activity. Overall, Arlinghaus and Cooke (2009), while Cooke and Cowx (2004) estimated that the activity is undertaken by 10 - 11.5% of the global population. Based on a population estimate of 7.7 billion in 2019 (Worldometer, 2019), this would mean that there were 760 billion - 874 million recreational fishers worldwide.

Other sports claim a larger audience. Football (4 billion), cricket (2 billion) and tennis (1 billion) (Shvili, 2020) had bigger audiences. Recreational fishing does not feature in the listing because it is not defined as a sport as it is against a non-human adversary (much like hunting) rather than another human being, whose capacities can be better standardized. While this disqualifies as being a sport in the traditional sense of its meaning, it has a sporting element to it in that it can be physically and mentally challenging.

Nonetheless, there are three aspects that separate recreational fisheries from any other sporting activity, including recreational hunting. Firstly, it is a global activity. This distinguishes it from football (soccer) that is not played extensively in the US and cricket, which is largely played in former British colonies. Basketball is widespread in North America (particularly the US) but is not as popular in South Asia or Africa (McCartthy, 2017). Where recreational hunting is concerned, many allow it only under specific circumstances, while the activity is banned in many countries. Often it is restricted to specific reserves, access to which is often limited. This is in contrast with recreational fishing, especially in developing countries, where water bodies are often regarded as common user resources.

Secondly, unlike the others, it is not a spectator sport. Its appeal is egalitarian, with anyone with access to the appropriate resource being able to participate it in. This makes assessment of the numbers that undertake recreational fishing difficult. Pitcher and Hollingsworth (2002) provides an example of the imprecision in evaluations in recreational fishing in Australia, where surveys conducted by the state governments and recreational fishing groups suggested 30% of the population was involved in recreational fisheries, while the national Bureau of Statistics suggested it was 4.8%. Meanwhile, the percentage for the state of Victoria (based on the number of licenses issued) was 14%. At the heart of the problem is the fact that recreational fisheries are an opportunistic activity, with fishers having different motivations to undertake the activity.

Thirdly, it has a social element, with angling being a matrix for familial and community bonding. Though the same could be potentially said for other sports, the egalitarian nature of the activity allows a greater degree of social intercourse than with other sports. The social element is also a major element that contrasts it with recreational hunting, especially in recent years.

In this respect, organisations like PETA (2019) have condemned recreational hunting as being cruel and painful to the animals involved (PETA, n.d.). The same argument has been made for recreation fishing as well (PETAUK, n.d.).

However, recreational fisheries has not had the same resonance with the public as has recreational hunting. The outrage in the social media that accompanied the killing of an iconic lion in Zimbabwe (Cecil the lion) is a case in point (Willingham, 2018). The reason for this could be differing manner in which the outcomes are projected. Recreational hunting is primarily about collection of trophies (Weisgerger, 2017), while

for most part, the catch by recreational fishers is consumed, particularly in Malaysia and not commonly displayed as trophies.

This thesis attempted to investigate whether these motivations had to do with gender, ethnic and cultural considerations, which also determine the kind of recreational fisheries that is undertaken. These considerations vary from country to country but while there is some data from developed nations, there is very little information on recreational fisheries from developing nations.

Nonetheless, there is a cross over between hunting and fishing in that the sucuess of terrestrial animal reserves have provided a methodological template for a similar focus on sustaining protected marine habitats (Day et al., 2002). Generally, has been to see the marine environment as an open environment, where physical, chemical and biological influences interact over large distances. This is exemplified by transboundary projects such as the Coral Triangle Initiative (Jasmin et at., 2012).

Recreational Fisheries – Environmental Considerations

This is a great paucity of data on landings of recreational fishers, an issue that haunts fisheries resource managers (Arlinghause and Cooke, 2009). Though individually, recreational fishers catch small volumes of fish in comparison to their commercial and artisanal counterparts, their greater numbers have the potential to impact deleteriously on the standing stock. Several studies have indicated marine recreational harvest to be of similar magnitude as commercial catch (Coleman et al., 2004; Cooke and Cowx, 2004).

However, there is very little data to indicate the collective relationship of recreational fishing effort and commercial fishing on the overall population dynamics of fisheries stocks (Ihde et al., 2011). Cooke and Cowx (2004) estimated the global catch by recreational fishers to amount to 47 billion fish annually, but no details on their relationship to commercial catch are available. A preliminary study in Trinidad indicated that recreational fishing catch amounted to 10% of commercial catch (Mike and Cowx, 1996).

Pitcher and Hollingsworth (2002) pointed out that recreational fisheries would need to report detailed evaluations of its direct and indirect economic and ecological impacts and to implement adaptive management plans using data gathered by sports fishers. They point out that data collection on a wide span of parameters that cover these requirements is a challenge for most management agencies.

Coupled with this is the wide range of gear that different countries allow in the recreational fisheries, or even the numbers of fishers involved. For example, though the US stipulates those recreational fisheries must be undertaken using rod-and-line (NOAA, 2015), other countries have adopted less rigid requirements. Finland, for instance, allows the use of nets, the distinction with commercial fisheries being made on the basis of income (those earning more than 30% of their income from fish sales are considered commercial fishers) and gear size (bow nets above 1.5m high, seines and trawls, lines with more than 250 hooks or set nets more than 900m are considered commercial gear). Other European countries have similar variations on what can, and cannot be considered, recreational fishing gear (Pawson et al., 2008).

The environmental impacts of recreational fishing are not limited to its impact on resources. Lloret et al. (2014), for instance, reported the loss of fishing gear (especially lead weights) in the Mediterranean coastal areas. Having said that, monitoring of fishing effort and catch rates are key elements in the management of recreational fisheries undertaken by these countries. Management measures include bag limits, size limits, closed seasons and gear limitations.

Recreational Fisheries – Economic Value

The immense economic accrual from recreational fishing has led to its recognition as a major industry in its own right, particularly in developed nations. Recreational fisheries in these countries have a long enjoyed a considerable degree of institutional support, while being monitored for fishing effort and impact on fisheries resource health. Templeton (1984) reported that angling to be the most popular of all water sports in the United Kingdom (outside of swimming), with participation in 1980 amounting to 3.38 million people. In the United States, US$18 billion was spent on recreational fishing in 1980, dwarfing marine fisheries value of US$2.2 billion (Royce, 1984).

More recent data suggests that recreational fisheries have continued to grow substantially, particularly in developed countries such as the United States (Ihde et al., 2011), Europe (Pawson et al., 2008), Australia (Henry and Lyle,)) 2003) and New Zealand (New Zealand Marine Research Foundation (2016).

In the United States, data from the 1980s indicate that fishing attracted 20% of the population over 12 years old, each participant spending an average of US$430 per year on the activity inclusive of travelling, transportation, equipment, and license fees (Everhart and Young, 1981; Royce, 1984).

Later data from the the National Oceanographic and Atmospheric Administration manages marine recreational fisheries in consonance with the National Saltwater Recreational Fisheries Policy and Implementation Plan. In 2011, the organization estimated that there were over 11 million marine recreational fishers in the country involving over 70 million fishing trips. The industry generated UD$56 billion in sales impacts, $18 billion in income impacts and supported 364,000 jobs (NOAA, 2015).

There are an estimated 21 million recreational fishers in Europe and together they spend several billion Euros on their hobby. Annual expenditure, however, is lower than that of the United States and probably amounts to about a third of annual expenditure in the US (Tisdell, 2003). In Australia, the National Recreational and Indigenous Fisheries Survey (Lyle et al., 2002) estimated that about 19.5% of the country's population (or 3.36 million) participated in recreational fishing in 2000/2001. During that period, recreational fishers undertook 23.3 million fishing events, caught 72 million finfish, and contributed AUS$1.8 billion to the economy (Henry and Lyle, 2003).

The New Zealand Department of Fisheries estimated that 19.5% of the country's population of 4.5 million (or 877,000 persons) undertook recreational fishing on a regular basis. Annual landings from recreational fishing were estimated at 25,000 tonnes (FAO, 2014). This appears insignificant next to commercial fish landings, which in 2016 amounted to 600,000 tonnes and an export value of NZ$1.8 billion (Seafood New Zealand, 2019).

However, there is little valuation data on recreational fisheries and the manner it compares with commercial fisheries. An earlier study in 1998/1999 (Williamson, 2000) indicated that the average recreational fisher spent NZ$38.05 per fishing trip and made 25 trips per year. Based on the angling population data above, this would have amounted to NZ$834,246,250 277. Thus, while the recreational fisheries catch represents 4% of the total commercial catch volume, its estimated value amounted to 46% of the industry's export value.

It is important to note that Williamson's assessment was made in 2000 i.e. 16 years earlier than the commercial catch it is being compared with in this analysis. It is more than likely that the value of recreational fishing would be far higher than estimated.

1.2 Recreational Fisheries - What it Means to Archipelagic Asia

It is little recognised that archipelagic South East Asia has a very high shoreline to land mass ratio. Malaysia, for instance, has a shoreline to land mass of 70 km^2/km of shoreline, Indonesia, 33.1 km^2/km and Philippines, 8.2 km^2/km in contrast with the United States 759km^2/km and 424.7km^2/km (CIA, 2017).

This means that, traditionally, the populations in these countries have looked at the sea as a primary source of food and income. Their linkage to the sea has had significant cultural and patrimonial bonds, and as emotive as it as economic. Recreational fisheries is consistent with this cultural predisposition and is reflected in the ethnic patterns that was recorded in the course of this research. It is important to note that the behavioural patterns in recreational fisheries in Malaysia would apply for much of archipelagic South East Asia as well. These patterns have clearly evolved from the same cultural milieu and would apply as much as to an average Indonesian as it would to a Malaysian. Thus, the findings of this study would have an application that would go beyond Malaysian shores.

1.3 Recreational Fisheries – The Malaysian Situation

1.3.1 Background and History

With a coastline length of 4,695km and a land to shoreline ration of 70km^2/km, fishing for seafood (or table fish) in Malaysia has a long-standing tradition, employing 126,595 full-time fishers in 2019 (Department of Fisheries, 2020). The industry is divided, for management purposes, into commercial and artisanal fishing. Commercial fisheries revolve around the trawl and purse seine fisheries, while artisanal fisheries are based on traditional fishing gears such as drift nets and portable traps (Gopinath et al., 2013).

The Malaysian fisheries industry is almost entirely marine-based. Riverine and lake fisheries are carried out only to a limited extent, and even then, only by inland communities operating on a subsistence basis. The major knowledge gap is recreational fisheries. The activity operates in an entirely unlicensed and unmanaged environment. This notwithstanding, available information (MIER, 2000) suggests that recreational fisheries has become economically important in Malaysia. This has accompanied the socio-economic development of the country, which has seen its population becoming increasingly urbanized.

When the country became independent in 1957, there were only 33 towns (designated municipal areas). In 2000, this had increased to 140 (Tarmiji et al., 2012). In 1970, 26.9% of the country's population lived in urban areas. It is currently 70% and by 2020, this is expected to expand further to 77.26% (JPBD, 2015).

The shift from a rural to an urban population base has been accompanied by major changes in lifestyle and employment. Urban workers now need, and do, seek recreational avenues as a relief from the often high-pressured, fast paced lifestyle that is characteristic of urban living. Recreational fishing is among the most popular of these recreational pursuits because it enables the participant, particularly those who had a

rural background to commune with nature in a special and intimate way (Jones, 1995), providing respite from the urbanised background which most of its adherents come from. In addition, unlike other sports (such as golf), its entry costs can be relatively low, thus enabling a wide spectrum of the population to undertake the activity.

However, in Malaysia (as in much of the developing world), recreational fishing operates in an unlicensed environment and there are no hard figures to substantiate its current scale and rate of growth. In addition to absence of even basic data on the numbers undertaking the activity, a major shortcoming has been the absence of a standard methodology by management agencies can assess fishing effort, the core requirement for assessing the economic and environmental dimensions of the activity.

The issue of a clear definition become crucial to identify who is, and is not, a recreational fisher. In Malaysia, commercial and artisanal fishers are defined as those who fish at least 120 days in a year (Ministry of Agriculture, 2015b) and are licensed as such. Part-time fishers are unlicensed individuals who accompany licensed fishers and undertake the fishing with them. They may or may not be employed in other industries.

However, it is the outcome of their efforts that distinguish them from recreational fishers. Part-time fishers accompany the licensed fishers to derive supplementary income from fishing i.e. they share in the returns of the fishing effort.

Recreational fishers, on the other hand, fish for the experience of fishing. Deriving an income is not the objective of the recreational fisher, though he may derive some benefit from sale or consumption of surplus catch.

Complicating the situation is the fact that Malaysia (as is much of archipelagic South East Asia) is a fish consuming country. Annual per capita consumption of fish in Malaysia in 2016 amounted to 59/kg (FAO, 2009), as opposed to the global average in 2014 of 20kg (FAO, 2016). Fishers polled during this study indicated that the fish they caught were largely consumed, depending on the size. Undersized fish, and fish that could not be consumed, were often discarded, or used as bait, suggesting that there was a selection process in the disposal of the catch.

In the absence of a local definition of what a recreational fisher is, this thesis will adopt a slightly modified version of the NOAA definition cited above i.e. *Recreational fishing is a form of fishing where the **primary** reward is the challenge of finding and catching the fish rather than the financial value of the fish itself.*

In addition to bringing clarity to the issue of who is, and is not, a recreational fisher, the definition also left open the manner in which recreational fishing is carried out in Malaysia. Though the rod-and–line is the most popular gear used in the activity, others such as squid jigging (Noorul Shaiful Fitri et al., 2020; Jarina, 2015) and cast nets (Borneo Post, 2015) are also employed in Malaysia. The jigging of squid is a more recent development in Malaysian recreational fisheries. Though squid jigging has a been a traditional activity in many areas (particularly in the East Coast state of Terengganu in Peninsular Malaysia), its evolution into a recreational fishery (inclusive of an annual Squid Jigging Festival) has been of recent vintage (Noorul Shaiful Fitri et al., 2020). Regrettably, there is no data on the numbers participating and the economic accrual to the traditional communities involved.

For that matter, there is very little information on this history of recreational fishing in Malaysia and is probably indicative of the historical institutional emphasis on the matter. What information that exists suggest that recreational fishing had a dedicated following from the 1950s, both in marine and riverine environments. Tan et al. (1973) also described in detail the fishing rice field paddies before the advent of double cropping in rice fields of Krian. While the study was in a specific area, it suggests that was an important activity in the rice growing area in the country. No doubt, the fishing in rice fields was for primarily for personal consumption, the recreational aspect of the activity cannot be discounted.

Much of historical published information comes from the journal of the now defunct Malayan Angling Association (MAA). Though there is a now a Malaysian Angling Association (PeMM), it has no connection with the MAA. Notwithstanding that, however, there were 136 members of the MAA in 1953, pointing to a large number of enthusiasts involved. Many of the members at that time were expatriate planters and government servants.

However, the MAA became defunct in the early 1960s. The fisheries management emphasis of the Government has never taken into account recreational fisheries. Policy documents reviewed in this study (National Agrofood Policy 2011-2020 (Ministry of Agriculture and Agrobased Industry, 2016) focused entirely on sustainable commercial catch to ensure food security. The literature review indicated that while the development of recreational fishing in Malaysia was strongly advocated by a number of parties (Mohammad Zaidi and Azmi, 1991; Thalathiah, 1997), none of these had the kind of hard data to support the size and value of the industry that would justify development initiatives on its behalf.

1.3.2 Current Status

Correspondingly, here are no hard figures that can substantiate the current growth of the recreational fisheries in Malaysia. However, there is considerable anecdotal evidence that the growth of activity has paralleled development that have has been observed in many developed economies. The evidence comes in the form of proliferation of retail outlets dedicated to recreational fishing in even smaller towns, the establishment of fee pond operations throughout the country (**Figure 1-1**) and dedicated recreational fishing boat services in major coastal towns (**Figure 1-1**). Institutional support by the Fisheries Development Board with respect to the participation of coastal communities also points to a strong push towards marine recreational fishing.

However, there is very little published information on the structure of the local angling industry. The most comprehensive treatment again is provided by the study by the Malaysian Institute of Economic Research (MIER, 2000). The continued urbanization of the country since that time would have, in all likelihood, expanded this number. In contrast, the number of licensed commercial fishermen in the same year as the report was 90,000 (Department of Fisheries, 2002).

Figure 1-1: Major Fee Pond Cluster in Klang, Selangor

Figure 1-1: Informal Recreational Fishing Boat Base, Taman ABF, Bintulu

The MIER report had several major findings as described below.

Industry Structure

The report identified two major sub-sectors for the industry i.e. privately developed recreational fisheries facilities, the most prominent of examples of which were fee ponds, and recreational fisheries in public (common user) waters such as rivers, lakes and marine waters. Both of these sub-sectors support a plethora of associated activities primarily boat services, accommodation, restaurants and marine fish farms and secondarily, transportation and fish tackle manufacturers. The socio-economic dimensions of both these sub-sectors were identified as being different. The overall structure of the industry as described by the MIER study is provided in **Figure 1-2**.

Recreational Fisher Population

Though the current number of recreational fishers is unknown, MIER (2000) estimated that were about 2 million recreational fishers at that time. The figure was based on guesstimates provided by the PeMM and selected recreational fishing retail outlets. The continued urbanization of the country would have, in all likelihood, expanded this number.

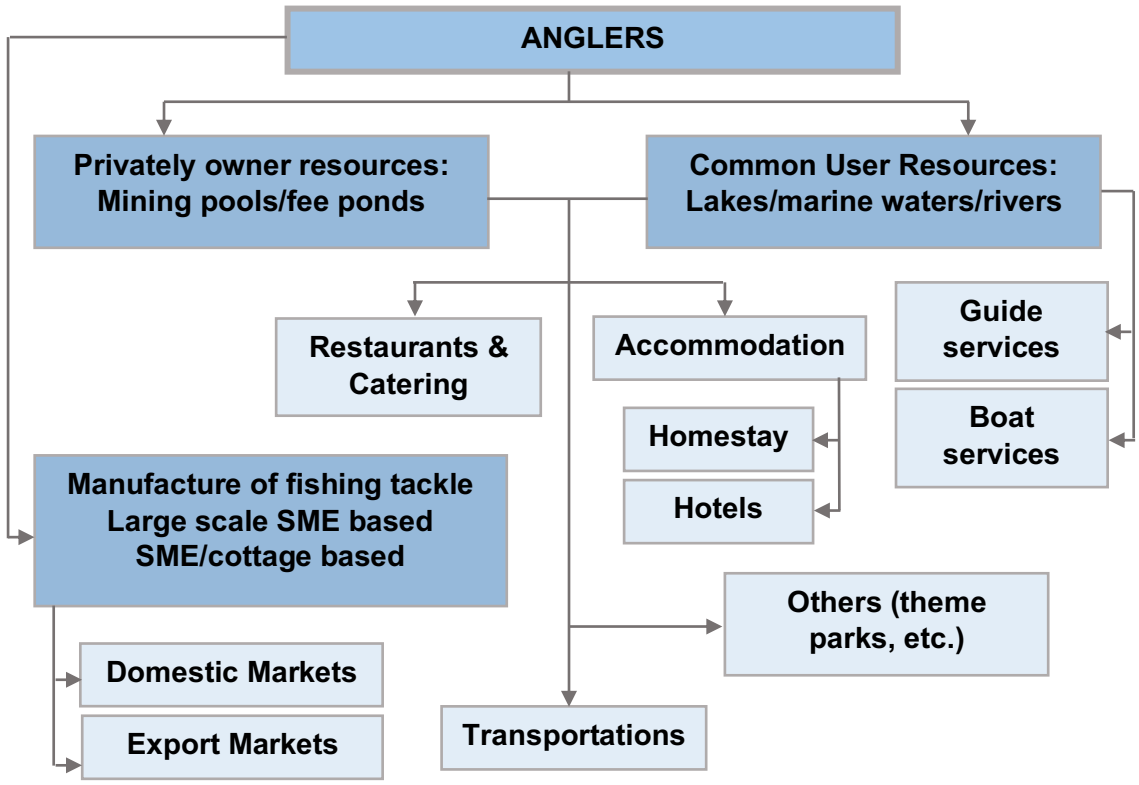

Figure 1-2: Structure of the Recreational Fisheries Industry in Malaysia *(Source: MIER, 2000)*

Growth Outlook

In addition, the urbanization of the country, there are several other factors that would support the growth of the industry. Malaysia has had a long-standing tradition of fishing, either commercially or for recreation. In the past, recreational fishing was undertaken from nearby ponds, rivers, swamps and rice fields in inland areas or from tidal lagoons or estuaries along the shoreline. Recreational fishing has thus strong traditional linkages and is part of the cultural backdrop of many Malaysians, particularly those who have rural or agrarian roots.

Another major factor that supports the continued growth of the angling and recreational fisheries industry is its egalitarian appeal. Entry into the activity is open ended and it can be undertaken in any water body that lends itself to the purpose. This puts it ahead green sports such of golf, which inevitably demands considerable investment in club membership or green fees. Equipment requirement for recreational fishing is also flexible, ranging from a basic rod and line that costs about RM20 to sophisticated deep sea trolling ensembles that can cost RM20,000 or more. These factors buttress a

strong and consistent support for recreational fishing by an increasing number of Malaysians. The development of recreational fishing in Malaysia along these lines has also been strongly reported by a number of other authorities (Mohammad Zaidi and Azmi, 1991; Gopinath and Ismail, 1991; Thalathiah, 1997).

The benefits of recreational fisheries, particularly marine recreational fisheries, does not accrue exclusively to its practitioners. There can be significant payoffs for those supporting the activity, such as baitworm collectors, boat operators and restaurants. Most of these enabling stakeholders who come from coastal fishing communities and have the skills and knowledge to play a major role in the activity.

The socio-economic importance of this also cannot be discounted. Malaysian fisheries stocks, both coastal as well as offshore, are significantly overfished (Gopinath and Puvanesuri, 2006). The impact of resource decline on the incomes of coastal fishers have been mitigated somewhat by rising prices (for instance, the average wholesale price of the widely consumed Indian Mackerel (*Rastrelliger kanagurta*) rose from RM2.40/kg in 1990 (Department of Fisheries, 1991) to RM9.90/kg in 2019 (Department of Fisheries, 2020), the future remains uncertain as consumers shift to chicken as an alternative. This is evidenced by the fact that chicken consumption per capita rose from 31.1kg in 2006 to 50.7kg in 2016 (Department of Veterinary Services, 2016).

In the face of this, recreational fisheries offers an alternative income source to coastal fishing communities, who by tradition and cultural predisposition, are averse to land based jobs. Evaluation of recreational fisheries that I undertook as part of the research for this thesis indicates recreation fisheries to have already been embedded as an important economic component in coastal communities in Penang and Lumut (along the West Coast of Peninsular Malaysia), Kuala Besut (East Coast of Peninsular Malaysia) and Miri (in Sarawak).

The impact of recreational fisheries on coastal communities is not limited to fishers or fishermen alone. Fee ponds (ponds on land that charge a fee for recreational fishing) require live fish to replenish their ponds. These are supplied by the marine cage aquaculture industry. Anecdotal information indicates that up to 70% of the marine fish farming cluster in Pulau Ketam (Klang), one of the largest in the country, is normally designated for the fee pond market (Chia Boon Teck, Manager, Sea Lion Fishing Park, Klang, pers.comm., 2017) The report also emphasised that the lack of awareness of economic value of the industry has continued to engender the current lack of public and private investment in the industry, and it has become more part of the informal sector than a mainstream industry, as should have otherwise been the case.

It is important to note that the absence of data and information is symptomatic of a larger issue i.e., that of poor regulatory and institutional support for the sector. This lack of information has stymied the ability of management authorities to adequately chart and the size of the industry (Mohammad Zaidi and Azmi, 1991; Gopinath and Ismail, 1991). This is because the focus of fisheries management authorities has historically been on commercial and artisanal fisheries and, given its socio-economic importance, understandably so. In addition, to the volume and value of landings, there were about 100,000 licensed fishermen in the country (Department of Fisheries, 2020).

1.3.3 Regulatory Environment

There are three primary legislative instruments governing the Malaysian fisheries industry as elaborated below.

Fisheries Act 1985 (Amended 1991) (Act 317)

This Act covers the management of marine commercial and artisanal fisheries for Peninsular Malaysia and Sarawak (Malaysian Borneo) and only in part in Sabah (another state in Malaysian Borneo). Though the Act defines fishing as the "…*catching, taking or killing of fish by any method…"* (Department of Fisheries, 2015b). However, it exempts all hook-and-lines with three hooks and less, direct collection and fishing using cast nets, effectively excluding recreational fisheries from its ambit. This seriously limits the ability of management agencies to monitor recreational fishing effort in terms of fishing effort, a crucial parameter in fisheries management.

At present, the only legislation specifically covering recreational fishing are the Marine Park Rules instituted under Part IX of the Act, which are limited to marine parks. The Department of Fisheries has drafted regulations for marine recreational fishing, but this has yet to be implemented. However, it does stand to reason that comprehensive licensing regulations would need to be put into place so as enable both service providers as well anglers to be enumerated. Such legislation would also prevent the use of unsustainable fishing methods, which have been instrumental in the decimation of some recreational fisheries (Khoo, 1991) and in setting bag limits and a code-of-conduct for anglers.

Institutional support for the industry is also largely absent. Until recently, the main management agency, the Federal Department of Fisheries, did not provide any support for recreational fisheries. This trend appears to have changed in the 1990s, but even now, it is sporadic and scanty (Gopinath *et al*, 2013).

There is no collection of data, for instance, on recreational fishing effort or value nor a clear action plan for the development of the industry. Current efforts are limited to a voluntary registration of marine anglers. The absence of a comprehensive database is probably one of the major factors behind the low level of investment in the industry. Investors would naturally be wary of putting in funds into an industry where there is so little official information on markets and output value.

Lembaga Kemajuan Ikan Malaysia (Malaysian Fisheries Development Board) (LKIM) Act 1971 (Act 49)

The LKIM Act provides the legal foundation for the establishment of Malaysian Fisheries Development Board (or LKIM). The LKIM Act does not define what "fisheries" is, but the objectives are for the promotion and development of the Malaysian fisheries industry, in particular, to " …*register, control and supervise Fishermen's Associations*" and to "..*to promote, stimulate, facilitate and undertake economic and social developments of Fishermen's Associations.*" (Ministry of Agriculture, 2015a).

"Fishermen" are also not defined under the Act, but are identified under the Fishermen's Association Act, 1971 (more below), which confines membership largely, but not exclusively, to commercial and artisanal fishermen. The LKIM has been more forward-looking with recreational fishing forming part of its community development efforts since the late 1980s. However, the emphasis on the Board's part has been more to promote fishermen participation in the industry than the development of the industry itself. There are no specific programmes, for instance, to promote investment in manufacturing or services. LKIM's development efforts, in this respect, comes in conflict with that the regulatory regime prescribed under the Fisheries Act, 1985, particularly where the use of fishing boats for recreational fishing is concerned.

Fishing boat licenses issued under the Fisheries Act, 1985 (Amended 1991) specifically stipulates that the boats are for commercial/artisanal fishing only and may not carry passengers. Passenger carrying vessels need to be licensed under the Merchant Shipping Ordinance, 1952 and must comply with Safety-At-Sea Standards (SOLAS) (Marine Department of Malaysia, 2007).

LKIM's approach has been aided by a significant degree of institutional fragmentation where recreational fisheries is concerned. While the Fisheries Act is supposedly a Federal Act, it has separate regulations for Sabah and Sarawak. Fisheries management in Sabah is entirely a State affair, but draws up its own rules under the Fisheries Act, 1985.

Similarly, recreational fisheries boating is governed by separate agencies in Peninsular Malaysia, Sabah and Sarawak, all of whom retain significant autonomy in local regulations. Coupled with the lack of enforcement, as well as an underappreciation of the socio-economic benefits of recreational fishing to coastal communities, the legality surrounding the use of fishing boats for recreational fishing is largely flouted.

Fishermen's Associations Act, 1971 (Act 44)

The Fishermen's Association Act 1971 (Ministry of Agriculture, 2015b) provides the legal basis for the establishment of Fishermen's Association. As with the LKIM Act, there is no definition for fishing except to indicate that "fishing" means "… *estuarine and marine fishing"* as per the Federal constitution. In this respect, the Fishermen's Association Act 1971 appears to rely on the definition provided in the Fisheries Act. The more important definition in the Act relates to the eligibility of the Association's membership. Though the term "fishermen" is not specifically defined, Section 11 (1) of the Act limits full membership to those who are:

- 18 years and above;
- Any person who is engaged in catching, harvesting or the culture of aquatic organisms for a minimum period of 120 days in a year.
- Any person who is a fish processor, handler or dealer;
- Any person who derives 60% or more of his total income from the fishery industry.

Outside of full membership, Section 11 (2) grants associate membership to those" ….*who conduct research or is engaged in the development and improvement of the fishing industry.."*

On both counts, it is clear that Section 11 is directed to artisanal and commercial fishermen i.e., those who derive an income from fisheries activities, either from capture, trading or processing. The framers of the legislation did not consider the potentials for recreational fisheries in the early 1970s when the legislation was passed. It is pertinent to note that, in implementing its recreational fisheries projects, LKIM used the Fishermen's Association as its vehicle. The confusing array of regulations relating to recreational fisheries in the country has meant that it has never been seriously reviewed and considered as part of the nation's fisheries sector. In this respect, the term "fishermen" has largely been used locally in relation to artisanal and commercial fishing and its use in relation to recreational fishing further confuses the issue.

Towards this end, this thesis will use the terms:

- *Fishermen* to describe commercial and artisanal fishing operatives i.e. those who seek livelihood from the commodity.
- *Fishers* to describe recreational fishing operatives i.e. those primarily undertake the activity for the experience. This term would also be appropriate from a gender perspective.

1.3.4 Economic Impact of Malaysian Recreational Fisheries

The economic value of recreational fishing in the country is also not clearly understood. Then absence of data on recreational fisheries as well as of a standardised method of quantifying its economic impact has meant that valuation of the industry has slipped under the radar. However, even basic assessments suggest that the economic value of recreational fisheries may be significant. The Malaysian Institute of Economic Research report (MIER, 2000) estimated that the activity involved 30 million-man-days annually with a direct value of RM1.5 billion. The report goes on point out that even this conservative estimate far exceeds the output value of aquaculture (RM608 million) and approaches the value of marine capture fisheries (RM4 billion) for the same year (2000).

There were also two case studies for rural sites engaged in recreational fisheries cited in the MIER report. These were at:

- Sg. Sekawang, Port Dickson, a fishing village located at the southern end of the district, which rented out boats for recreational fishing over the weekend. It was estimated that for every weekend about 50 people, mainly domestic tourists, are involved in recreational fishing activity. At the rental charge of RM10/person, this would have amounted to RM24,000 annually.
- Along the Muar river in the districts of Muar and Pagoh. The lower reaches of the river have long been favoured as a recreational fisheries destination. Data from a study conducted in 1998 as part of the Muar River Flood Rehabilitation Study (Drainage and Irrigation Department, 1997) indicated that that total output value of recreational fisheries along the Muar River alone amounts to RM4.8 million annually. The valuation was based on surveys encompassing a single sampling event in the two district and extrapolating the results over a year. Clearly this methodology was crude and did not capture variations due to holidays and weekends, where fishing effort would have varied considerably.

There is also no data on supporting activities such as retail trade for fish tackle and bait supply. The MIER (2000) report quotes a market assessment of USD1 billion for fishing tackle for the regional Singapore/Malaysia market by the European Fishing Tackle Trade Association. This comes in contrast with the FAO (2009) document that cites USD54 million for the Malaysian market alone. In addition to its direct economic values, recreational fisheries also have corollary impacts on artisanal/commercial fisheries and aquaculture.

Fee ponds, for instance, acquire their livestock from cage culture farms. The marine cage farms in Pulau Ketam, Klang, for instance, are estimated to consign up to 70% of the farmed stock to fee ponds (Cheah Boon Teck, Sea Lion Fishing Pond, Bagan Hailam, pers.comm., 2020). Shrimp farmers in Johor also reportedly farm the white shrimp, *Penaeus merguiensis* (**Figure 1-3**), for live bait, specifically for recreational fishers (K. Subramaniam, Department of Fisheries, pers.comm., 2019). Other than bait worms (**Figure 1-4**), most marine fishers purchase fish and shrimp harvested by artisanal/commercial fishermen (pers. observation).

1.3.5 Environmental Impact of Malaysian Recreational Fisheries

As pointed out earlier marine recreational harvests can be of the same magnitude as commercial harvests in many localities (Cooke and Cowx, 2004) making assessments standing stock based on commercial/artisanal fishing data totally inadequate.

In Malaysia, there are other environmental considerations that need to be taken into account. Preliminary observations and discussions indicate that while local marine anglers are generally opportunistic and will catch any marine fish of table size and value, the favoured catch of many marine anglers are larger members of estuarine and reef fish such as the sea bass (*Lates calcarifer*), groupers (mainly *Ephinephelus* sp.), wrasses (Labridae) and snappers (*Lutjanus* sp.). Many of these species exhibit sequential hermaphroditism (i.e. change sex after reaching a certain size), and are either protogynous (i.e. originally female then changing into males), such as the wrasses (Kawamura et al., 2002) or protoandrous (i.e. originally male then changing into females) like the sea bass (Barlow, 1981).

Figure 1-3: Live Shrimp Sold as Bait (Port Dickson)

Figure 1-4: Bait Worm Sold to Recreational Fishers (Port Dickson)

The capture of larger fish thus targets not just members of a different age cohort, but those that are also sexually differentiated. The continual removal of parent fish of these species means would have serious implications on resource health since it would have a direct impact on recruitment (Sadovy, 2005) and, as such, have been raised as a serious concern by conservation organisations such as WWF (The Sun, 2015). However, there is no data on the species or sizes of fish caught by Malaysian anglers.

There is also no data on other aspects of the environmental impact of recreational fisheries. For instance, the issue of ghost fishing from lost tackle in Malaysian waters has never been addressed. Lloret et al. (2014) estimated the impact of recreational tackle loss on wildlife in Costa Brava (Spain) and found lead sinkers, lure clips and other recreational fisheries paraphernalia, Though the paper does not specifically identify the impacts on this debris on the environment, clearly to discount it would not be tenable as could impacts of other activities such as shipping and industry.

However, the scope of these activities on the marine environment is beyond what is being attempted here. This thesis focused on understanding the structure of the industry and the to provide a platform by which management agencies can better understand the activity and its economic and environmental implications.

1.4 Challenges in the Management of Recreational Fisheries in Malaysia

The current situation, with respect to the data, monitoring, regulation, and institutional support that prevails where the Malaysian recreational fisheries industry is concerned, is totally inadequate to support any means of sustainable management of the activity. This comes in stark contrast to the levels observed in developed countries, where recreational fisheries is seen as part of the fisheries sector, and is extensively monitored as part of their fisheries management regimes. Even then, Pitcher and Hollingsworth (2002) pointed out that there are three complicated balance sheets for recreational fisheries i.e., benefits that are desired but poorly measured, ecology, which have only been recently recognised, and social impacts, which have rarely been considered at all. Kearney (2002) posited that these balance sheets needed to be taken as a whole for the industry. He reported that for developed nations 53% of the issues were in the ecological balance sheet, 30% of the economic balance sheet and 27% of the social balance sheet based on the available data. The absence of even basic data from developing countries means that such balance sheets cannot even begin the be drawn up.

As a consequence, Malaysia is unable to capitalise on what is probably a major economic opportunity with strong socio-economic dimensions, particularly where coastal communities are concerned. More important, the impacts of recreational fisheries on fish resources are ill understood and may be far more significant than currently assumed.

The general overall perception, at least among senior anglers, is that there is serious decline in resource quality (Simon Thesiara, Simpson Marine, pers.comm., 2016; Isa Samsuddin, fisherman, Marina Island, Lumut, pers.comm., 2016). These anecdotal reports dovetail with resource studies that have indicated that much of the Malaysian coastal waters are overfished (Gopinath and Puvanesuri, 2006), leaving many artisanal fishers with declining incomes and an uncertain future.

However, the continuing ability to assess total fishing effort (and the consequent pressure on fishing stocks) is stymied by the fact that only data from the commercial and artisanal fishing sector is being monitored. Though recreational fishing, undertaken on a sustainable basis, has the potential to offer alternative livelihoods to coastal communities, it is critical that at the same time, its impact on the resource be considered. In attempting to obtain an idea of the character and dynamics of the recreational fisheries in Malaysia, three major dimensions of the activity need to be investigated. Consistent with the approach advocated by Pitcher and Hollingsworth (2002), these concern the economic, social and environmental impact of the activity.

The *economic value* of the commercial and artisanal fisheries has traditionally been based on commodity value (Department of Fisheries, 2015). This is in tandem with approach of the Food and Agriculture Organisation's approach to the same activity (FAO, 2014). However, recreational fishing is a service industry, akin to tourism, where valuation needs to be based on a basket of tangible and intangible inputs. Much like tourism, the contents of that basket need to defined in specific terms before valuation can be carried out. Recreational fishing effort, for instance, is not just measured on standard parameters such as catch per unit effort (CPUE) alone but intangibles such as satisfaction and enjoyment. Thus, the models that are used in traditional fisheries modelling thus cannot apply where recreational fisheries are concerned.

The issue of economic modelling of recreational fisheries has been extensively discussed by a number of authorities (e.g. Parkkila et al., 2010; Anon., 2009; Sen et al., 2011). However, most of these models have been framed and applied in developed countries, where the behaviour of recreational fisheries and the economic stakeholders involved are regulated and thus easier to monitor. There is a need, therefore, for these

models to be re-examined in relation to unique character of recreational fisheries in Malaysia, and by extension, the rest of the region, which share the same industry character.

Where the *social impact* of the activity is concerned, recreational fishing management regime needs to understand the social and demographic profile of the industry's stakeholders, in particular, their divergent economic and educational backgrounds.

My preliminary observations at a number of recreational fish sites suggest that stakeholder communities are highly varied, with divergent interests and motivations. Recreational in developed countries fishers are generally far more open to conservation and management regimes (Granek et al., 2008) and involving them in stakeholder-based resource management would demand an understanding of their social character and the quantitative assessment of different demographics involved, without which up-scaling of any model developed for managing resources would not be relevant.

While there has been no profiling of recreational fishers in Malaysia, anecdotal information suggests that they are more educated and more aware of resource constraints than their commercial and artisanal counterparts (Ismail Feisol, Fmr. President of Malaysian Angling Association, pers.comm., 2015).

The *environmental impacts* of recreational fisheries, most particularly on existing fisheries resource health is an important issue to investigate as it determines the long-term sustainability and direction that management regimes will consequently have to take. The dimensions of the problem that would need to be considered would be volumes, species and sizes of fish that are taken, seasonality of catch and manner of the disposal. The issue is complicated by the kind of angler (for instance, fly fishermen generally practice catch-and-release, their primary pleasure coming from having outwitted the fish with their home-woven flies (Diyan Vimal, Fly Fisherman, pers.comm., 2016), the fish they are targeting and where they fish.

In summary, if a recreational fishery in Malaysia is to be managed on a sustainable basis, we need to address the following research questions aimed at understanding:

1. An understanding of what makes up the current recreational fishing effort. This would relate to the motivation for recreation fishing.
2. An assessment how best that fishing effort can be determined.

3. Its social and economic character and the degree to which the current spatial and temporal extent of the activity can be supported by both man-made and natural infrastructure.
4. What the environmental underpinnings of the activity in terms of fisheries habitats that support and influence the activity and its impact is on fish stocks and recruitment.
5. What are the more recent trends in fisheries resource health, whether deleterious or otherwise, as observed or perceived by recreational fishers.
6. Based on the previous questions what interventions are needed to ensure the sustainability of activity, how do communities currently benefit, or otherwise, from the activity and in what form and how are the various stakeholders in the industry affected by the more recent perceived changes in recreational fisheries resource health and can we make predictions on future changes based on environmental decline predictions

The impacts of an investigation in these issues have far ranging consequences. Economic valuation of the industry would provide the justification for public investment in management inputs, the environment understanding would enhance current resource management regimes while the social backdrop would provide the backdrop to how management is to be pursued. These impacts are not limited to Malaysia. The location of the country within a larger archipelagic region (Singapore, Indonesia, Philippines) means that these same issues apply to them as they do to Malaysia. Their resolution would thus go beyond local and national boundaries. The outcome of this study, therefore, can serve as a springboard for recreational fisheries assessment and management throughout the greater region.

In relation to the above, the objectives of the study are as follows:

1. To determine the physical character (locations/infrastructure/support services) of the marine boat-based recreational fisheries industry.
2. To profile the stakeholders in the industry particularly fishers and their service providers.
3. To estimate current boat-based recreational fishing effort in the district including landings (size, volume, species, etc.), and assess, together with commercial fish catch, its potential impact on fish stocks.
4. To describe and assess the presence of natural capital (particularly of coastal and offshore fisheries habitats) in the PDD's waters, especially those have an obvious linkage to boat-based recreational fisheries.

5. To characterise and quantify recreational fisheries in the district in terms of its economic and environmental impact and based on that, make recommendations on how far the activity can be developed and what kind of interventions need to be applied to ensure sustainability.

These objectives are further discussed and elaborated below.

CHAPTER 2: APPROACH AND METHODOLOGY - WHY, WHERE AND HOW

2.1 Introduction

This chapter explains how the study was approached in its implementation. It is important to understand the challenges faced by recreational fisheries industry in the country (and by extension, the region), as detailed in the closing section of **Chapter 1**. These challenges form the basis for the objectives of the study, covering a spectrum of interrelated outcomes that is the hallmark of a complex activity, one that grapples with social, economic and ecological issues. This chapter lays out the methodologies used to achieve the objectives of the study that follows.

First, the research objectives and their links to the research questions are described in detail. The study approach adopted in this study is then laid out, providing an overview of the landscape approach to the study of recreational fisheries and the justification for the primary metric for assessing recreational fisheries i.e. fishing effort. I also provided a preliminary assessment of the study site and its relevance to those metrics, though a more detailed description of the District's physical and marine resources that form the basis of its recreational fishing activity is provided in **Chapter 3** and **Chapter 4**. Also covered in detail are the specific methodologies used for each objective. Studies assessing recreational fishing (specifically in developed countries) have applied diverse methodologies. In this context, I have investigated these methodologies and discussed their applicability to the Malaysian (specifically Port Dickson) context.

Port Dickson is the name of the administrative district that my study covered as well as the name of its capital (Port Dickson town). It is pertinent to note that I have used abbreviations that distinguished between Port Dickson town (PD) and Port Dickson District (PDD). The geographical significance of the two terms is explained later in this thesis.

2.2 Research Objectives

Arising from the backdrop in Chapter 1, in which the research questions were identified, this section directs itself to the following objectives, using the PDD as a basis. To reiterate, these objectives are as follows:

I. To determine the physical character (locations/infrastructure/support services) of the marine boat-based recreational fisheries industry.

II. To profile the stakeholders in the industry particularly fishers and their service providers.

III. To estimate current boat-based recreational fishing effort in the district including landings (size, volume, species, etc.), and assess, together with commercial fish catch, its potential impact on fish stocks.

IV. To describe and assess the presence of natural capital (particularly of coastal and offshore fisheries habitats) in the PDD's waters, especially those have impacts and dependencies of the recreational fishing industry on Natural Capital.

V. To characterise and quantify recreational fisheries in the district in terms of its economic and environmental impact and based on that, make recommendations on how far the activity can be developed and what kind of interventions need to be applied to ensure sustainability.

These objectives attempt the resolve the elements of Research Questions raised at the end of **Chapter 1**.

Objectives I and II.

These focus on providing answers for research questions 1 and 2 and is provided in **Chapter 3 and Chapter 4**.

Objective III, IV and V

This attempts to address the challenges raised by research questions 3, 4 and 5. These are provided in **Chapters 3 and Chapter 4**.

Objective V

This is the concluding outcome of the study and its findings appear in **Chapter 5**.

These linkages are visually represented in (**Figure 2-1**).

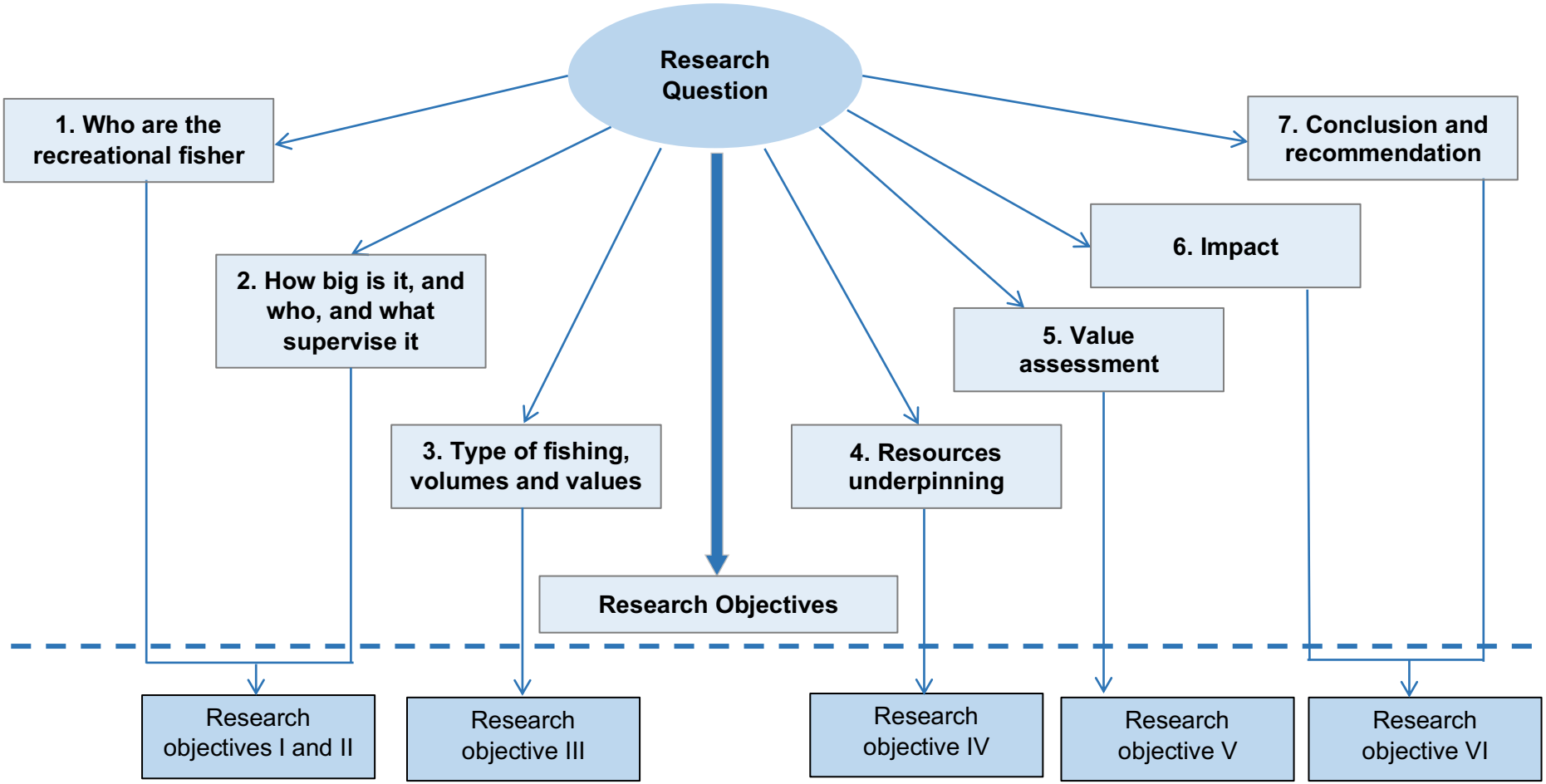

Figure 2-1: Visual Rendition of the Linkage Between Research Questions and Research Objectives

2.3 Study Approach

2.3.1 Overview

Any landscape is the result of a combination of both direct and indirect interactions between human and non-human entities which collectively produce and reproduce a specific set of arrangements. Likewise, recreational fishery in Port Dickson is a synthesis of human effort (fishers, polluters, bait sellers, boat owners etc.) and its non-human counterparts (fish, coral, geomorphology). It is impossible for this study to understand the complexity of these plethora of factors and the manner in which they interact to create a particular landscape but their individual contributions to recreational fisheries cannot be trivialized, especially when there is a habitat driven pattern to the species that recreational fisheries targets.

Therefore, we have chosen a mixed landscape method approach to looking at these different elements. The conceptual approach to this landscape model is as in **Figure 2-2**.

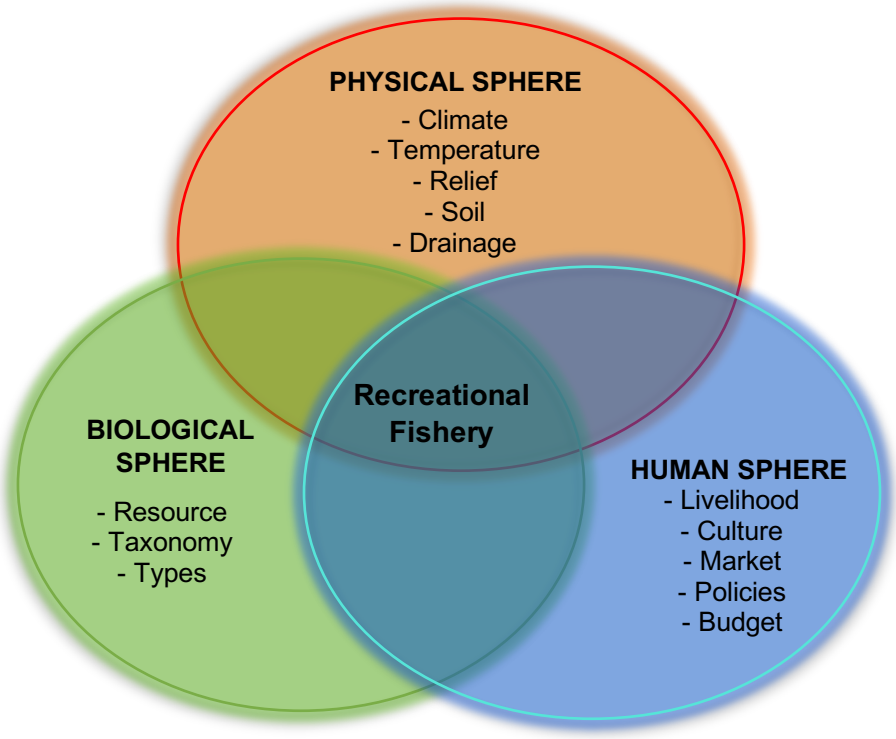

Figure 2-2: Landscapes as the Emergent Product of Interactions between Human and Non-Human Entities *(Source: Toledo, 1992)*

2.3.2 The Primary Metric: Fishing Effort

While the landscape model provides the overall perspective of the recreational fisheries scenario being investigated, the issue becomes one of identifying the kind of metrics that can best be used to describe it. The complexity of the proposed landscape is such that no single metric is likely to fully capture the full range of environmental, economic, environmental and social impacts of the recreational fishery. The tendency is to look at existing metrics used in commercial and artisanal fisheries. As a basic quantitative anchor for this study, fishing effort was identified as a useful starting point. In commercial and artisanal fisheries, fishing effort is measured by Catch Per Unit Effort (CPUE) which is a measure of the amount of fish that is caught in a given time span using a specific gear (Allen et al., 2020).

In short, CPUE is a relative measure of fisheries abundance, relative because its variables include gear type, fishing time and location. In relation to the commercial/artisanal fisheries, fishing effort forms the basis of a series of metrics aimed at evaluating commercial performance of a given fishery. It is a proxy unit that is used to represent the combination of inputs that go into the fishing activity, such as the number of hours or days spent fishing, type of gear and their character (numbers of hooks in long-line fishing, type and length of nets used, etc.). The complexity in calculating CPUE in commercial/artisanal fisheries comes from reconciling the rates with the different types of gear that are used (Maunder et al., 2006). For instance, fishing effort using a trawl net can be expressed as *n* kg/hour of a given trawl size and specification. For gill nets, CPUE can be expressed as catch per unit area of net (m^2) per hour for *x* mesh size. Notwithstanding its complexity, CPUE is a useful measure, when coupled with catch data, to calculate, economic returns to fishermen who are often gear specific, and by extension, to the rest of the industry (Jensen et al., 2011).

The issue of gear diversity does not apply significantly to recreational fisheries, since the rod and line is the mainstay in angling (though there are variations in peripheral issues such as the quality of rods, the reel mechanism and type of bait). However, the key failing of CPUE is the metric it represents. CPUE is a commodity-centric parameter and, therefore, has little relevance in recreational fishery where the output and benefit that relates to the fisher participation is not necessarily the size and commercial value of the catch. For instance, juvenile yellowfin tuna (*Thunnus albacares*) in Semporna (Sabah) waters are sought after by recreational fishers because of their fighting quality (Major (Retired) Ismail, Former President, Malaysian Angling Association, pers.comm., 2017) but not by artisanal or commercial fishermen since it has a low market value.

While recreational fish catch would potentially report a low CPUE in comparison to commercial fishing, it would still be significant given its poularity. Nevertheless, fishing effort in relation to recreational fishing relies on its capacity to provide us with a useful proxy which, at least partially, captures some information of relevance to the economic, environmental, and economic dimensions of the activity. Other metrics such as catch volume and financial outlay are shaped by it while some such as environmental impact are strongly implied by it. However, in order to be useful, fishing effort needs to be redefined in ways that reflect the reality of recreational fishery. Recreational fishers are not there to earn an income from their catch. They are there to enjoy the experience of catch and the environment in which that experience occurs. A fruitless recreational fishing expedition is still a valued recreational exercise if an emotional disappointment. Unlike for fishermen, it is not a financial loss.

A review of mathematical models to assess recreational fishing effort (Lackey, 1975; Raguragavan et al., 2010; Sen et al., 2011; Gao and Hailu, 2011) indicated that basic data on the number of fishers and the time they spent fishing was critical to their personal outcomes. Thus, the metrics of recreational fishing effort, for most part, would vary significantly from that of commercial and artisanal fishermen, who seek economic return for their activity. While the motivation of commercial fishermen is clear - to catch enough fish to pay for the cost of fishing and provide a reasonable net income for the effort, recreational fishers are different - they fish for the experience and are willing to pay for that experience. These factors make their motivation and, more importantly, the value they derive from the activity, difficult to quantify.

In that sense, there are parallels between recreational fishing and service industries such as tourism where the product can be intangible and multidimensional, and assessments of values must rely on proxies such as number of hours in the activity and the amount spend per unit time. However, while such basics for tourism have been worked out for Malaysia, it is much more difficult to establish in relation to the much less regulated (and understood) recreational fishery (Morales-Nin *et al*, 2015).

One way around this problem is to simply treat recreational fisheries as a subset of tourism (foreign or domestic) and developing estimates of its direct and indirect economic value. However, there are multiple reasons why such an approach is unsatisfactory. The first and most obvious of these is that we are unable to determine how recreational fisheries relates to tourism as a whole. A second problem was that such assessments still would not capture the particular and unique way in which recreational fishing reflexively interacts with the natural capital of a preferred angling site.

To reiterate, the methodology employed in this study needed to consider the fact that there was no licensing regime that could separate those who did and did not undertake recreational fishing. This was a major ally in recreational fishing assessments in developed nations (Myers and Worm, 2003; Allan et al*.,* 2005). In Malaysia, only commercial/artisanal fishermen are licensed, and management regimes are exclusively designed for their benefit (Gopinath and Puvanesuri, 2006). Where recreational fishing is concerned, it can operate without regulation or restriction. Thus, the boundaries of the recreational fisheries constituency are unknown.

However, in asking existing management agencies tasked with ensuring the socio-economic, sustainability and food security dimensions of the fisheries resource to take on recreational fisheries management, they legitimately ask - how big is recreational fishing as compared to commercial fishing? If it is a niche activity, then why bother? From a resource standpoint, what is the impact on existing fish stocks. If it is minimal, again, then why bother?

The answers to these questions in developing nations, which have traditionally been focussed on commercial fisheries for socio-political reasons, is largely unknown. The reason for this is the perception of fisheries managers has been to regard resource uptake by recreational fishers to be inconsequential as compared to artisanal/commercial fisheries. However, as pointed out by Lewin et al. (2006), while a single angler has a much lower impact on resources as compared to a fisherman operating a trawler, the cumulative impact of millions of anglers can be significant. When those numbers are not known, it induces a major uncertainty in resource assessments (Arlinghaus et al., 2005). The key to knowing how important recreational fisheries is, thus, the numbers indulging in the activity.

However, establishing this in the absence of a licensing regime means that any kind of assessment on a national basis, such as by MIER (2000), cannot be anything but a terribly coarse estimate of the recreational fishing population. It is pertinent to note that establishing numbers of anglers, even in developed countries, is dicey. Not all licensed recreational fishers fish regularly while there are also recreational fishers that do so incidentally and do not seek licensing. In federated nations such as Germany, United States and Australia, laws on recreational fishing can vary from state to state. Recreational fishing by indigenous communities (particularly in Australia) is also not subject to licensing.

Kearney (2002) pointed out the lack of detailing in Australian studies of recreational fisher populations, pointing out that these surveys cannot even pin down the percentage of Australians who fish, with official figures ranging from 30% to 4.8% depending on how the counting was done. A figure of 14% was cited to be the more accurate possibility but this,

too, was based on anecdotal information from enforcement authorities in the State of Victoria. Reid and Schneiker (2008) reported 20% nationally, with participation rates varying from 13% to 32%. The data covered both freshwater and marine recreational fishers.

Thunberg and Milon (2002) described two studies to ascertain recreational fisher numbers of North Eastern and South Eastern Atlantic states of the US. Similar data was collected in each survey, and both surveys used the same methodologies, yet differences in the sampling frame demanded different approaches to estimate angler participation. Steffens and Winkel (2002) similarly pointed out that 1.7 - 2.4% of the German population undertook recreational fishing. Exact numbers could not be established despite a licensing regime that demanded fishers undergo a training course before being licensed.

The primary means of data collection on recreational fisheries is a thorough survey of recreational fishers. This has been accomplished directly or through case studies (Steffens and Winkel, 2002; Lyons et al., 2002; Toivonen, 2002). Direct data collection was undertaken using standardised questionnaires and focused on recreational fishers themselves or their proxies, such as recreational fisheries boat operators. A large-scale survey method for evaluating recreational fisheries was by Lyle et al. (2002) using a predetermined profiling of the general population (or license list) to establish the recreational fishing populations, diary data collection by the fisher and follow up by phone by interviewers. A similar approach using phone interviews was undertaken by Herfaut et al. (2013) and Rocklin et al. (2014) in France. Like Malaysia, the activity there is not licensed, and the phone numbers were randomly selected from an existing database of landline and cell phone numbers appearing in the national telephone directory coupled with on-site surveys.

An examination of these methodologies in relation to this study indicate major challenges to their applications in local conditions. This is elaborated further in **Section 2.4.1**.

2.3.3 Study-Specific Approach Taken for The Study

In relation to this study, the focus was on two major components.

The first was to obtain background information on the activity as a whole in PDD, covering the various locations where recreational fisheries in PDD is carried out and their characteristics as well as the numbers of recreational fishers as per each recreational fishing point and their demographic, economic and ethnic composition and fishing practices. This first component was necessitated by the lack of published data on recreational fisheries locations and the absence of licensing data on PDD's recreational fisher population. This component is identified as Phase 1 of the study and is described later in this chapter.

The second component was to dovetail on those points that supported boat-based recreation fishing and collection of detailed data on the fishers who use them, including the time they spent at sea, the nature and volume of their catch catches, their financial outlay for undertaking the activity, their origin (within/outside PDD). This component is identified as Phase 2 of the study and is described later in this chapter.

A combination of qualitative and quantitative data was generated through a series of research instruments aimed at generating information from a range of stakeholders concerning recreational fishers in PDD. While in the case of some of these actors (bait and tackle shops for example), identification was relatively easy, in the case of others, in particular, the fishers themselves this was much more difficult, and collaborators had to be identified opportunistically. through direct interviews of those who undertook recreational fishing.

2.3.4 Study Site

The site of a study of this nature required to support a significant level and variety of recreation fisheries and the necessary habitats that could support the activity. PDD, fronting the Straits of Malacca (**Figure 2-3**) was chosen since it complied with these requirements, supporting a significant level of recreational fisheries as well as related habitat formation. These qualities of the site would be elaborated further in **Chapter 3.**

Figure 2-3: PDD, Fronting the Straits of Malacca *(Source: PlanMalaysia, 2018)*

2.3.5 Objective - Specific Methodological Approaches

The approach that was taken for the study related intrinsically to meeting the questions in highlighted in **Chapter 1** and the corresponding Research Objectives in **Section 2.2** above. The linkages between the objectives and the approaches taken to address them are described below and appeared in graphical form in **Figure 2-4**.

Study Approach as It Related to Research Objective I

Research Objective 1 reads as *"To determine the overall physical character (locations/infrastructure/support services) of the marine recreational fisheries industry in Port Dickson. as a whole, with a view of pinpointing centres of boat based recreational fishing activity".*

The approach undertaken in relation to this objective was to provide a background of recreational fisheries in Malaysia as a whole and to zoom into the Port Dickson study site to inventory all recreational fishing landing points, their proximity to urban enclaves within the District, the infrastructure that enabled recreational fishing as well as the socio-economic character of the recreational fishers that used them and the methodology employed to collect this data. Another aspect of this approach was to inventory the stakeholders (including fishers themselves) of recreational fisheries, such as baitworm and angling equipment retailers, including the location of these services.

Research Approach as It Related to Research Objective II

Research Objective II calls for the study "…*to zoom into boat-based fishing points, specifically to profile the stakeholders in the boat based recreational fisheries industry in terms of their ages and gender, estimate current boat-based recreational fishing effort in the district including landings (size, volume, species, etc.), estimate annual boat-based recreational fishing effort and financial values of the activity and assess the manner in the catch is disposed of*."

The approach taken to meet this objective was to gather detailed data on boat-based recreational fishing location in relation to their stakeholder, fishing effort, disposal of catch and other metrics and to estimate the boat-based recreational fishing effort as well as the volume of boat-based recreational fisheries catch on an annualised basis and compare it with commercial/artisanal fisheries collected by the Department of Fisheries. Also recorded was the manner in which the catch was disposed. The data and its analysis appear in **Chapter 4**.

Research Approach As it Relates to Research Objective III

Research Objective III that reads "… *to appreciate and understand the role of coastal and offshore fisheries habitats in the district's waters, especially those have an obvious linkage to recreational fisheries*".

The approach here was to establish, at least at a preliminary level, the kind of habitats that supported boat-based recreational fishing. This was because boat-based recreational fishing appeared concentrated in the southern side of the district, while static fishing seemed to prevail in the north and clearly the natural capital provided in the area would have underpinned the species that chose to aggregate there. The predisposition for boat-based recreational fishing in south Port Dickson cannot be coincidental and must be due to character of the marine habitats found there.

To test this hypothesis, the identification and description of representative coastal marine habitats that relate to these landings to points frequented by recreational fishers and their importance in sustaining relevant species targeted by them was explored. Where data on these habitats were not available, primary data collection was carried out (of representative habitats) to obtain details of their health and extent of habitats in the study area.

Research Approach As it Relates to Research Objective IV

It is given that current metrics of fishing effort and productivity based on traditional capture fisheries (such as CPUE) has no relevance to recreational fisheries. Thus, there is a need to develop a recreational fisheries-specific set of metrics that would better reflect fishing effort on a quantitative basis. An example of this would be the stratified time-based model of recreational fisheries effort developed by Gopinath et al. (2013), which effectively captured the heterogeneity of the socio-economic landscape.

The data obtained enabled the assessment of the financial value and importance of the boat based recreational fishing industry. Included in the discussion later in this thesis is the manner in which recreational fisheries can potentially offer a better value return for coastal fishing communities faced with declining catches.

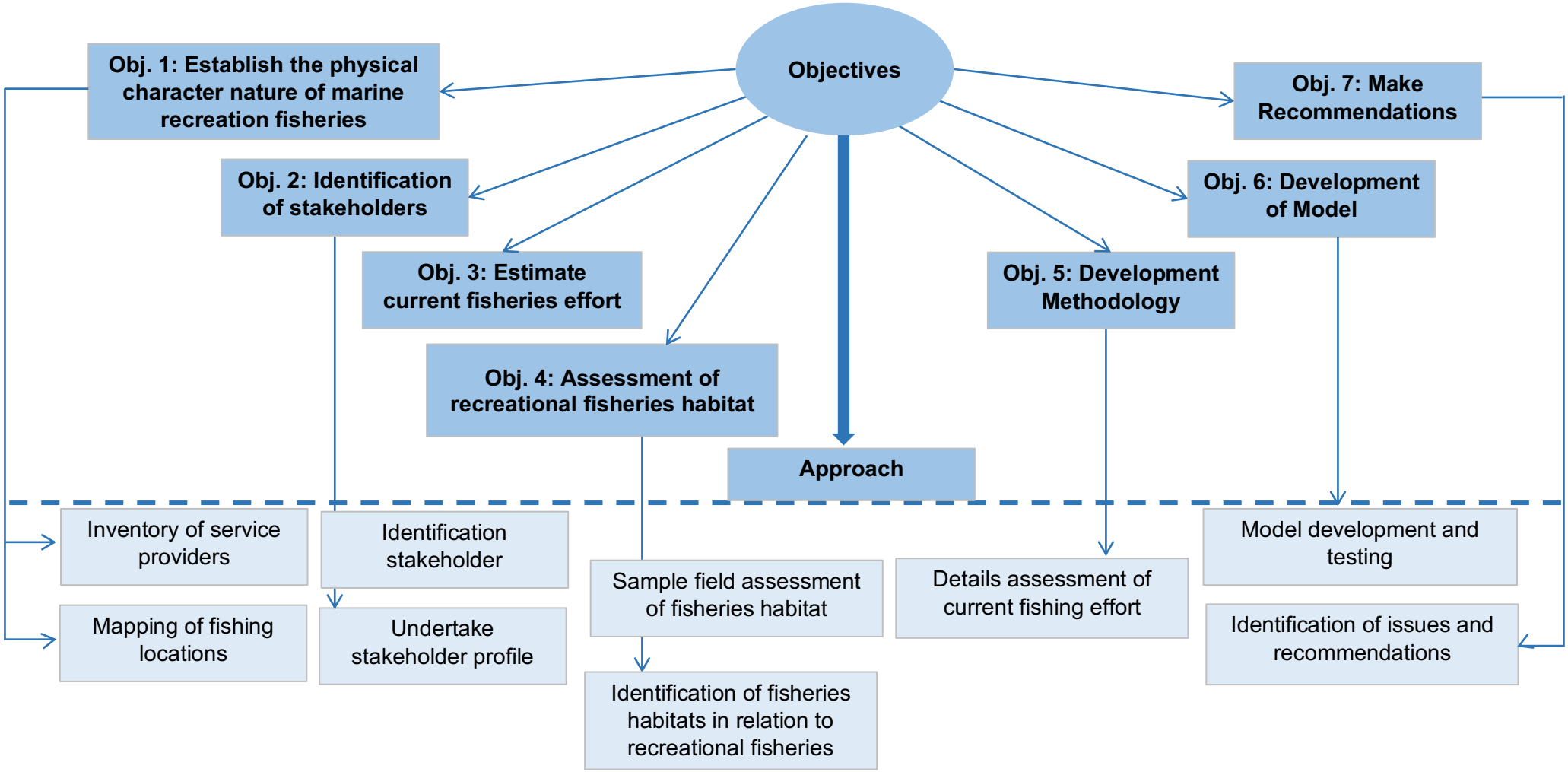

Figure 2-4: The Linkages Between the Objectives and the Approaches Taken

2.4 Methodologies Applied

2.4.1 Primary Data Collection

Where the survey methodology was concerned, the review in **Section 2.4** came down to two possibilities i.e. remote surveys such as by Rocklin et al. (2014) that employed phone interviews or direct interviews with recreational fishers *in-situ* on a semi-random basis. The application of the telephone survey method in this study was not deemed useful given the absence of any directory or list of recreational fishers and confidentiality issues related to phone number access. Besides the technical and legal constraints of such an approach, there is also a cultural unwillingness to share information with strangers in Malaysia with notable better results emerging from face-to-face contacts (Ong et al., 2011).

Given the nature of the subject and difficulty in identifying recreational fishery participants (unless they are actually in the process of fishing) meant that direct interviews administered opportunistically represented the only viable method for generating information and data concerning this group. Given these constraints the study chose to focus exclusively on fishers based in PDD. This was logical given the areas status as a recreational fishery destination, the mixture of habitats and species, fishing practices and the range of human activities found there. Furthermore, the area has been the site of several previous projects I had previously undertaken and thus I had the benefit of a degree of local knowledge concerning sites and local stakeholders. While the conditions in Port Dickson are by no means typical of the rest of Peninsular Malaysia, the lessons learn from Port Dickson can potentially provide an indication of the type of issues that emerge around recreational fisheries in many coastal areas.

The methods I employed drew on work in the United States (Gray et al., 2011) to establish the spatial characterization of marine recreational boating. However, even before even developing a questionnaire that could answer questions on boat-based fishing, basic questions on where recreational fishing takes place, their locational values (i.e. proximity to towns, access roads) and supporting services (such as bait supply) needed to be assessed.

This preliminary assessment (Phase 1) was critical to provide the basis for the development of the main questionnaire, which needed to take into account the main landing points which boat-based recreational fishers gravitated to, their reasons for doing so, their socio-economic background and the fish techniques that they employed.

The subsequent (Phase 2) questionnaire development (i.e. on boat based fishing) was based on this initial appraisal of the recreational fisheries in the study area, especially the manner in which the questions needed to be phrased to tease out the kind of data that was needed to meet the objectives of the study. The scope of the study needed to be multidisciplinary in the sense that data collection needed to encompass social, economic and natural resource issues at each landing point, much of which relied on interviews, often informal, with fishers or boat operators and culling information from their engagements.

The questionnaire (especially that of the Phase 2) was developed using an ethnographic approach based on Whitehead (2005). Ethnographic research is a qualitative method where researchers observe and/or interact with a study's participants in their real-life environment (Reeves et al., 2013). Ethnographic researchers often live with their target communities to obtain the data they require (Reeves et al., 2013). However, recreational fishers are a transient community and a residential approach would not work. A better approach was to create a questionnaire that had a non-structural element where fishers could speak their minds beyond the data platform that the questionnaires that would have otherwise represented.

This involved a design that sought a combination of both quantitative and qualitative information. This approach was thought to be most effective since most recreational fishermen do not themselves discuss their outcomes in quantitative parameters but in more subjective terms as related to their experiences. Including some quantitative data concerning the fisher's socio-economic and personal characteristics allowed us to explore the extent to which such attributes informed their practices. Quantitative data on catch and time spent fishing was also gathered to develop some metrics concerning the extent and impact of the recreational fishery.

Primary data collection was planned as series of sequential phases as described below. However, variations to the sequence had to take into account environmental and weather conditions. For instance, poor air quality caused by haze at the end of 2016 in the southern and central coastal zones in Peninsular Malaysia in the latter half of 2017 (Department of Environment, 2017) meant that most outdoor activities had to be curbed. Recreational fishers heeded Government health warnings to stay indoors and avoid any physical activity that could increase respiration rates.

The haze has been a long-standing problem and occurs annually (Awang et al., 2000; Jamal et al., 2014) though at different intensities. It is caused by slash-and-burn agriculture practices, particularly peat lands in the Indonesian island of Sumatra and in Kalimantan (Indonesian Borneo). The resultant smoke represents a major transboundary pollution event particularly in Malaysia, Singapore and Brunei (Yan et al., 2016). However, the impact on the air quality these countries vary according to its source of the smoke and its intensity. Peat forest fires in Kalimantan mainly affect the Malaysian Borneo states of Sabah and Sarawak. Peat fires in Sumatra can, and do, affect Peninsular Malaysia in terms of haze events, but even then, its intensity varies according to prevailing winds, receiving location and the source fires.

The haze in 2016 represented one of the worst experienced by Port Dickson and adjoining districts caused by peat fires in Sumatra (Department of Environment, 2017). Schools were closed and people advised to stay indoors. The experience, however, was not without its merits. Since air quality appeared to be a factor that affected the intensity of recreational fisheries activity, it was included in the questionnaire developed and administered in Phase 2. However, the haze events since then have been not been as intense.

As pointed out earlier, two phases of the primary data collection undertaken in the context of this thesis is as follows:

Phase 1

This was a baseline assessment of recreational fishing activity in Port Dickson. These involved ground surveys using a standardised questionnaire that was designed to elicit basic information from recreational fishers and other stakeholders. The questionnaires collected data on recreational fishing points, general socio-economic data of fishers that used them and locations of retail outlets for tackle and bait. The questionnaires we targeted were at recreational fishers, tackle shops and bait worm sellers. The questionnaires involved are in **Appendix 1** to **Appendix 3.** In addition, this phase also involved the identification and survey of fisheries habitats based on secondary data that were gravitated to by recreational fisheries and covered by published literature.

To assume that recreational fishers capriciously chose their angling locations was unreasonable. Sample sites (especially those to the shoreline) were thus investigated to affirm if there was a predisposition of recreational fisheries to target the locations that they did on the basis of their natural capital. The presence of these habitats was determined through the angler survey under Phase 1 of the study.

The main fisheries habitats involved were coral reefs and seagrass meadows, as well as mangroves, all of which of which are of major ecological significance to the marine environment and artificial fisheries habitats (or aggregating infrastructure) included shipwrecks.

Where mangroves are concerned, data on these were obtained from the Departments of Forestry in Negeri Sembilan and Melaka, while shipwreck data was obtained from the Marine Department in Port Dickson. The challenge was for natural, submerged fisheries habitats, particularly coral reefs and seagrass meadows. Two sample sites were chosen to indicate the kind submerged marine habitats that prevailed in the District's waters.

Where coral reefs were concerned, assessments were undertaken using SCUBA. A quadrat- based method (Bohsack and Bannerot, 1986) was used to assess the sessile benthic community, flora (seaweed) and fauna (reef fish and invertebrates) of the coral reefs and establish the diversity, density, and health status of reefs. The survey method employs a modified Line Intercept Transect (LIT), which involved the arrangement of quadrats in parallel rows (English et al., 1994).

Where seagrass meadows were concerned, assessments were based on the method described by McKenzie et al. (2007) with minor modifications. The methodology called for the use of quadrats and description of speciation and density within each quadrat. The detailed methodologies for both undertaken for the coral reef and sea grass assessments are as in **Appendix 4** and **Appendix 5.**

Phase 2

The Phase 2 study was a much more comprehensive assessment of boat based recreational fishing sites based on the demographics identified in Phase 1. It involved development of a questionnaire that could capture the scope of the data that this thesis rests. The questionnaires (**Appendix 6** to **Appendix 7**) focused on the spatial and temporal basis of the profile of fishers at each landing point by considering: numbers, gender, ethnicity, income cohort, age cohort and origin (from/outside Port Dickson); recreational fisheries catch (species, sizes) by fish landing point, gear type, frequency of catch, disposal of catch (self-consumption, etc), value of catch based on prevailing market prices, direct expenditure, fishing gear used including numbers, type and estimated value.

The questionnaire took into account the following major issues arising from Phase 1 of the study into account:

Behaviour of Boat-based Recreational Fishing Populations

This was based on the work undertaken by Gopinath et al. (2013) on a preliminary assessment of the behavior of anglers in Port Dickson. The model that was developed to estimate fishing effort is in **Appendix 8**.

Timing

While there is strong predisposition for boat-based fishing to be undertaken during weekends, there was also the influence of public holidays (Malaysia has 12 Federal public holidays and up to 3 State holidays that were confined to individual states) and school holidays in both Malaysia and Singapore (There is a significant Malaysian diaspora in Singapore who return to Malaysia when opportunity presents itself). However, data on the visitor numbers from Singapore to Port Dickson was not available for this study.

School holidays are relevant because many urban families take their children to their village homes to be with their grandparents, while the male adults often go out fishing (Ayahuddiin, recreational boat operator Kg. Sekawang, pers.comm., May 2016). The questionnaires developed took this diversity of recreational fishing habits into account. The interviews were carried out on a randomised basis based on at least 20% of those at each recreational fishing point based on the time schedule provided in **Table 2-1.**

Table 2-1: Sampling Dates for the Boat Based Landing Points

Weekday Type	Regular	Public Holidays	School Holidays	Comment
Weekdays	-	-	15/09/2016	Thursday
	28/09/2016	-	-	Wednesday
	03/11/2016	-	-	Thursday
	16/11/2016	-	-	Wednesday
	-	12/12/2016	-	Maulidur Rasul
	-	-	21/12/2016	Wednesday
	17/01/2017	-	-	Tuesday
	23/02/2017	-	-	Thursday
	14/03/2017	-	-	Tuesday
	-	-	23/03/2017	Thursday
	18/04/2017	-	-	Tuesday
	-	01/05/2017	-	Labour Day
	17/05/2017	-	-	Wednesday
	20/06/2017	-	-	Tuesday
	19/07/2017	-	-	Wednesday
	03/08/2017	-	-	Thursday
	14/08/2017	-	-	Monday
Weekends	-	-	10/09/2016	Saturday
	22/10/2016	-	-	Saturday
	19/11/2016	-	-	Saturday
	-	-	03/12/2016	Saturday
	-	-	31/12/2016	Saturday
	07/01/2017	-	-	Saturday
	04/02/2017	-	-	Saturday
	08/04/2017	-	-	Saturday
	-	-	11/06/2017	Sunday
	08/07/2017	-	-	Saturday

Implementation of the Questionnaires

While the questionnaires had been prepared, the survey was undertaken on an informal, conversational basis, teasing out information casually rather than being interrogative in nature. More representative of a casual discussion, data was gleaned from groups of fishing gear retailers, boat operators and fishers that would come together to discuss their fishing experiences, among other things. Such discussions thus took much longer than the questionnaire would otherwise suggest.

Interviews for both Phase 1 and 2 were undertaken during daytime hours, particularly in the morning (0700 –1200), when fishers left for fishing trips, evening (1600 -1900) when they returned from day trips and in the forenoon (from 1000 -1200), when they returned from overnight trips. The exact timing would depend on the prevailing tides.

The Phase 2 survey involved collection over an entire calendar year from September 2016 to August 2017 at the 5 landing points identified above. The survey data for each site was obtained from the fishers surveyed, boat operators, heads of the Local Fishermen's Unit (which, in turn, were components of the District Fishermen's Association) and the Department of Fisheries, Port Dickson District and analysed initially by day type.

The need for these multiple data sources was underscored by the fragmented manner in which fisheries management is carried out in the country. As pointed out in Chapter 1, there is no definition for a fisherman under the law. The Fisheries Act (1985) does not cover recreational fishermen. Only those employing hook-and-lines with three hooks per line or more qualify for licensing. Under the same law, all full-time fishermen needed to be licensed. However, the identification of who is, and who is not, a full - time fisherman is left to the discretion of the local officer from the Department of Fisheries. On the other hand, the *Persatuan Nelayan Kawasan* (Area Fishermen' Association), which is organised on a district basis, but has local component units based at each landing point, does make recommendations on who qualifies, though the Department of Fisheries officer retains the right of refusal where licensing is concerned.

Under these circumstances, there are a significant number of individuals who identify themselves as fishermen but who are not licensed for one reason or another. Estimates from the Department of Fisheries (Effendi Abd. Aziz, District Fisheries Head, Port Dickson, pers.comm., 15th August 2019) puts the number at five times the number of licensed fishermen.

While, strictly speaking, they are illegal, there seems little appetite from Department of Fisheries to enforce rules relating to their presence. However, not being part of the formal (licensed) fishing community, their catch is not recorded. Official data on fisheries is only collected from licensed fishermen and undertaken by the Department of Fisheries and estimated based on a district-wide sampling frame (Effendi Abd. Aziz, District Fisheries Head, Port Dickson, pers.comm., 15th August 2019). Data on licensed fishing landings at individual landing points are not recorded.

This is a serious omission where assessment of fishing effort and other catch statistics are concerned.

The data cited in this thesis is from my surveys of the various landing points, included discussions with fishermen and with their respective unit heads, in addition to recreational fishers themselves. Recreational fisheries data collection is not carried out by any agency. Boats that charge for carrying passengers come under the Merchant Shipping Ordinance (Marine Department of Malaysia, 2007) and needed to be licensed as such. However, there are no licensing stipulations for individually owned yachts and recreational vessels below 500 DWT (deadweight tonnes). Fishing boats are, by law, not allowed to carry passengers since compliance with SOLAS (Safety of Life at Sea) and other safety conventions are limited. However, the rule is widely flouted. It is important to note that illegal fishermen also rent out their boats for recreational fishing. It needs to be pointed out that there were no official records I could refer to for verification. However, the discussions with recreational fishers and artisanal fishermen (and their institutional stakeholders) enabled cross-verification of the data.

Weather

This was the visual assessment of weather at the site at the time of sampling. The weather at one site was not necessarily the weather at another site. It also does not imply that that the same weather prevailed in the fishing grounds. However, the weather at the various sites did impede, or otherwise, the loading of the boats at the onset of each angling trip.

Tides

Port Dickson has a diurnal tide pattern, as much of Peninsular Malaysia. Detailed tide data for the district on the respective survey dates was obtained from *tides.mobilegraphics.com*.

2.4.2 Secondary Data Collection

This work involved a review of the available peer-reviewed literature, conference papers and unpublished reprints of grey literature on the nature and impact of recreational fishing in developed countries as well as Malaysia to draw lessons from them on the kind of data that needs to be collected, the manner in which they should be analysed and modelled and how these relate to the kind of resource management regimes that may were/needed to be pursued. This review was informed **Chapter 1** and in this chapter.

The on-going literature review also covered artisanal fisheries landing statistics for Port Dickson district by species and month from the Department of Fisheries, recreational fishing boat rentals arranged by the Area Fishermen's Association and private operators and data on fisheries habitats (specifically mangroves, sea grasses and coral reefs) locations and health.

Secondary data collection began with a review of journal literature as well as conference proceedings, particularly the manner in which developed countries have assessed and managed the industry, including the environmental and resource challenges they have faced. However, as a consequence of the lack of information on recreational fisheries locally meant that anecdotal and unpublished information needed to be gleaned from fisheries management institutions (such as Department of Fisheries- Port Dickson office and its headquarters in Putrajaya; Fisheries Research Institute -from its centres in Penang, Terengganu and Lumut; Fisheries Development Board (LKIM) and the Area Fishermen's Association (PNK) for Port Dickson and Teluk Kemang). Most of the secondary data from these management institutions were scanty from a quantitative point of view. However, the personnel in the offices were forthcoming in terms of their perceptions or observations and, where relevant, were incorporated in this report.

Other environmental data such as the marine water quality of the District's waters was obtained from the Department of Environment, while the geomorphology of its coastline was obtained from National Hydrological Institute of Malaysia (NAHRIM). It is pertinent to note that, given the highly fragmented nature of environmental governance in Malaysia, even this basic data was not available at a single source and necessitated discussions with the numerous agencies at various locations. Even surprising was the lack of historical data on Port Dickson in either the Negeri Sembilan State Museum or the Armed Forces Museum in Port Dickson.

More useful data was anecdotal information from NGOs, particularly the Malaysian Nature Society, the Worldwide Fund for Nature and the Malaysian Angling Association (PeMM), who helped substantiate our findings in this this thesis. The private sector represented by angling shops and baitworm collectors were also major contributors of Port Dickson-centric information. Other data came from recreational fisheries magazines (Shanghai) and individual fishermen. The secondary data sources for the study are described graphically in **Figure 2-5**.

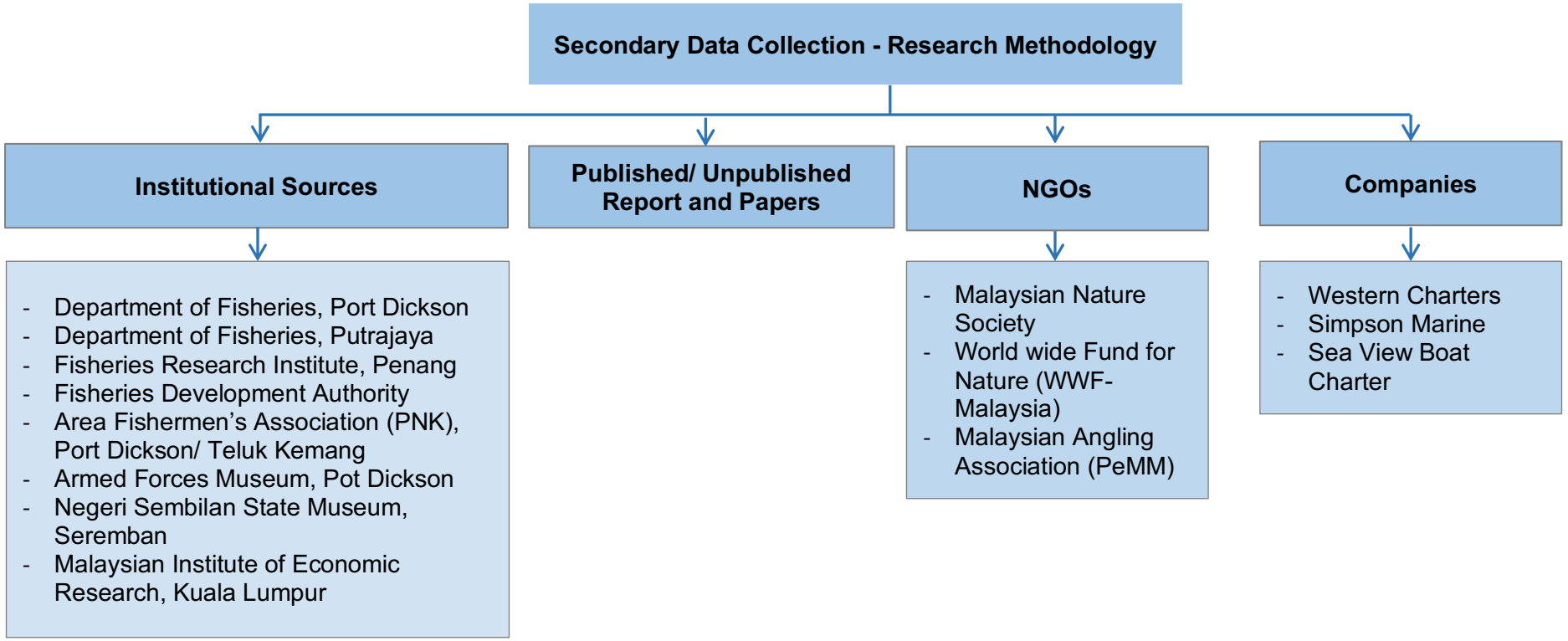

Figure 2-5: Sources of Secondary Data Collection

2.4.3 Data Analysis

Financial Impact

Quantitative data from the interviews/questionnaires was used to establish the outlay of boat based recreational fishers in pursuit of their activity, particularly of boat hire, bait purchases and transport. The figures do not amount to being a comprehensive estimate of economic accrual to the local economy but was designed to provide a perspective of its financial value and how its broader economic value could be assessed. The data was extrapolated from the sampling data for the number of similar day types over the 2016-2017 period.

Environmental Impact

The data gleaned from the interviews provided insights into the species that are targeted by recreational fishers, their sizes (and by extension their age) and the locations where they were found. This data also indicated the approximate volumes of fish caught by recreational fishers. This, in itself, made it possible to establish the recreational fishing pressure on the existing standing stock and its relative contribution to the overall population dynamics of commercial fish populations in Port Dickson's waters.

Data on changes in catch that had occurred over the last 5 years was also captured, as this is significant as an indicator of stock health. The predisposition of recreational fishers to certain areas points to the potential for sensitive fisheries habitats to be located in or within reasonable proximity of these areas. The habitat assessments confirmed their presence, and potentially provide an economic justification for their conservation.

The research methodology and the manner it links with the research approach is provided graphically in (**Figure 2-6**)

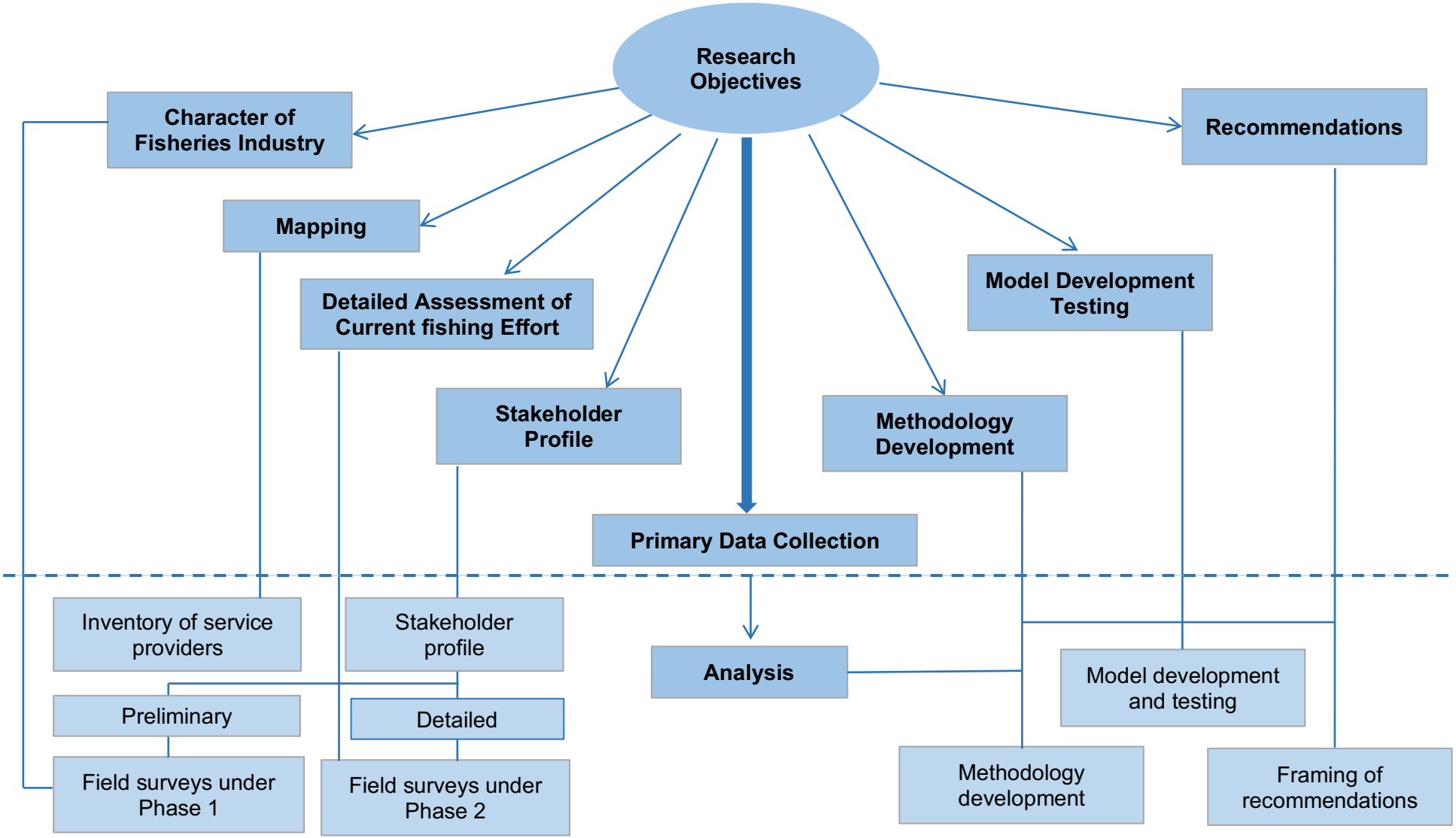

Figure 2-6: Linkage Between Research Approach and Research Methodology for Primary Data Collection

Statistical Modelling

Univariate data analysis was used to assess differences across recreational fisheries locations in PDD and differences across boat-based recreational fishing locations. Fishing effort was a core parameter for the latter.

In this, the model developed by Gopinath et al. (2013) (**Appendix 8**) was used as a basis for calculating fishing effort. Comparisons across groups were based on means, medians, bar plots and boxplots. Tests across two groups were based on the Mann-Whitney U Test, while tests across more than two groups were based on the Kruskal-Wallis Statistic, with post-hoc tests based on Dunn's Test (McDonald, 2014). The data were summarised using Microsoft Excel (Excel version 16.43) and statistical analysis carried out in R (R Core Team, 2020).

2.5 Conclusion

In this chapter, we have discussed the diverse methods used to get information that answers the research objectives. The methodologies enable baseline assessment if recreational fisheries sites (boat-based and non-boat based) in PDD, enabled some assessment of sites frequented by recreational fishers and identified the appropriate unit of fishing effort as the primary metric in the assessment of recreational fisheries. It is important to note that the study does not attempt to identify a national recreational fishing population or participation rate. Instead, the focus on PDD is expected to serve as a template for recreational fisheries assessment elsewhere. The study also does not attempt a detailed economic evaluation of the industry. Such a study would demand data collection and analysis well beyond the scope of this thesis.

In summary, we need to understand: Who are recreational fishers and why they are doing it? Why do boat-based fishers fish where they do? What is the social, economic, and environmental dimensions of the activity? The next chapter takes a first step in that direction by describing the study site and its economic and natural capital, and subsequently, how they synthesize in the recreational fisheries.

CHAPTER 3: KNOWN NATURAL AND ECONOMIC CAPITAL OF PORT DICKSON – A LITERATURE REVIEW

3.1 Introduction

Drawing from the previous **Chapter 2** that identified Port Dickson as a study site, this chapter looks the at the factors which have shaped the character of the marine environment in the District. I identify some of the human and natural processes and objects that underlie the recreational fisheries industry. These contribute to the assemblage of natural and human entities that have been arranged around the recreational fisheries in the area. They also contribute to the manner in which the industry relates to its marine resources and the activities that depend on it.

The discussion underscores the choice of Port Dickson as the study site, given its environmental and economic character, the latter being the fact that it is a major domestic destination for marine tourism, particularly recreational fishing (Gopinath et al., 2013). The study area covers both the District of Port Dickson (PDD) broadly, and its capital city, Port Dickson town (PD), specifically.

The many biological and human aspects of PDD's coast have resulted in a diverse range of habitats which have, in large part, been shaped by the interactions between living and non-living factors, and human and natural interventions and processes. The areas of ecological habitats and their attendant biodiversity have shaped patterns of recreational fishing in PDD, as the fishers respond to the presence of habitats that support different target species.

This chapter elaborates on the multidimensional forces that underpin the development of recreational fisheries in its many facets. Crucially, it explores PDD's natural capital that is known, and the spatial and social organization of its recreational fishing practices. The discussion covers location and administrative boundaries, shoreline, geology, geomorphology, oceanography, coastal forestry, marine biodiversity, land use and economy and the fisheries industry. The information in this chapter is based entirely on secondary sources, though some are not in public domain.

3.2 Location and Administrative Boundaries

PDD is the only coastal district in the state of Negeri Sembilan. It comprises a land area of 572.63 km² and a high tide coastline length of 60km. It is located about 80km south of the Klang Valley and just 35km west of Seremban, the state capital of Negeri Sembilan, as well its adjoining suburbs. It is also about 25km south of the Kuala Lumpur International Airport.

The state of Negeri Sembilan (and a consequence, PDD's boundary) abuts Selangor state in the north and the state of Melaka in the south (**Figure 3-1**). A more detailed profile of the District's coastal geography is provided in **Figure 3-2.**

The Malaysian federal system allots each state absolute suzerainty over land, water and seabed resources up to 3 nautical miles from the lowest water line. Though terrestrial boundary lines have been officially demarcated by rivers (with the Sepang River (Sg. Sepang) being the boundary with Selangor in the north and Linggi River (Sg. Linggi) in the south) the state's marine boundaries are yet to be officially surveyed and so designated. However, a map of its waters based on 3 nautical-mile delineation is provided in **Figure 3-3.** Though not officially demarcated by the State Government, a similar map is used by the Federal Department of Fisheries as a basis for setting the boundaries of its management zones (Siti Rabiatul Adawiyyah Haron, Fisheries District Head, Department of Fisheries, Port Dickson, pers.comm., 2017). Based on this delineation, the marine waters off the district amounts to 2,091km². Port Dickson's coast is only about 40km from the designated international shipping lanes (officially called Traffic Separation Lanes) of the Straits of Malacca and about 80km from the Indonesian island of Sumatra. The western edge of the shipping lane acts as a *de facto* boundary between Malaysia and Indonesia and the waters east of them fall under Malaysian jurisdiction. The lanes themselves are not part of either Malaysia or Indonesia, though shipping traffic is managed by Malaysia.

The shipping lanes are of major importance to the marine environment of Port Dickson. The Straits of Malacca is one of the busiest shipping lanes in the world. In 2007, more than 80,000 ships traversed the Straits of Malacca (Mohd Rusli, 2020), many of them oil tankers, thus exposing Port Dickson's waters to transboundary environmental influences including ballast water discharge and oil slicks (Gopinath et al., 2013).

Figure 3-1: Location of Negeri Sembilan in Relation to Surrounding Urban Areas

(Source: PLANMalaysia, 2018)

Figure 3-2: Map Detailing the Coastal Profile of Port Dickson *(Source: National Hydrological Research Institute (NAHRIM), 2008 - modified from Google Earth).*

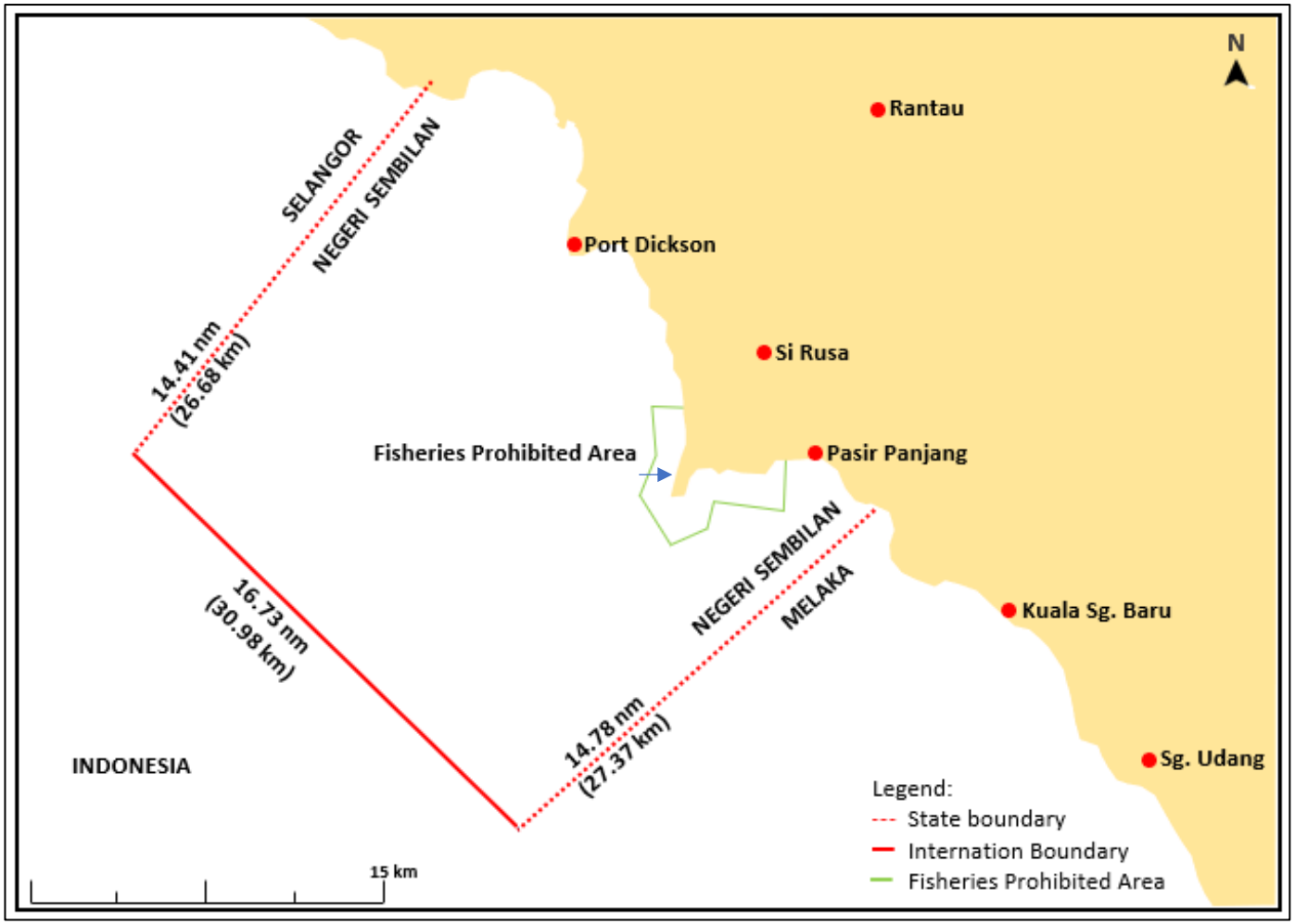

Figure 3-3: Port Dickson's Marine Estate *(Source: Based on information from Port Dickson District Department of Fisheries, 2019 – unpublished)*

Solid Red line: Negeri Sembilan state marine waters based on 3 nautical mile limit of State jurisdiction
Dotted Red line: Boundary with adjoining state marine waters
Green line: Fisheries Prohibited Area (No-take zone limited to licensed fishermen)

3.3 Coastal Zones

The Port Dickon ISMP (NAHRIM, 2008) provides an overview of the geology and geomorphology of PDD. Other publications are more focused on specific stretches of the coastline. For instance, there has been some work on the beaches of Port Dickson (Ayob, 1970; Sharifah, 1984; Eyles, 1970). However, there is little clear information concerning the interrelations between the factors such as geomorphology, oceanography, biodiversity and human activity and specific fishing activities. Nonetheless, such issues are central to understanding patterns of human activity linked to the exploitation of living marine resources.

One of the key factors in the relationship between the district's geomorphology, oceanography and ultimately the distribution of fish habitats and fisheries activities lies in the presence of two significant headlands and the shoreline in between the Port Dickson headland in the north and Cape Rachado (Tanjung Tuan) in the south. The Port Dickson headland, being the most prominent, juts out into the sea in a south-west to north-east direction for about 1.7 km. The north-south width of the headland is also about 1.7 km at its broadest point. It is at this headland that the Port Dickson town centre is situated (**Figure 3-4**). Cape Rachado (Tanjung Tuan) in the south extends out to sea for nearly 1.6 km in a north-east to south-west direction. Its north-south width is nearly 1.1 km at its broadest point, but only 0.4 km at its narrowest. Cape Rachado is a hilly, forested headland with its highest peak 74 m above sea-level (**Figure 3-5**). The oceanographic impact of these headlands includes significant influence on wave refraction and inshore currents (**Figure 3-6**).

The diverse geomorphological features of the coastline has contributed to a complex coastline which includes several distinct biophysical zones. Moving from north to the south of the District, the following apparent delineation takes place.

i. From the northern boundary of the District till the Port District headland, the shoreline is characterized by mangrove habitats and mudflats extending seaward almost 1 km or more during low tide (**Figure 3-7**).

ii. South of the Port Dickson headland and up to the Tanjung Tuan headland, sandy beaches and sandflats occupy a large section of the coastline in an almost continuous strip, interrupted only by short rocky stretches (**Figure 3-8**). In contrast, with the northern section of PDD, the shoreline extends out as sand flats, rather than mudflats at low tide, extending as much as 1.5km during spring lows.

Figure 3-4: Perspective View of the PD Headland *(Source: NAHRIM, 2008)*

Figure 3-5: Perspective View of the Cape Rachado (Tanjung Tuan) Headland

(Source: NAHRIM, 2008)

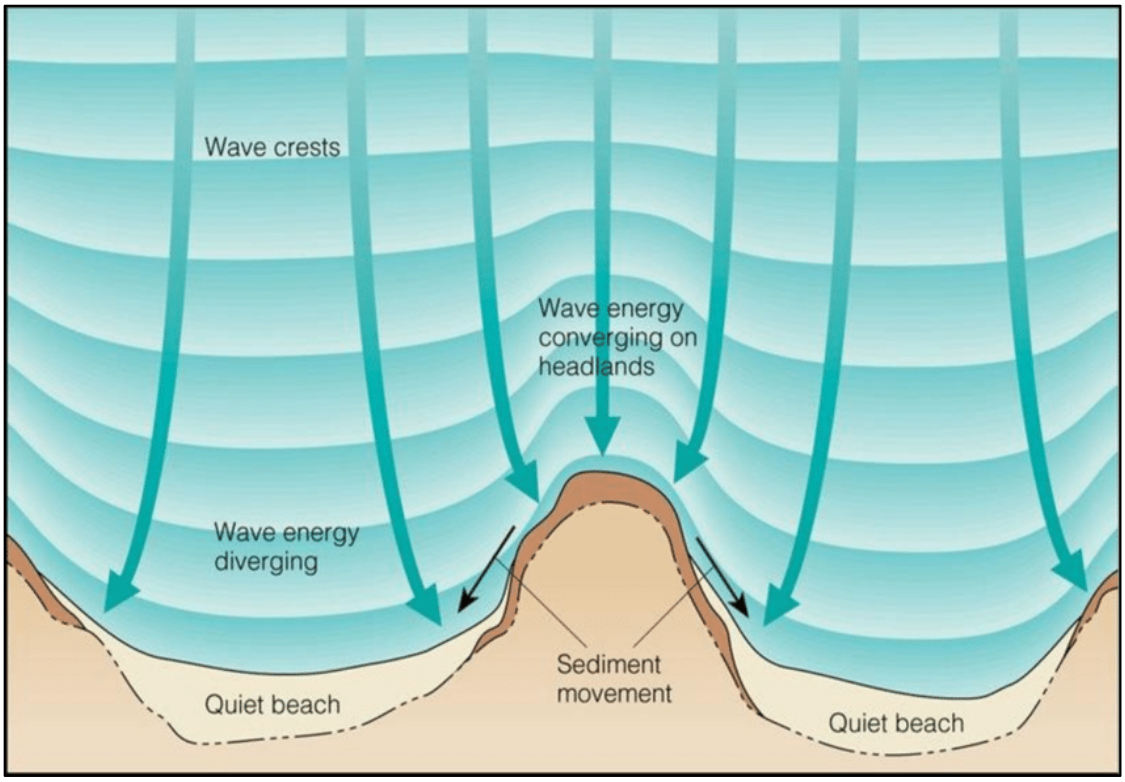

Figure 3-6: Wave Refraction focusing Wave Energy on the Headlands and Dissipating Energy on Sandy Beaches *(Source: Garrison, 2005)*

Figure 3-7: Perspective View of the Typical Coastline North of the Port Dickson Headland *(Source: NAHRIM, 2008)*

Figure 3-8: Perspective View of the Typical Coastline South of the Port Dickson Headland *(Source: NAHRIM, 2008)*

iii. South of the Tanjung Tuan headland, the character of the marine environment changes again. Unlike the more homogenous shorelines described above, the shoreline south of the Tanjung Tuan headland is more variable featuring small islands, bays, and coves. There are few sandy beaches and diverse marine habitats, including coral reefs in the immediate south of the Tanjung Tuan headland, in the Teluk Pelanduk bay, merging into mangroves near Pulau Babi (Pig Island) and finally terminating at the Pasir Panjang headland, which supports a rare incidence of a Dipterocarp forest (that are normally found further inland) (**Figure 3-9**).

Figure 3-9: Perspective View of the Dipterocarp Forest South of the Cape Rachado (Tanjung Tuan) Headland *(Source: NAHRIM, 2008)*

From a fisheries standpoint, the variable Port Dickson coastline provides the natural conditions for diverse habitat formation, and accompanying it, a significant variation in the species of fish that depend on it. This influences patterns of fisheries activity since it has implications concerning the availability of target species for both commercial and recreational fisheries. In the northern mangrove zone, the target species of fishermen and recreational fishers alike are euryhaline and mangrove species such as the Asian Sea Bass (*Lates calcarifer*), Snappers (*Lutjanid johnii, L. malabaricus* and *L. argentimaculatus*) and crabs (*Scylla* sp.).

While there are a small number of fishing landing points, the central beach areas are subject to much more intense human activity and is known more for beach tourism than for recreational fishing. In the southern zone, the key fishing species are related to coral reefs and open waters. These include groupers (*Epinephelus* spp.), threadfins (Polynemidae, especially Indian Threadfin, *Leptomelanosoma indicum*) and other coral and deep-water species.

3.4 Geology and Geomorphology

There are few publications on the geology and geomorphology of PDD especially as it relates to its submerged habitats. Most publications incorporate its geology and geomorphology in a more generalized description of the West Coast of Peninsular Malaysia (Chung and Yin, 1970) but there is nothing that relates the terrestrial geology. An attempt to describe the coastal morphology of the Port Dickson coastline is included in the Port Dickson Integrated Shoreline Management Plan (ISMP) (NAHRIM, 2008).

PDD's coastline itself extends from the Lukut River estuary in the north to the Linggi River estuary in the south. It has a North-South orientation, without any serious obtrusive land formations. The coastal physiographical profile of Port Dickson indicates a range of ecotypes. The coast north of Port Dickson consists primarily of marine alluvium extending to the lower valley of the Lukut River with small amounts of peat (**Figure 3-10**).

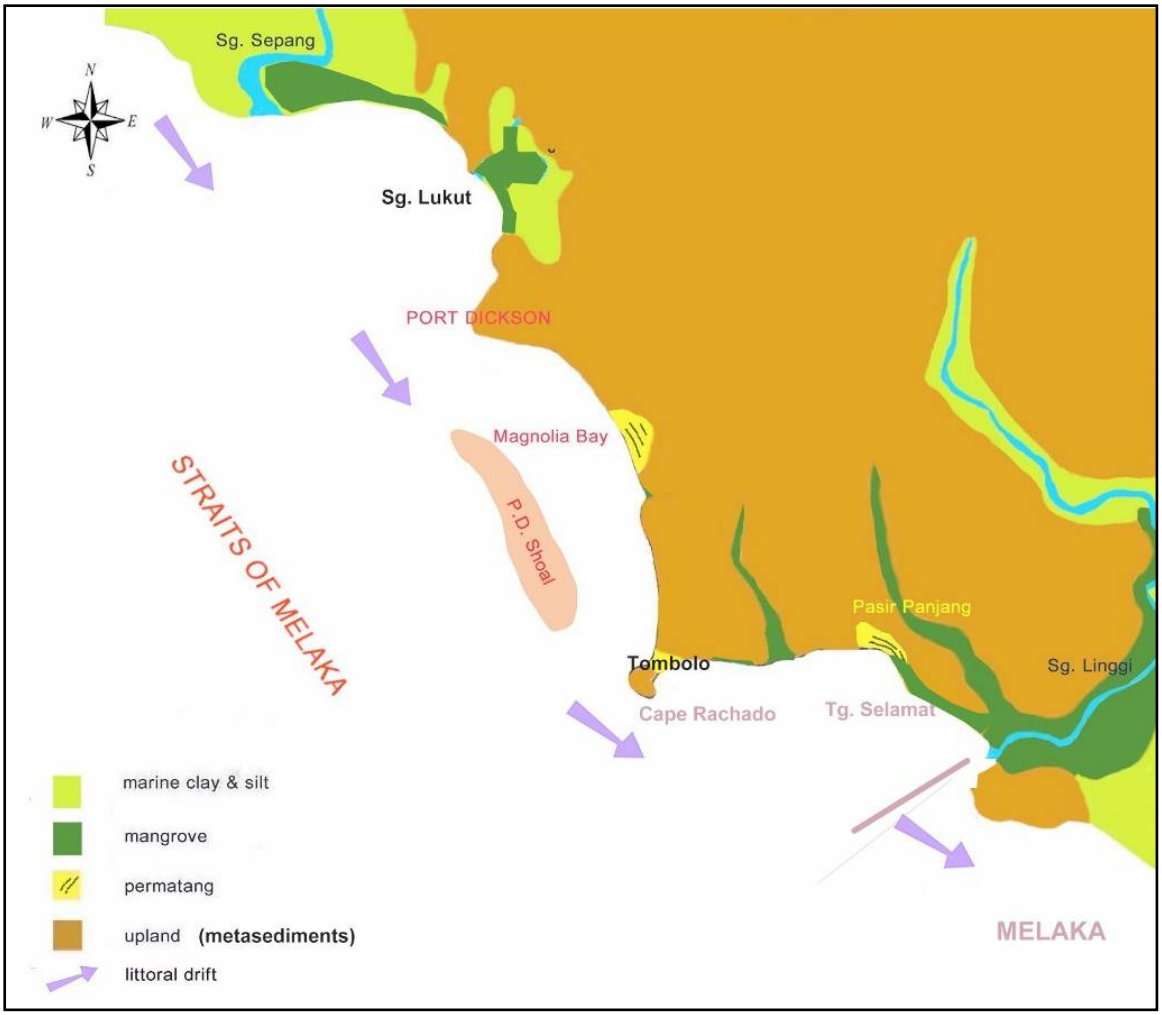

Figure 3-10: General Geomorphology of Port Dickson *(Source: NAHRIM, 2008)*

The coastline 25-km south of Port Dickson up to Tanjung Rhu (Cape Rachado) headland consists of coarse sandy beaches interspersed with sandstone outcrops. South of Tanjung Rhu, the coastline largely returns to a mudflat/mangrove structure interspersed with small tracts of sandy beach at Teluk Pelanduk and stone/pebble beaches at Pasir Panjang. The mudflat/mangroves intensify around the Linggi river mouth, entirely dominating the coastline. Extensive mangrove forests are found in Tanjung Agas at the Linggi River mouth and upstream until Lubuk China. The coastline immediately south of the Linggi estuary, which is in Melaka State, reverts to sandy beach.

The morphology of the district has been significantly affected by human activity. In particular tourism development, especially along the Port Dickson – Tanjong Tuan stretch, involving the construction of beach resorts and hotels and associated clearing and beach nourishment has changed the coastline structure significantly, while the shoreline Port Dickson town is one of the earliest places in the Malaysia where land reclamation was been carried out for urban expansion. About 250ha of mudflats around Port Dickson town were reclaimed in the 1980's (NAHRIM, 2008). Weathered earth was used to reclaim the land at that point though offshore sand was used for a piece of land to the south and all reclamation activity subsequently. While some of the reclaimed areas remains undeveloped, their presence themselves has impacted on the area's oceanography. Small sandy coves have developed along the retreating coasts and spits formed in areas where offshore sands were used for reclamation. Where the old, reclaimed fringe was temporarily protected by large laterite boulders, coastline retreat has left the line of old defence stranded in the sea. In fact, the best beaches on Port Dickson are backed by a newly accreting beach ridge plain and have developed in front of the reclaimed land (NAHRIM, 2008).

More recently, a further 3,200 ha of mudflat off the Lukut (north of Port Dickson town) has also slated for reclamation (Singh, 2017). Other major reclamation projects for the district have been proposed, all involving changes in the shoreline profile. For instance, a significant level of reclamation has been proposed for the Tanjung Agas mangrove forests, leading to a fundamental change in the morphology of the coastline in the area (Jimmy Yeow, Bonvests Sdn. Bhd. (property developer), pers.comm., December 2019). Though details of the reclamation remain unclear, it is expected to target the mangroves and mudflats at PDD's southern boundary. This will clearly destroy the ecosystem services that they currently provide to the health of the marine environment in the area.

3.5 Oceanography

3.5.1 Physical Oceanography

Reference to the Admiralty Charts indicate that Port Dickson's offshore submarine topography consist of shallows ranging 1.5-2m immediately off the shoreline for up to 1.5km, with water depths increasing rapidly after the 10m contour. The deepest water is found off Cape Rachado (Tanjung Tuan). The District has a tidal range of about 1.7m at neap tide and 2.5m during the springs. The Port Dickson ISMP (NAHRIM, 2008) described current patterns in its waters as complex, with the tidal flows south and north of the Straits of Malacca leading to strong eddys, particularly off the headland of Tanjung Tuan, with currents exceeding 1.4m/s.

The Tanjung Tuan headland also generates coherent separation zones towards the north and south, creating slightly different hydroecological conditions and, together with different habitats (below), may account for variation of some of the fish species found in Port Dickson's waters.

Another feature of PDD's coastline is the presence of runnels running roughly in a north south orientation along the District's water, on the edge of its sub-tidal zone (Sharifah, 1984). Little attention has been paid to the ecohydrology of these runnels and there are no detailed surveys of their hydraulics. However, NAHRIM (2008) indicated that the marine water quality in Port Dickson was probably sustained by the distribution of pollutants and nutrients by these runnels (which continued to flow during low tide) from the northern waters of the District to its less developed southern waters. Conversations with fishermen (who call them *paloh*) indicate they are also migration routes for fish. This makes sense since mangroves act as a nursery ground for many species of fish and shrimp that migrate to deeper waters as adults (Ahmad Ainuddin et al., 2020; Nagelkerken, 2009; Sheridan and Hays, 2003). In short, fisheries stocks in the southern Port Dickson may thus be dependent on the recruitment of juveniles from mangrove nurseries in its northern waters.

3.5.2 Chemical Oceanography and Water Quality

Law et al. (1991) extensively studied the chemical and physical oceanography off Port Dickson. His data indicated substantial mixing in the southern part of the district, particularly in the nearshore areas. On the other hand, flushing appears limiting in the northern half, particularly around Port Dickson town. There is little data on oceanographic movements north of Port Dickson town. However, littoral movements are expected to be influenced by the outflows from the Lukut and Sepang Rivers as well as the urban sprawl along PDD's coastline.

Until the late 1990s, raw sewage and sullage from PD was discharged directly into the sea. The resorts along the coastline also had rudimentary sewage treatment facilities and discharged wastewater through marine outfalls. Though there has been considerable investment in sewerage infrastructure since then, older housing and commercial tracts have yet to be connected.

The data collected by Law et al. (1991) indicated that nutrients such as ammonia, nitrate, nitrite and orthophosphate to be high within 1 km of the coastline. Readings averaged 0.180 mg-at N/L for ammonia, 0.220 mg-at N/L nitrate, 0.090 mg-at N/L nitrite and 0.0009 mg-at P/L orthophosphate. However, the readings 1 km from the coastline were far less due to the flushing regimes prevailing in the PDD's offshore waters, averaging 0.00017 mg-at N/L ammonia, 0.0006 mg-at N/L nitrate, 0.00041 mg-at N/L nitrite and 0.00018 mg-at P/L orthophosphate.

A follow up study by Law et al. (2000) recorded slightly lower nutrient levels in coastal water of Port Dickson i.e 0.009 mg-at N/L for ammonia, 0.016 mg-at N/L nitrate, 0.004 mg-at N/L nitrite and 0.006 mg-at P/L orthophosphate. However, a study undertaken by Praveena and Aris (2013) along the Port Dickson showed higher levels of nutrients, ranging from 0.12 – 0.18 mg-at N/L for ammonia, 0.01 – 0.05 mg-at N/L for Nitrate and 0.06 – 0.08 mg-at P/L for Phosphate suggesting the water quality of the Port Dickson could not keep up with its development.

In terms of bacterial levels, Law et al., (1991) reported coliform levels up to 5km south of the town to be extremely high (>150,000MPN/100mL) mainly due to the discharge of raw sewage from Port Dickson town at that time. The highest levels were seen in Port Dickson town where levels of 110,000-170,000 MPN/g prevailed. However, bacterial loads decreased rapidly with distance. At the 4th mile, the level was 372.6 MPN/100 mL and at Teluk Kemang, 523.4 MPN/100mL. In the waters 1 km off the coastline, he reported bacterial levels at a level of 2 MPN/100mL.

However, lower levels were recorded by Law et al. (2002), where 7.9 MPN/100 mL recorded at 4th mile, 3.7 MPN/100 mL at Centre of Marine Science (Teluk Kemang), 72 MPN/100 mL at 8th mile and 5.3 MPN/100 mL at southern edge of Tanjung Tuan.

The presence of two major oil refineries in Port Dickson gives hydrocarbon concentrations in the water and sediment an important profile. The data of Law et al. (1991) indicated that soluble hydrocarbon levels in the PDD's waters ranged from 0.77 – 7.87 µg/L, while, in sediment, the levels ranged from 21-33 - 75.5 mg/kg.

However, there was little difference in hydrocarbon levels between nearshore and offshore (1 km) areas suggesting that the hydrocarbons were coming from offshore sources rather than from the refineries. However, higher levels of hydrocarbon recorded by Law et al. (2002), i.e. 151.24 µg/L at coastal water of Port Dickson.

3.6 Coastal Forestry

The ISMP report (NAHRIM, 2008) provides the best consolidated information on coastal forestry in PDD. It made clear that much of the Port Dickson coastline has been developed and lost its original vegetation character. In general, the coastal vegetation types in Port Dickson can be divided into five categories, i.e. mangrove forest, coastal hill forest, beach vegetation, *Melalueca* (or heath) forest and shrub (or secondary vegetation), including planted forest for aesthetic purposes.

Where the marine environment was concerned, the most important of these were mangroves. Mangroves act as nutrient traps (Reef et al., 2010), sequester carbon (Kaufman and Donato, 2012) draw down and precipitate heavy metals (Zhang et al., 2014; Nguyen et al., 2020) and break down organic pollutants (Friesen et al., 2018), thereby protecting the fragile and commercially valuable nearshore/coastal ecosystems from siltation and pollution, act as nursery grounds for many fish species and contribute considerable levels of degraded leaf litter to the coastal marine food chain (Srisunont et al., 2017). Thus, the role of mangroves as an aquatic nursery as well as a nutrient trap would have influenced both the recruitment rates of commercial fisheries stocks as well as the carrying capacity of the nearshore environment for these stocks. Mangroves cover extensive tracts of land both in the northern and southern portions of the district.

In 2017, the total mangrove area in Negeri Sembilan was 1,557 ha (Hamdan and Muhamad Afizzul, 2020) (**Figure 3-11**), which was a reduction of 46.2% from 2,276.50 ha in 2010 (Hamdan et al., 2012). Based on Hamdan and Muhamad Afizzul (2020), mangroves decreased by an estimated at 788 ha per year or about 0.13% per annum since 1990. The major contribution to this loss of mangroves included continued development of the coastline (change in land use), predominantly for commercial-scale agriculture and aquaculture as well as coastal erosion. Overharvesting and pollution are amongst other factors also affected the mangroves, albeit to a lesser degree.

There is little detailed data in the public domain on mangrove forests of Port Dickson. However, evaluations undertaken by a number of authorities (Persatuan Alam Sekitar Selangor, 2014-unpublished; Hossain et al., 2001; Nur Anis Fadilah et al., 2015; Gan, 2006; Singh, 2013; Wan Faridah Akmal et al., 2010; Roshidi and Wan Masyitah, 2018; O&L Jurutera Perunding, 1997) indicate that more than 20 major species were found in

the forests (**Table 3-1**). However, the dominant species in all the forests was the *Rhizophora apiculata* and *R. mucronata*. Others major species included the *Lumnitizera racemosa* and *Bruguiera gymnorrhiza*. The mangrove fern *Acrostichium* spp. was also found in abundance.

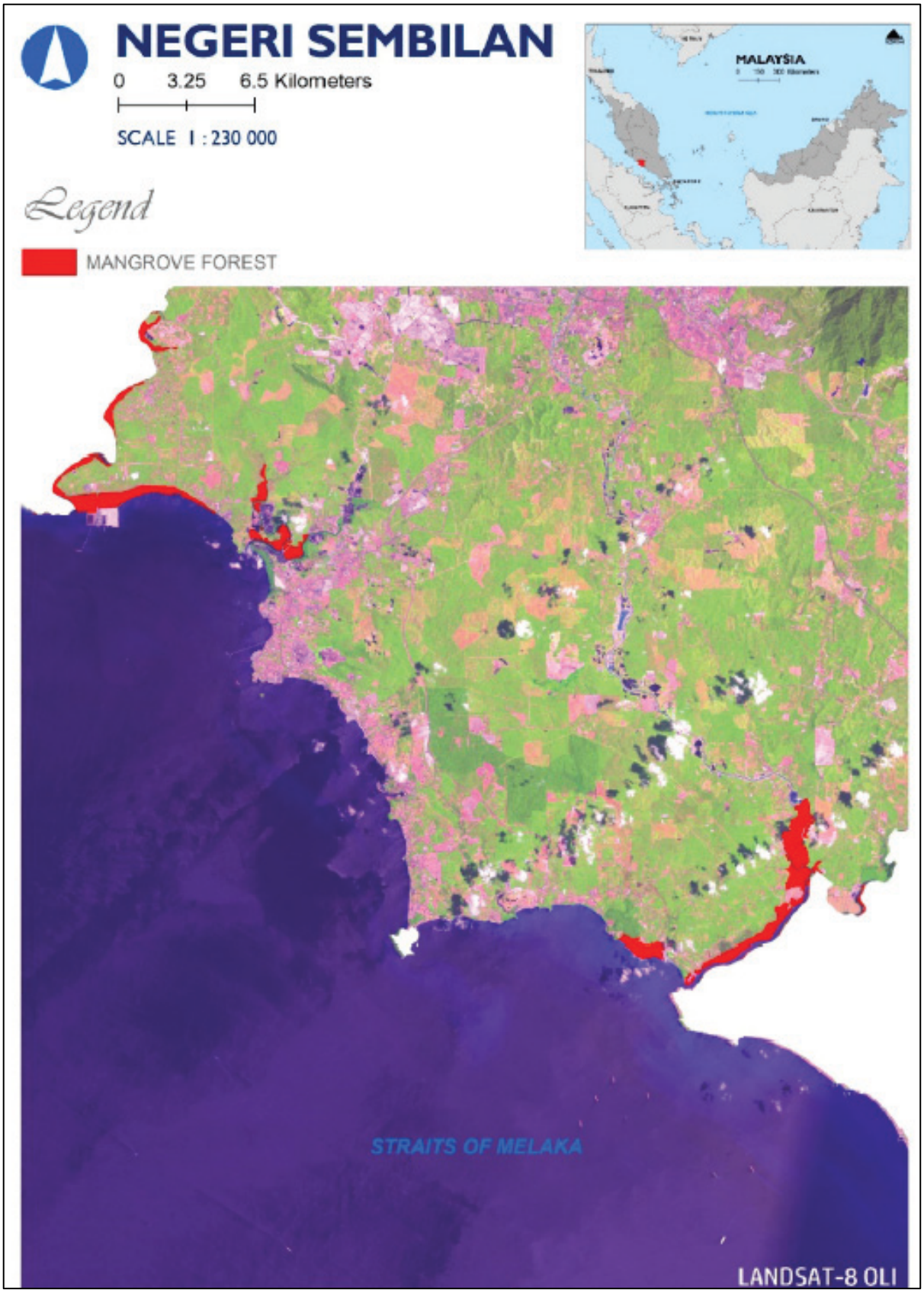

Figure 3-11: Distribution of Mangroves in Negeri Sembilan *(Source: Hamdan and Muhamad Afizzul, 2020)*

Table 3-1:Tree Species in Mangrove Forests of Port Dickson

Species	Sepang[1]	Lukut	Tg. Tuan	Linggi
Rhizophora apiculata	+[1,2]	+[3]	+[4,5]	+[6,7,8]
Rhizophora mucronata	+[1,2]	+[3]	+[5]	+[8]
Rhizophora stylosa	-	-	+[5]	+[7]
Bruguiera gymnorrhiza	+[1,2]	+[3]	+[4]	+[8]
Ceriops tagal	+[1,2]	+[3]	+[4]	
Ceriops decandra	-	-	-	+[7]
Sonneratia alba	+[1,2]	+[3]	+[5]	+[6,7]
Sonneratia ovata	-	-	+[5]	-
Sonneratia caseolaris	+[1]	-	-	+[6]
Avicennia officinalis	+[1]	-	+[5]	-
Avicennia alba	+[1,2]	+[3]	-	-
Avicennia marina	-	-	-	+[8]
Xylocarpus granatum	+[1,2]	+[3]	-	+[8]
Lumnitzera racemosa	+[1]	-	-	+[8]
Lumnitzera littorea	+[1]	-	-	+[7]
Excoecaria agallocha	-	+[3]	-	-
Nypa fruticans	+[1]	+[3]	-	+[8]
Scyphiphora hydrophyllacea	+[1]	-	-	+[8]
Acrostichum aureum	+[1]	-	-	-
Acrostichum speciosum	+[1]	-	-	-
Heritiera littoralis	-	-	-	+[8]
Hibiscus tiliaceus	+[1]	-	-	+[6,7]
Intsia bijuga	-	-	-	+[8]

Note: '+': Present, '-': Absent
Source:
1: Persatuan Alam Sekitar Selangor (2014-unpublished)
2: Hossain et al., 2001
3: Nur Anis Fadilah et al., 2015
4: Gan, 2006
5: Singh, 2013
6: Wan Faridah Akmal et al., 2010
7: Roshidi and Wan Masyitah, 2018
8: O&L Jurutera Perunding, 1997

Most of the mangroves in Port Dickson are in a highly precarious state. The extent of the Sepang mangroves have been considerable reduced. In 1980, for instance, the forest covered 249ha. The Lukut forest has almost been totally denuded and developed for oil palm. Only small fringes remain along the Lukut Besar River (**Figure 3-12**). The Linggi reserves still stand (**Figure 3-13**). However, much of the mangrove has been given out for development of tourism and educational facilities.

Figure 3-12: Mangrove Forest at Sg. Lukut

Figure 3-13: Mangrove Forest at Sg. Linggi

3.7 Submerged Marine Biodiversity

3.7.1 Habitat Types in Port Dickson

Coral Reefs

Port Dickson has moderate coral reef resources. All fringe the mainland, in contrast with other major reefs in the country, which are found near islands (Praveena et al., 2012). The main concentrations of reefs are in Tanjung Tuan, Teluk Pelanduk, Blue Lagoon and Teluk Kemang. However, much of these reefs, with the exception of those at Tanjung Tuan, have been degraded through siltation and unrestricted collection (Gopinath et al., 2000). Coral reefs at the Tanjong Tuan promontory were studied by Goh and Sasekumar (1980). About 41 coral species were reported, of which 35 were from the family Sceleractinidae, 1 from Milliporinidae and 5 from Alcyonaceanidae. The main species were *Lobophytum pauciflorum, Lobophytum crassopiculatum* and *Pavona frondifera*.

From the viewpoint of diversity, the Tanjung Tuan reefs compared well with other reefs in the Malacca Straits. These include Pulau Payar (70 species) and Pulau Sembilan (30 species) (Gopinath et al., 2000). A study by Safuan et al. (2018) indicated 25 genera of hard coral recorded at Tg. Tuan. The coral cover has been determined to be in 'fair' coral condition, with the average coral cover close to the borderline condition of 'poor'. Among the most common genera recorded were *Pectinia* sp., *Galaxea* sp., *Diploastrea* sp. and *Fungia* sp.

There have been other studies, albeit unpublished, on the coral reefs of the area. Hydec (2008, unpublished) reported the presence of a soft coral reef at the mouth of the Menyala River (**Table 3-2**). The reef sits at the estuary of the Menyala River that drains a heavily disturbed catchment. A tidal gate to prevent saline intrusion (it is closed at high tide and opened at low tide) means that there are spasmodic discharges of large volumes of sediment and freshwater, both of which are major stressors of corals (Hydec, 2008, unpublished).

Notwithstanding that, there were significant populations of soft corals and associated marine species (**Figure 3-14** to **Figure 3-16**). The survey identified over 27 coral species present. From a functional standpoint, the site is dominated largely by soft corals (23 species). Hard corals were confined largely around the leeward side of Pulau Perjudi and were relatively limited from a species diversity standpoint (4 species) (Hydec, 2008, unpublished).

Table 3-2: Soft and Hard Coral Species Identified During Survey of Menyala Reef

Common Name	Genera	No. of Species Observed
Soft Corals		
Sea fans	*Gorgonia*	3
Sea fan	*Mopsella*	1
Sea fan	*Mopsella*	1
Gorgonian coral	*Leptogorgia*	2
Foxtail whips	*Rumpella*	3
Skeleton whips	*Eunicella*	2
Plexaurid gorgonian	*Plexaurid*	1
Sea whip	*Ellisella*	1
Sea whips	*Juncella*	3
Cauliflower corals	*Sclerophthya*	2
Carnation corals	*Dendronephthya*	2
Sun coral	*Denyrophyllia*	1
Hard Corals		
Stony coral	*Porites*	1
Cup corals	*Tubinaria*	3
Invertebrates		
Porifera		
Glass rope sponge	*Hyalonema*	2
Rag sponge	*Sertella*	2
Conical sponge	*Polymastia*	1
Cnidaria		
Tube worms	*Tubularia*	1
Echinodermata		
Feather star	*Himerometra*	1
Feather star	*Lamprometra*	1
Sand star	*Astropecten*	1
Sea star	*Archaster typicus*	1
Reef cucumber	*Pentacta*	1
Mollusca		
Cone shell	*Conus consors*	1
Green Mussel	*Perna viridis*	1

Source: Hydec, 2008 - Unpublished

Figure 3-14: Sea Cucumber (*Pentacta* sp.) Caught from Menyala Reef. Notice gorgonial strands within the sample *(Hydec, 2008, unpublished)*

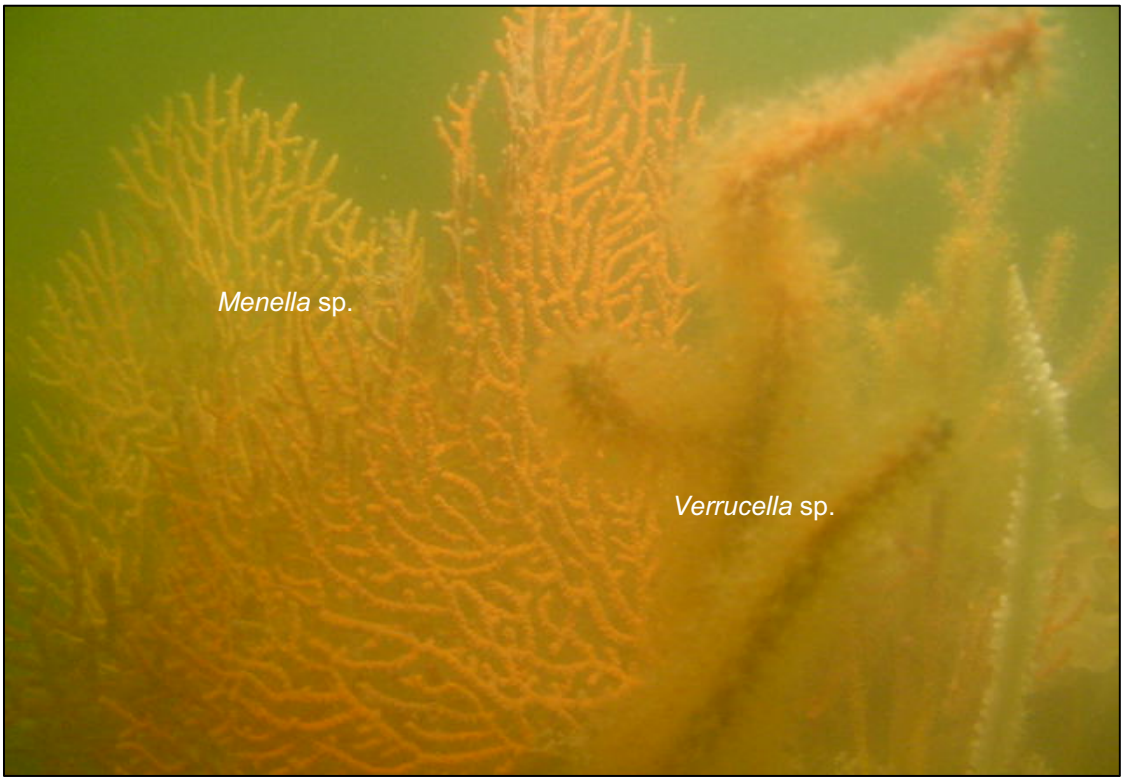

Figure 3-15: Soft Corals (Gorgornians) found in South of Perjudi Reef *(Hydec, 2008, unpublished)*

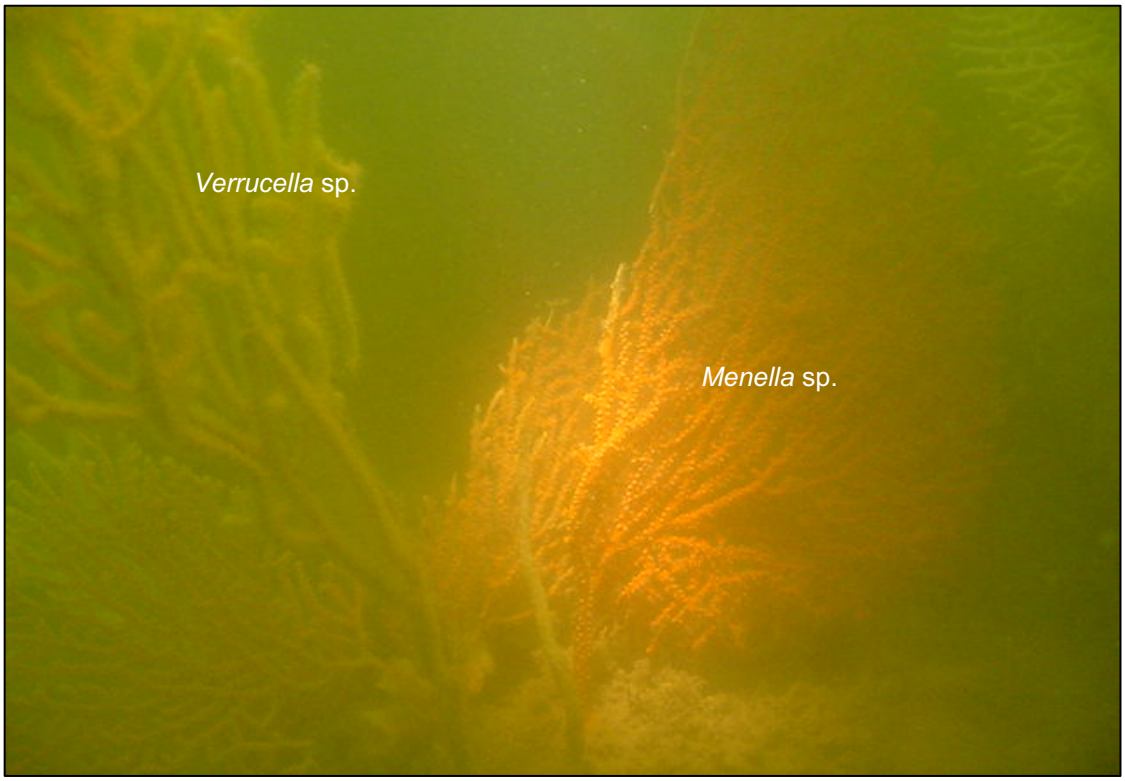

Figure 3-16: Soft Corals (Gorgornians) found in East of Perjudi Reef *(Hydec, 2008, unpublished)*

DHI (2016, unpublished) reported the presence of a soft coral reef off the Linggi estuary. However, they used a tow camera for the survey and the details appears at low resolution with little detail (**Figure 3-17**). The corals observed during the survey were mostly soft corals from the Gorgonian family (order Alcyonacea). Hard coral was observed in a small area near Tg. Dahan and several patches at Tg. Tuan. It was observed (from video footage) that most of the soft coral patches found were associated with hard substrate (e.g. rocky areas) and most were very patchy, resulting in poor coral cover. **Figure 3-18** show some images of the coral observed in the video footage.

In addition, the Port Dickson ISMP (NAHRIM, 2008) also reported the presence of reefs at Pulau Terembu (off Teluk Kemang), though no detailed studies were undertaken. Other anecdotal reports suggest that there were other unrecorded reefs in Port Dickson's waters, a full inventory of which was adjudged to be out of the scope of this study.

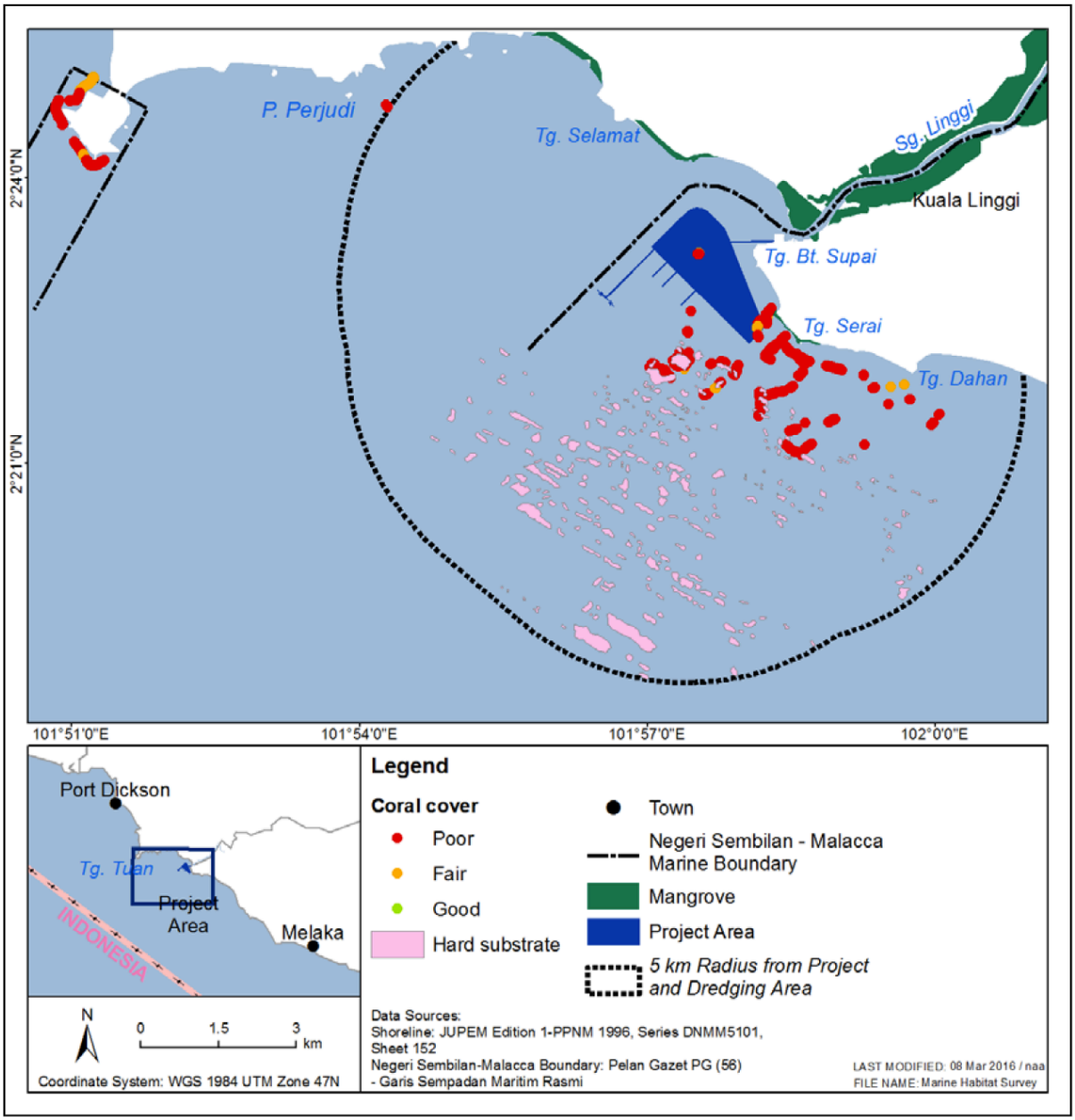

Figure 3-17: Coral Reef Off Linggi River *(Source: DHI, 2016- unpublished)*

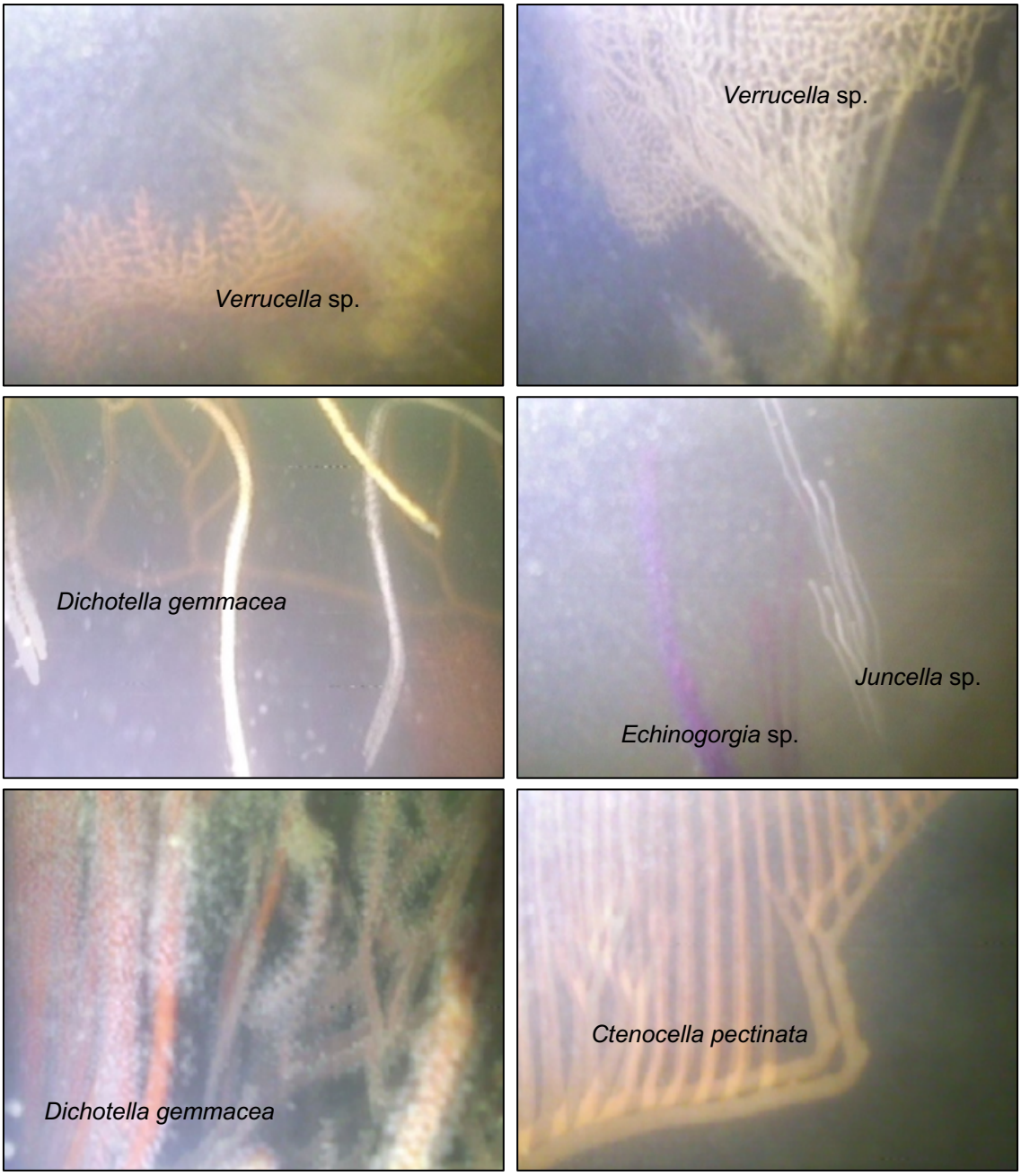

Figure 3-18: Image of Coral Reef Off Linggi River *(Source: DHI, 2016- unpublished)*

Seaweed Beds

Seaweeds are found extensively along the Port Dickson coast. The main sites are Bagan Pinang, Batu Teluk Kemang, Kampung Seri Rusa, Magnolia Bay, Pantai Batu 12 (Stesen Petronas), Teluk Kemang, Pasir Panjang, Pantai Dickson and Tanjung Tuan (Cape Rachado) (Ahmad, 1995; Phang and Wee, 1991; Phang, 1995) observed 30 taxa of Rhodophyta (red algae) and 18 taxa of Phaeophyta (brown algae) at Tanjung Tuan. Asmida et al. (2017) recorded 44 species of seaweed in Blue Lagoon, where 19 species of Phaeophyta (brown algae), 16 species of Chlorophyta (green algae) and nine species of Rhodophyta (red algae). The most diverse seaweed was represented by genus *Sargassum (S. polycyctum, S. siliquosum, S. cristaefolium, S, ilicifolium, S. asperifolium and S. oligocystum), Dictyota* (*D. dichotoma, D. ciliolate, D. dentata, Dictyotaceae* sp. and *Dictyopteris delicatula)* and *Padina* (*P. japonica, P. minor, P. tetrastomatica* and *P. australis*). Wong and Phang (2004) reported the presence of at least five (5) species of *Sargassum*, including *S. baccularia*, *S. binderi*, *S. myriocystum, S. oligocystum* and *S. ciliquosum* in Port Dickson, including in Cape Rachado and area adjacent to Blue Lagoon.

However, Port Dickson coast has less species of seaweed compared to other areas (Penang and Pulau Langkawi) along the Straits of Malacca (Phang et al., 2019). **Table 3-3** lists the major seaweed species found along the coastal area of Port Dickson.

Seagrass Meadows

Several localities along the Straits of Malacca support well-developed seagrass communities and a large portion (40% - 85.7%) of all known seagrass species in Malaysia. The central and southern region of the Straits has a greater diversity of seagrass compared to the northern reaches (Japar Sidik et al., 2001). In Port Dickson waters, a total of nine (9) species of seagrass have been reported at several locations such as Teluk Kemang, Mile 1, Mile 4, Mile 7, Pantai Dickson (Teluk Pelanduk) and Tanjung Tuan (Cape Rachado). The most dominant genera reported were *Enhalus*, *Cymodocea* and *Halodule* (Japar Sidik, 1994; Japar Sidik et al., 1995; Phang, 2000; Japar Sidik et al., 2001). However, the greater diversity of seagrass was recorded at Teluk Kemang. Several past studies have also reported other species of seagrass found at these areas (Japar Sidik, 1994; Japar Sidik et al., 1995; Phang, 2000; Japar Sidik et al., 2001).

The differences in seagrass density and diversity between sites were probably related to physicochemical factors such as current regime, nutrient availability, light intensity, water temperature and salinity (Muta Harah and Japar Sidik, 2013; Hillman et al., 1995; Walker and McComb, 1990; Fonseca and Kenworthy, 1987; Short, 1987; Bulthuis, 1987).

Table 3-3: List of Seaweed Species Identified along the Coastal Area of Port Dickson

Species	Location			
	Teluk Kemang	Pantai Dickson	Blue Lagoon	Not specified
Chlorophyta				
Analipus japonicus	-	-	+	-
Avrainvillea erecta	+	-	-	-
Avrainvillea longicaulis	-	-	-	+
Bryopsis corymbosa	-	-	-	+
Bryopsis pennata	-	-	-	+
Caulerpa lentillifera	+	-	+	+
Caulerpa microphysa	-	+	+	+
Caulerpa prolifera	+	+	-	+
Caulerpa racemosa	+	+	+	+
Caulerpa serrulata	-	-	+	+
Caulerpa Serrulate var. pectinata	-	-	-	+
Caulerpa sertulariodes	+	+	+	+
Caulerpa sertulariodes cf. longiseta	-	-	-	+
Caulerpa suberrata	-	-	+	-
Caulerpa taxifolia	+	-	-	+
Caulerpa verticillata	-	-	+	-
Chaetomorpha linum	-	-	-	+
Chaetomorpha sp.	-	-	+	-
Codium yezoense	-	-	+	-
Cladophora sp.	+	-	-	+
Halimeda sinulans	-	-	-	+
Udotea argentea	-	-	+	-
Udotea occidentalis	-	+	-	-
Udotea javensis	+	+	+	+
Ulva fasciata	-	-	+	-
Ulva lactuca	-	-	+	-
Ulva spp.	-	-	-	+
Enteromorpha clathrata	-	-	+	-
Enteromorpha intestinalis	-	-	+	-
Rhodophyta				
Acanthophora spicifera	+	+	+	+
Amphiroa fragilissima	+	-	-	+
Amphiroa rigida	-	+	-	+
Ceramium gracillimum	+	-	-	+
Ceramium tennuissimum	-	-	-	+
Ceratodictyon spongiosum	+	-	-	+
Eucheuma alvarezii	-	-	+	-
Galaxaura oblogata	-	-	-	+
Gracilaria arcuata	-	-	+	-
Glacilaria blodgettii	-	-	+	-
Gracilaria coronopifolia	-	-	-	+
Gracilaria foliifera	-	-	+	-
Gracilaria salicornia	+	-	-	+
Gracilaria vermiculophylla	-	-	+	-
Gracilaria sp.	-	+	-	-

Species	Location			
	Teluk Kemang	Pantai Dickson	Blue Lagoon	Not specified
Hypnea pannosa	+	-	-	+
Jania decussato-dichotoma	+	-	+	-
Lithophyllum pygmaeum	-	-	+	-
Laurencia cartilaginea	-	-	+	-
Laurencia corymbose	+	-	-	+
Leveillea jungermannioides	+	-	-	+
Polysiphonia nigrescen	-	-	-	+
Spyridia filamentosa	-	-	-	+
Tolypiocladia glomerulata	+	-	-	+
Phaeophyta				
Dictyota cervicornis	+	-	-	+
Dictyota ciliolata	-	-	+	-
Dictyota dichotoma	+	-	+	+
Dictyota dentata	-	-	+	-
Dictyopteris delicatula	-	-	+	-
Dictyotaceae sp.	-	-	+	-
Feldmannia enhali	-	-	-	+
Feldmannia indica	-	-	-	+
Lobophora variegata	+	+	+	+
Padina australis	+	-	+	+
Padina boergesenii	-	-	-	+
Padina boryana	-	-	-	+
Padina japonica	-	-	+	-
Padina minor	-	-	+	-
Padina tetrastomatica	+	-	+	+
Padina spp.	+	-	-	-
Hormophysa cuneiformis	-	-	-	+
Sargassum asperifolium	-	-	+	-
Sargassum baccularia	-	-	-	+
Sargassum carpophyllum	+	-	-	+
Sargassum cristaefolium	+	-	+	+
Sargassum ilicifolium	+	-	+	+
Sargassum polycystum	+	-	+	+
Sargassum oligocystum	-	-	+	-
Sargassum siliquosum	-	-	+	-
Sargassum spathulaefolium	-	-	-	+
Sargassum swartzii	+	-	-	+
Sargassum spp.	+	-	-	+
Turbinaria conoides	+	-	+	+
Turbinaria ornata	-	-	+	+
Turbinaria luzonensis	-	-	+	-

Note: '+' = present, '-' = absent

Source: Ahmad, 1995; Phang and Wee, 1991; Wong et al., 2000; Japar Sidik et al., 2001; Asmida et al., 2017

3.7.2 Marine Megafauna

There have been no detailed studies of the marine reptiles and mammals of Port Dickson. However, an investigation by the Department of Fisheries, Melaka/Negeri Sembilan (DoF, 1993, unpublished) indicated that the Painted Terrapin (*Battagur borneonsis*) traditionally nested along beaches in Kg. Balak, Teluk Kubu, Teluk Pelanduk, beaches at the 9th, 10th and 11th mile Port Dickson - Pasir Panjang road and at Pantai Tambak Pasir with the nesting season being from March - October. The frequency of nesting was reported at 15-20 days during each month of the season. Hawksbill Turtles (*Eretmochelys imbricata*) and Green Turtle (*Chelonia mydas*) have also been observed basking in Port Dickson (Enviro Exceltech, 2020) (**Figure 3-19**) but there have been no reports of them nesting along the District's beaches. Nonetheless, beaching of turtle's carcasses likely killed by boat/ship propellors net have also been reported **Figure 3-20**). A resort along the Tanjung Gemok has established a hatchery as a social project (**Figure 3-21**), but its impact is still unknown. However, given the unprecedented pace of tourist development along the coastline, it is highly improbable that the turtles will return to nest there.

Other marine megafauna of conservation importance reported by fi shermen include the Dugong (*Dugong dugon*), Indo-Pacific Humpback Dolphin (S*ausa plumbea*) and Irrawaddy Dolphin (*Orcaella brevirostris*) (Gopinath et al., 2000). There have been occasional sightings of dolphins in Port Dickson (**Figure 3-22**) waters, though there is little no data on their populations. Gopinath et al. (2000) reported the dugong was hunted for meat in the early 1970s but the activity (or the dugongs) apparently no longer exists.

Maps showing the locations of currently as-known habitats appears in **Figure 3-23** and **Figure 3-24.** These locations are based on existing literature and do not represent an exhaustive assessment of marine habitats in Port Dickson's waters. The presence of unchartered habitats was alluded to by the Port Dickson Integrated Shoreline Management Plan (NAHRIM, 2008) which pointed to the presence of unrecorded reefs such as those in Pulau Terembu ("reef island" in Malay) off Teluk Kemang.

Figure 3-19: Hawkbill Turtle (*Eretmochelys imbricata*) Resting on the Revetment of the Tuanku Jaafar Power Station *(Photo credit, Muhamad Faiz Bin Muhamad Iqbal, Tuanku Jaafar Power Station, 2019)*

Figure 3-20: Green Turtle (*Chelonia mydas*) Mortality Caused by Propellor Damage

(Source: Department of Fisheries Negeri Sembilan, 2020-unpublished)

Figure 3-21: Turtle Hatchery in Port Dickson Sponsored by a Private Resort

Figure 3-22: Dolphins Observed in Port Dickson *(Photo credit: F.T. Wong; KL Metropolitan, 2018)*

Figure 3-23: Known Marine Habitats in PD North (*Source: Modified from Google Earth*)

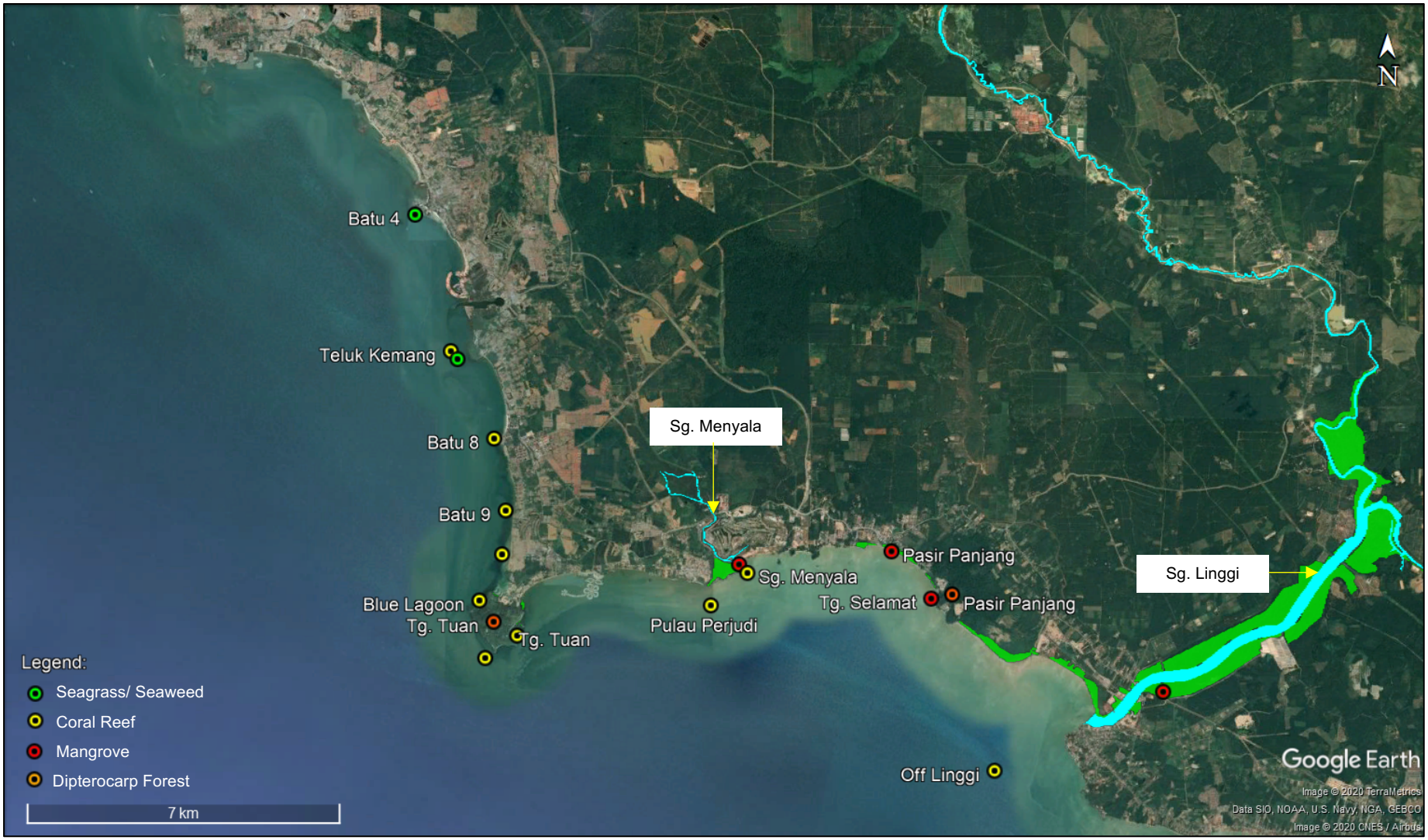

Figure 3-24: Known Marine Habitats in PD South (*Source: Modified from Google Earth*)

3.8 Land Use and Economy

3.8.1 Settlements

Another compelling feature of Port Dickson is the existence of varied fish stocks and habitats in an area which is the subject of intense human activity. The general topography of Port Dickson is one typical of the West Coast of Peninsular Malaysia i.e. a narrow coastal strip backed by undulating hilly land (**Figure 3-25**). Most of the district's urban development has been confined to the coastal strip, while the areas of ≥30m above mean sea level tend to be employed in forestry and agriculture (NAHRIM, 2008).

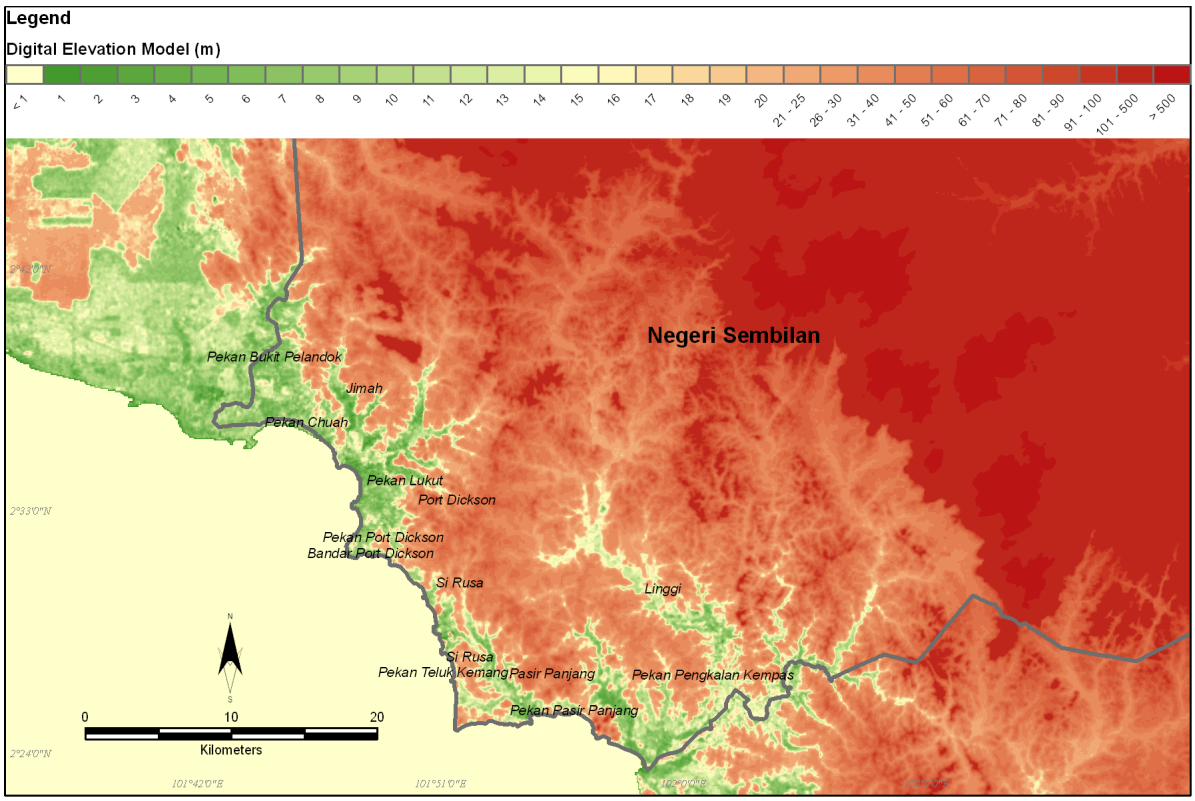

Figure 3-25: Digital Elevation Model of Port Dickson *(Source: NAHRIM, 2008)*

The economy of Port Dickson District is driven by tourism, agriculture, and manufacturing (NAHRIM, 2008). Oil palm (*Elaeis guineensis*) is the dominant agricultural crop in the state. In 2013, the oil palm area estimated at 167,077 ha. Other crops include rubber (84,960 ha), an assortment of fruits (6,316 ha) and vegetables (780 ha), paddy (907 ha) as well as short-term agricultural crops (6,329 ha) (PLANMalaysia, 2018). Livestock used to be another primary activity and swine farming was especially significant in the Port Dickson until it was decimated in the mid-1990s by the Nipah virus (Looi and Chua, 2007). As such, livestock farming is no longer a major contributor to the district's economy.

Port Dickson has a significant economic profile both within the state as well as part of the national economy. In 2018, PDD was one of the most important domestic tourist destinations in the country, catering for an estimated 6.1 million visitors (Tourism Malaysia, 2019). This is related to the presence of beach areas within the district as well as its proximity to major urban centres such as Kuala Lumpur, to the Kuala Lumpur International Airport and the state capital of Seremban. In the last two years, Port Dickson has also hosted large numbers of tourists from the Peoples' Republic of China (Simon Theseira, Sinclair Marine, Port Dickson, pers.comm., 2017) in recnt years. The State Structure Plan 2045 estimates total tourist arrivals to Port Dickson of between 545,000 and 636,000 annually, with the bulk comprising domestic tourists (PLANMalaysia, 2018).

In the National Physical Plan 2 (JPBD, 2010), the state was designated as part of a Central Development Region (along with the Klang Valley – KLIA in the north of PPD and Melaka in its south) where tourism is accorded a high priority as an engine of economic growth. In line with national policy objectives for the tourism sector, the Negeri Sembilan Government had accorded strong emphasis on tourism as an important economic activity to generate economic growth (Negeri Sembilan Tourism Master Plan, 2006). The document provides useful data at the state level and examines tourism products available in all districts. The Negeri Sembilan Tourism Master Plan proposes the strategies and action plans needed. These are based on both the findings of the current situation and future potential of the tourism industry to achieve the tourist development targets of Negeri Sembilan. The Master Plan proposed several low impact development plans for Port Dickson to make it the main tourist destination of the state.

Based on the action plans proposed for the period 2007-2010, no mega or large-scale infrastructure projects were proposed along the coastline. Most proposal were on upgrading, extending and creating new business centres, picnic sites and camp sites. The focus was on promotion of natural resources, cultural and heritage resources and man-made resources such as resorts. It is pertinent to note that recreational fishing does not feature in the Master Plan.

3.8.2 Manufacturing

As detailed earlier, manufacturing has gained in importance and currently account for around 40% of Gross Domestic Product (GDP) of the state. It is also of major economic significance in PDD as well as with capital-intensive petroleum refineries existing alongside smaller enterprises and there are several industrial parks in inland areas such as Tanah Merah and Springhill. The first oi refineries in the country were established in Port Dickson in the 1960s by Shell and Esso.

Though since taken over by other parties, they are still an important contributor to its economy. It is worth noting that whilst manufacturing in PDD is of major importance as regards value added, it is not a major source of employment, due to its capital-intensive nature.

This has been recognized by the state government, and the current focus is on non-polluting SME's to provide more employment opportunities to local residents. Over the period from 2001 and 2005 approved manufacturing projects in the state totalled 184 involving some RM6.3 million in capital investment with a potential employment created by this investment as estimated to total 12,898 (NAHRIM, 2008).

3.8.3 Agriculture

Rubber and oil palm are the two dominant crops in the District. Generally, oil palm is increasing in relative importance compared to rubber. Other crops include an assortment of fruits, vegetables, short-term and cash crops. Fishing and aquaculture are other primary sector activities. It is pertinent to note that the coastline of the district supports a small but locally important fishing industry that also benefits from recreational fisheries demand.

3.8.4 Energy

Energy production represents another major economic resource to the District. The District has several major powerplants including the Tuanku Jaaafar Power Station (TJPS) and PD Power in Port Dickson town and the Jimah power plant complex at the northern edge of the District's boundary. The TJPS is located next to a seagrass meadow (described in **Chapter 4, Appendix 9**) while the Jimah Power Plant is located in the midst of what was a mangrove swamp in the northern boundary of the District. No ecological details are available on the mangroves in the area, though the issue of mangroves as a whole in Port Dickson District is discussed in this chapter.

3.8.5 Shipping

Though there is a commercial port in Port Dickson, it acts only as secondary cargo terminal. Originally it was the primary means by which crude was landed to meet the needs of the two refineries in the district. However, Shell constructed its own terminal in the 1990s.

3.9 Fisheries Industry

3.9.1 Capture Fisheries

The fishing industry in Port Dickson is essentially artisanal in nature in that it relies on traditional fishing gear such drift nets and not on commercial gears such as trawls and purse seines. There are also no fisheries-based processing industries of importance.

3.9.2 Fish Landing Points

There are 11 major fish landing points in the district i.e. Pengkalan Kempas, Tg. Agas, Pasir Panjang, Teluk Pelanduk, Teluk Kemang, Batu 4, Port Dickson, Kuala Lukut, Bukit Palong, Chuah and Bukit Pelandok (**Figure 3-26**).

3.9.3 Fishing Population

A total of 455 licensed fishermen (fulltime) operated in Port Dickson in 2018 (**Table 3-4**). The highest number of fishermen was recorded in Chuah (21.3% of total number of fishermen), followed by Kuala Lukut (14.9%) and Port Dickson (14.7%). Other fish landing points only contributed around 2.4 – 11.4% of total number of fishermen.

From an ethnic standpoint, most of the fishermen at Port Dickson were Malays (50.3%), followed by Chinese (41.3%) and Indians (8.4%) (Port Dickson District Department of Fisheries, 2019-unpublished). Generally, the number of licensed fishermen increased by 14.6% from 460 in 2009 to 527 in 2013, before slightly decreasing by 13.7% to 455 in 2018 (Department of Fisheries, 2010 – 2019) (**Figure 3-27**).

Table 3-4: Number of Fishermen at Port Dickson, 2018

Fish Landing Points	Number of Fishermen			
	Malay	Chinese	Indian	Total
Pengkalan Kempas	12	3	2	**17**
Tg. Agas	11	1	0	**12**
Pasir Panjang	45	7	0	**52**
Teluk Pelandok	23	1	1	**25**
Teluk Kemang	23	2	2	**27**
Batu 4	32	0	0	**32**
Port Dickson	41	22	4	**67**
Kuala Lukut	1	65	2	**68**
Bukit Palong	0	6	5	**11**
Chuah	40	43	14	**97**
Bukit Pelanduk	1	38	8	**47**
Total	**229**	**188**	**38**	**455**

Source: Port Dickson District Department of Fisheries, 2019 – unpublished

Figure 3-26: Fish Landing Points in Port Dickson *(Source: Port Dickson District Department of Fisheries, 2019 – unpublished)*

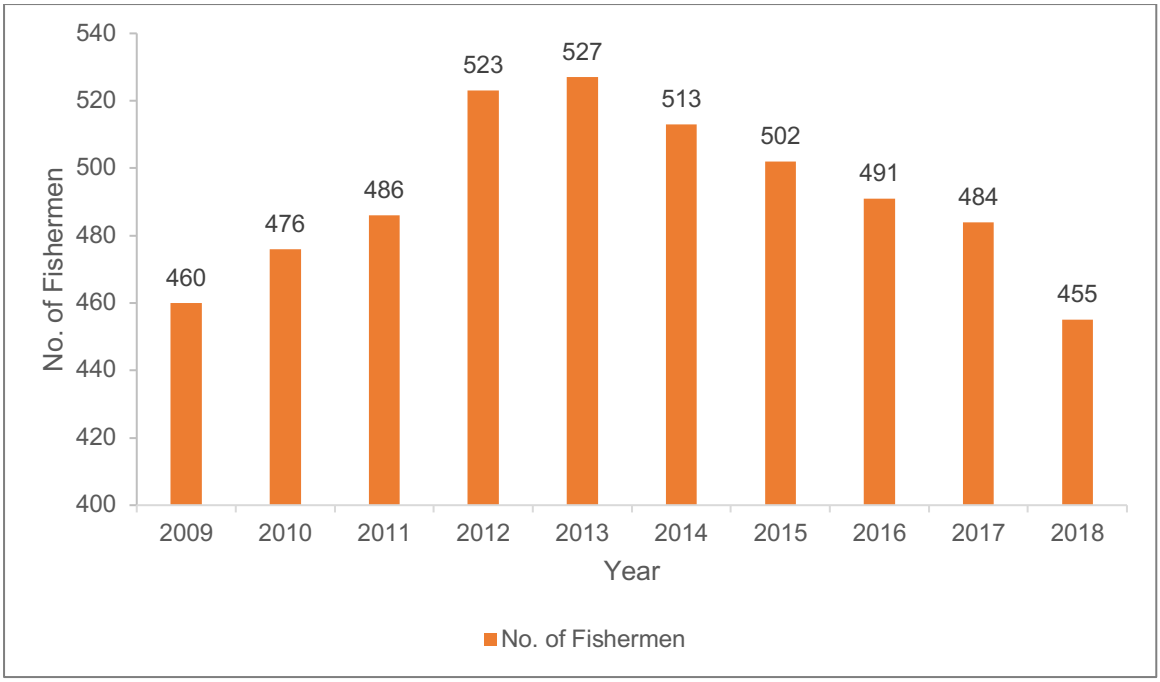

Figure 3-27: Number of Fishermen at Port Dickson, 2009 – 2018 *(Source: Department of Fisheries, 2010 – 2019)*

3.9.4 Productive Assets

Fleet

Outboard-powered boats were mostly deployed in the fishery and only a small number of inboard powered boats were used. In 2018, a total of 329 outboard and 24 inboard powered boats were licensed at Port Dickson (**Table 3-5**). As for outboards, the highest number were recorded in Chuah (24.9% of total number of outboards), followed by Pasir Panjang (14.3%) and Bukit Pelanduk (12.5%), while other fish landing points supported less than 11% of total number of outboards each. The inboard powered boats only operated from Tg. Agas (1 unit), Teluk Kemang (1 unit), Port Dickson (8 units) and Kuala Lukut (14 units) (Port Dickson District Department of Fisheries, 2019 - unpublished). Most outboard engines were between 10 - 19 h.p., while inboards were within 5 - 9 h.p. The Gross Registered Tonnes (GRT) of inboards ranged from 5 – 14.9.

The total number of licensed outboard powered boats decreased 18.9% from 2009 (412 units) to 2013 (334 units), then increased 10.8% in 2013 (370 units), before decreased back 11.1% in 2018 (329 units). As for inboards, the numbers increased 52.4% from 21 units in 2009 to 32 units in 2010, then continuously decreased to 24 units in 2018 (Department of Fisheries, 2010 - 2019) (**Figure 3-28**).

Table 3-5: Number of Fishing Boat at Port Dickson, 2018

Fish Landing Points	Number of Fishing Boat		
	Inboard	Outboard	Total
Pengkalan Kempas	-	15	**15**
Tg. Agas	1	10	**11**
Pasir Panjang	-	47	**47**
Teluk Pelandok	-	17	**17**
Teluk Kemang	1	19	**20**
Batu 4	-	27	**27**
Port Dickson	8	36	**44**
Kuala Lukut	14	27	**41**
Bukit Palong	-	8	**8**
Chuah	-	82	**82**
Bukit Pelanduk	-	41	**41**
Total	**24**	**329**	**353**

Source: Port Dickson District Department of Fisheries, 2019 – unpublished

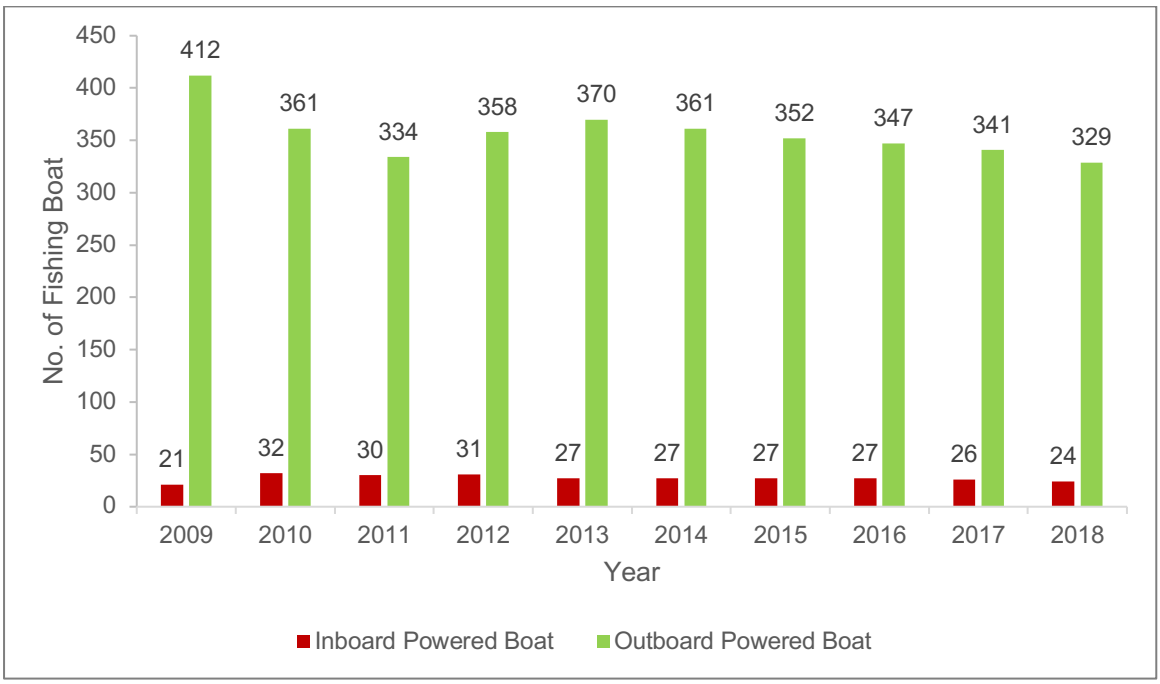

Figure 3-28: Number of Fishing Boats at Port Dickson, 2009 – 2018 *(Source: Department of Fisheries, 2010 – 2019)*

Fishing Gear

Fishing gears in Port Dickson are entirely artisinal. Of these, drift/gill nets are the most significant, accounting for about 95.5% of the total number of licensed fishing gears in 2018, followed by hooks and lines (2.8%) and portable traps (1.4%). The common types of drift nets include trammel nets and species-specific drift/gill nets (such as for shrimp (*jaring udang*), crabs (*jaring ketam*), pomfret (*jaring bawal*), Spanish mackeral (*jaring tenggiri*) and four fingered threadfin (*jaring senangin*). In terms of fish landing points, Chuah recorded highest number of fishing gears (23.2% of total number of fishing gears), followed by Pasir Panjang (13.3%) and Port Dickson (12.5%), while other landing points only recorded 2.3 – 11.6% of total number of fishing gears (Port Dickson District Department of Fisheries, 2019 - unpublished) (**Table 3-6**).

From the data, the numbers of most fishing gears have fluctuated over the years, except for beach seines, of which only 1 unit has been recorded since 2013 (Department of Fisheries, 2010 - 2019) (**Figure 3-29**). The inconsistency in the registered numbers of fishing gears was due to the several factors, primarily because some fishermen did not register the gears and used them without licenses. In other cases, fishermen needed time and money to replace damaged gears thereby missing licensing deadlines.

Table 3-6: Number of Fishing Gears at Port Dickson, 2018

Fish Landing Points	Drift Nets	Hook & Lines	Portable Traps	Other Seines	Total
Pengkalan Kempas	15	-	-	-	**15**
Tg. Agas	10	-	-	1	**11**
Pasir Panjang	46	1	-	-	**47**
Teluk Pelandok	17	-	-	-	**17**
Teluk Kemang	16	4	-	-	**20**
Batu 4	21	5	1	-	**27**
Port Dickson	43	-	1	-	**44**
Kuala Lukut	38	-	3	-	**41**
Bukit Palong	8	-	-	-	**8**
Chuah	82	-	-	-	**82**
Bukit Pelanduk	41	-	-	-	**41**
Total	**337**	**10**	**5**	**1**	**353**

Source: Port Dickson District Department of Fisheries, 2019 – unpublished

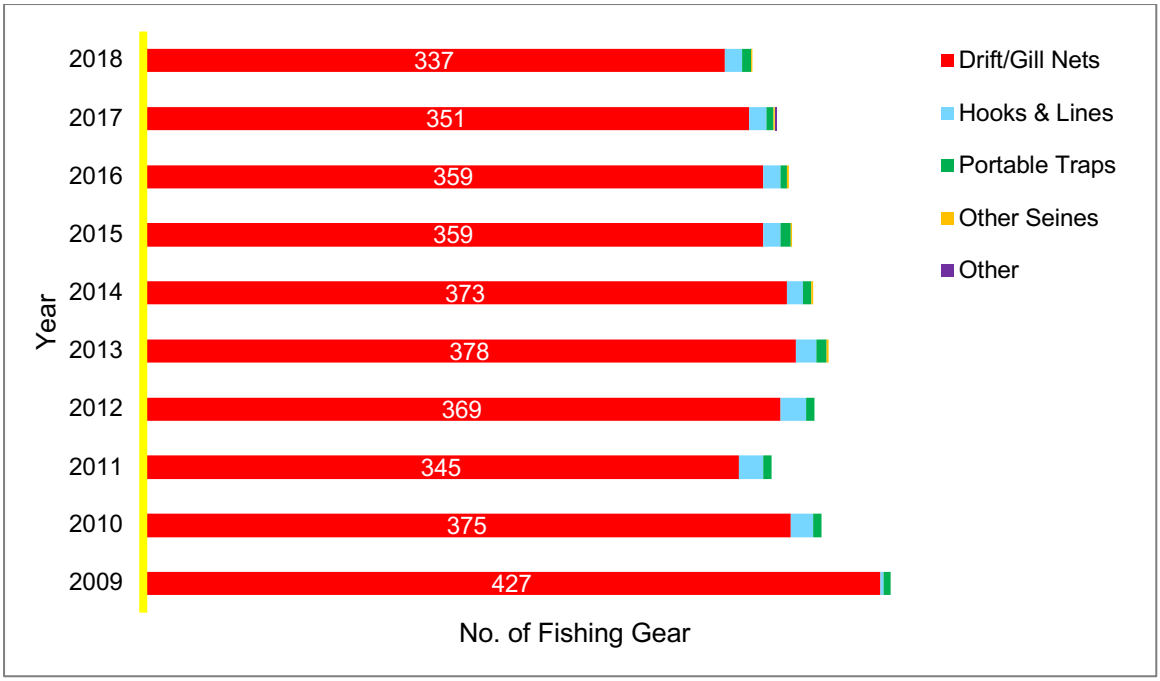

Figure 3-29: Number of Fishing Gears at Port Dickson, 2009 – 2018 *(Source: Department of Fisheries, 2010 – 2019)*

3.9.5 Fishing Grounds

Most fishing activity is conducted in the fishing grounds or at shoals (*beting*). The major fishing ground is in north of the district (Bukit Pelandok, Chuah, Sg. Rambai and Kuala Lukut) and ranges from 1 – 3 km from the shoreline for outboard vessels and beyond 3 km to the international shipping lane for the inboard vessels. In the middle and in the south of Port Dickson, most fishing activities are carried out within 1 – 10 km from the shoreline for outboard vessels including at shoals from Kg. Teluk to Teluk Pekan, Tg. Tuan, Karang Kurau and Palm Springs. Inboard vessels also fish in the deeper sections of the same grounds. In addition, they also fish at specific channels named *Banjau Dalam* (5 – 6 km from shoreline), *Banjau Kapal 1* and *Banjau Kapal 2* (international waters) (**Figure 3-30**), though the last is generally avoided due to safety concerns. There is also the Fisheries Prohibited Area around Tanjung Tuan, which is a Fisheries Prohibited Area where fishing is disallowed.

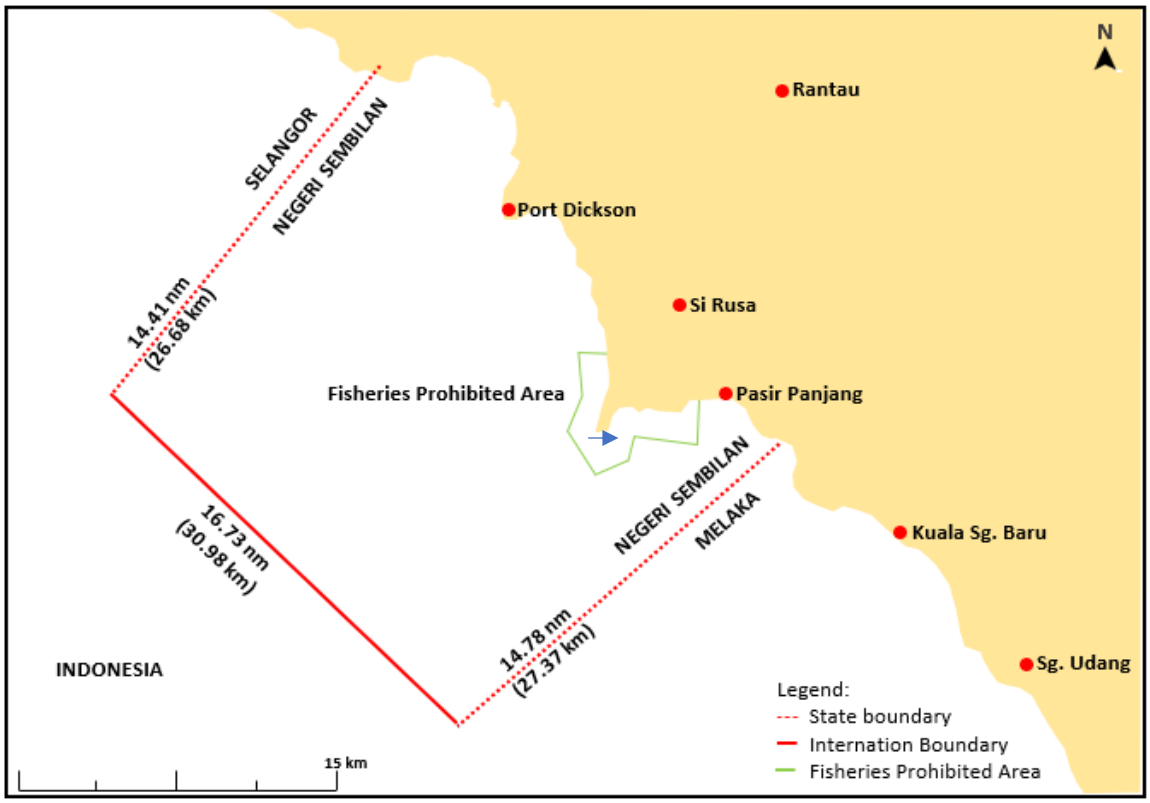

Figure 3-30: Artisanal Fishing Grounds in Port Dickson *(Source: Based on information from Port Dickson District Department of Fisheries, 2019 – unpublished)*

NAHRIM (2008) reported that fishermen make extensive use of runnels (or *paloh*) that run roughly parallel to and about 0.5 -1.5 km from the shoreline. These runnels are used for navigation purposes. The runnels also serve as hides and migration channels for fish (NAHRIM, 2008), though fishing within the runnels themselves is difficult due to strong currents. The presence of runnels along the coast suggests that, in addition to facilitating migration of fish, they also serve to channel and distribute nutrients as well. This has an implication where water quality and nutrient distribution is concerned. The loss of the runnels would clearly impinge on fisheries activities as well as reduce the flushed character of the Port Dickson coastline.

3.9.6 Landings and Production

I. Artisanal Fisheries

Volume

In 2018, the fish landings amounted to 670 tonnes (**Table 3-7**). Highest landings came from drift/gill nets (628 tonnes), which contributed 93.7% of the overall catch, followed by hooks and lines (3.7%; 25 tonnes) and portable traps (2.7%; 18 tonnes) (Department of Fisheries, 2019).

Landings fluctuated from 2009 to 2018 with the highest landing being recorded in 2014 at 806 tonnes, followed by 2016 (717 tonnes), 2015 (704 tonnes) and 2010 (690 tonnes), while the lowest landing was recorded in 2008 (376 tonnes) (Department of Fisheries, 2010– 2019) (**Figure 3-31**).

Value

The wholesale value of fish landed in 2018 was RM8.81 million (Department of Fisheries, 2019). Wholesale values also fluctuated from 2009 to 2018. The highest values were recorded in 2014 at RM9.96 million, followed by 2017 (RM9.55 million) and 2011 (RM9.27 million), while the lowest value recorded in 2013 (RM6.31 million) (Department of Fisheries, 2010 - 2019).

The highest values were recorded in 2014 at RM9.96 million, followed by 2017 (RM9.55 million) and 2011 (RM9.27 million), while the lowest value recorded in 2013 (RM 6.31 million) (Department of Fisheries, 2009 - 2018) (**Figure 3-31**).

Table 3-7: Fish Landing (tonnes) and Wholesale Value (RM million) at Port Dickson, 2018

Type of Gear	Fish Landing (Tonnes)	Wholesale Value (RM million)
Drift Net	628	
Portable Traps	18	Data not available by fishing gear
Hook & Lines	25	
Total	**670**	**8.81**

Source: Department of Fisheries, 2019

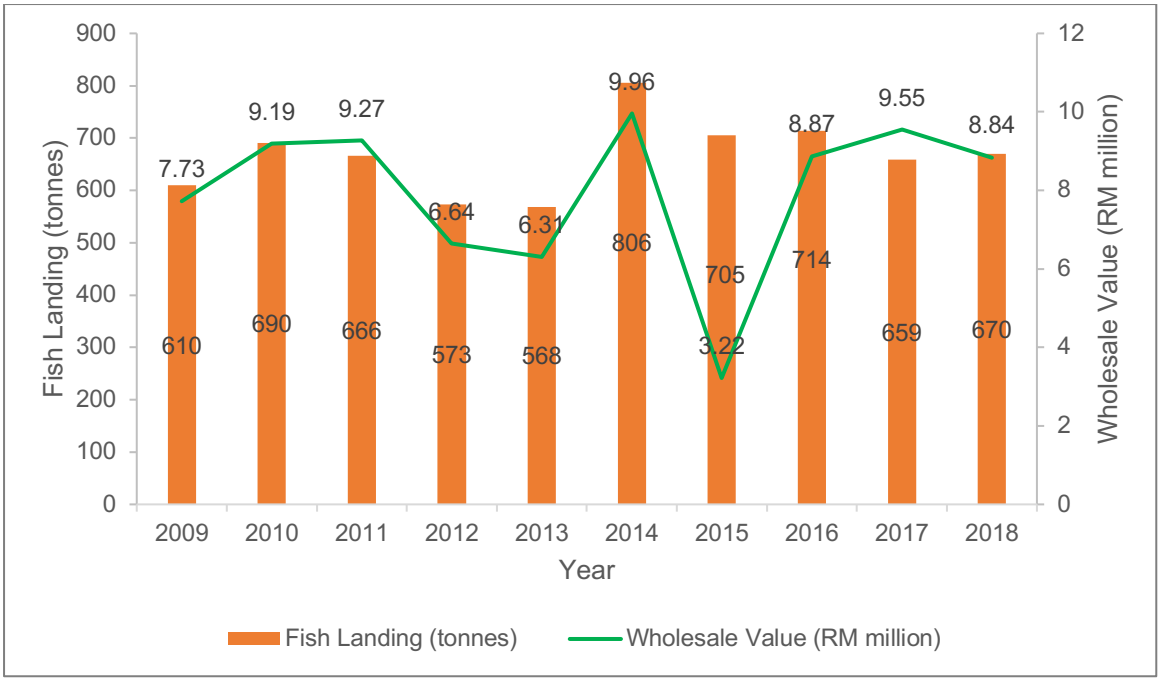

Figure 3-31: Fish Landing (Tonnes) and Wholesale Value (RM Million) at Port Dickson, 2009 – 2018 *(Source: Department of Fisheries, 2010 – 2019)*

Catch Profile

In 2018, more than 28 species of fish, shrimp and crab were caught from Port Dickson waters (Department of Fisheries, 2019). The most common pelagic species caught were Beliak Mata (*Ilisha elongata*), Talang (*Scomberoides commersonianus*) and Parang (*Chirocentrus dorab*), while demersal species caught including Gelama/Tengkerong (*Johnius sina/Pennahia macrophthalmus/Otolithes ruber/Nibea soldado*), Semilang (*Plotosus* sp.) and Daun Baharu (*Drepane punctata*). The common shrimp and crab caught was Udang Putih (*Penaeus merguiensis*) and Ketam Renjong (*Portunus pelagicus*). A full list appears in **Table 3-8.**

Table 3-8: List of Fish Species Landed by Licensed Fishermen in Port Dickson, 2018

Local Name	Common Name	Scientific Name
Fish		
Kebasi	Chacunda shad	*Anodontostoma chacunda*
Puput	Longfin Herrings	*Ilisha* spp.
Beliak Mata	Elongated ilisna	*Ilisha elongata*
Sebelah	Flatfish	*Pseudorhombus* spp.
Daun Baharu	Spotted batfish	*Drepane punctaca*
Dengkis	Rabbit fish	*Siganus* spp.
Duri	Marine catfish	*Arius* spp.
Gelama/Tengkerong	Croaker	*Johnius* spp.
Gerut-gerut	Grunter	*Pomadasys* spp.
Jenahak	John's snapper	*Lutjanus johnii*
Kaci	Sweetlips	*Plectorhinchus* spp.
Kapas Laut	Majorras	*Gerres* spp.
Kerapu	Grouper	*Epinephelus* spp.
Malong	Conger eel	*Muraenesox* spp.
Merah	Red snapper	*Lutjanus malabaricus*
Bulus-bulus	Sillago-whitings	*Sillago* spp.
Semilang	Eel catfish	*Plotosus* spp.
Tanda	Russel's snapper	*Lutjanus russelli*
Alu-alu	Barracuda	*Sphyraena* spp.
Bawal Hitam	Black pomfret	*Parastromateus* spp.
Bawal Putih	Silver pomfret	*Pampus argentius*
Cermin	Trevally	*Alectis indicus*
Chaping	Trevally	*Alectis spp.*
Cincaru	Hardtail scad	*Megalapsis cordyla*
Kurau	Threadfin	*Polynemus paradiseus*
Senangin	Threadfin	*Polynemus* spp.
Kerepoh	Bigeye Travally	*Caranx sexfasciatus*
Talang	Queen fish	*Scomberoides* spp.
Parang-parang	Wolf herring	*Chirocentrus dorab*
Tenggiri	Spanish mackerel	*Scomberomerus* spp.
Ikan Campur	Mix fish	-
Crustacean		
Ketam Renjong	Swimming crab	*Portunus pelagicus*
Udang Putih	Banana prawn	*Penaeus merguiensis*

Source: Department of Fisheries, 2019

II. Recreational Fisheries

A study by Gopinath et al. (2013) indicated a fishing effort of 67,910 visitor days with an estimated direct value of RM7.05 million. However, the study was not comprehensive in terms of landing sites while the value was based on a broad cost estimate. For instance, the paper cites 14 sites for angling, while my study suggests that there are 30 sites. There was also no data on catch volumes and impact on the resource.

Outside of the case study cited in Chapter 1 (MIER, 2000), there were two other studies undertaken in 2003 in Linggi river (Merchant Asia, 2004) and in the Lukut river in 2010 (Gunung Ganang, 2011) the latter employing the same model as Gopinath et al. (2013). The studies indicated that the Linggi site involved a fishing effort of about 10,000 days with a value of RM0.7 million (Merchant Asia, 2004). A more organised study at the Lukut river region (the river and its estuary) indicated a recreational fishing effort of 29,858 visitor days with a financial value of RM1.811 million (Gunung Ganang, 2011).

3.9.7 Aquaculture

In addition to fishing, there was also substantial aquaculture activity bordering the coastal zone of Port Dickson. The aquaculture system in Port Dickson recorded both freshwater (ponds, ex-mining pools, cages, cement tanks and canvas tanks) and brackishwater (ponds and cages).

In 2018, aquaculture production in PDD amounted to 4,730.22 tonnes, of which 60.1% was contributed by freshwater ponds (2,840.74 tonnes), 13.7% by freshwater ex-mining pools (647.03 tonnes), 13.1% by brackishwater ponds (619.68 tonnes) and 11.6% by freshwater cement tank culture (548.9 tonnes). Other culture systems contributed less than 1.5% (Department of Fisheries, 2019) (**Table 3-9**). The trend of the aquaculture production showed decreased 64.3% from 13,247 tonnes in 2009 to 4,730.22 tonnes in 2018 (Department of Fisheries, 2010-2019) (**Figure 3-32**).

As for the species, among the major species reared were Red Tilapia (*Oreochromis niloticus*), Carid catfish (*Clarias* spp.), Asian Seabass (*Lates calcarifer*), Pacific White Shrimp (*Litopenaeus vannamei*) and Tiger Shrimp (*Penaeus monodon*). In terms of wholesale value, production from aquaculture activities in 2018 was valued at RM52.7 million, with 46.5% coming from freshwater ponds (RM24.5 million), 29.3% from brackishwater ponds (RM15.4 million), 12.2% from freshwater ex-mining pools (RM6.4 million), 10.7% from freshwater cement tanks (RM5.6 million) and less than 1.5% from other culture systems (Department of Fisheries, 2019). Wholesale values decreased 30.4% from 2009 (RM65.8 million) to 2016 (RM45.8 million), before increasing back 15% in 2018 (RM52.7 million) (Department of Fisheries, 2010-2019) (**Figure 3-32**).

Table 3-9: Aquaculture Production (tonnes) and Wholesale Value (RM million) at Negeri Sembilan, 2018

Aquaculture System	Production (Tonnes)	Wholesale Value (RM million)
Freshwater culture		
Freshwater Pond Culture	2,840.74	24,495.45
Ex Mining Pools Culture	647.03	6,436.42
Freshwater Cage Culture	66.05	660.50
Cement Tanks Culture	548.90	5,612.09
Canvas Tanks Culture	6.91	30.49
Subtotal	*4,109.63*	*37,234.95*
Mariculture		
Brackishwater Pond Culture	619.68	15,432.83
Brackishwater Cage Culture	0.91	16.38
Subtotal	*620.59*	*15,449.21*
Total	**4,730.22**	**52,684.16**

Source: Department of Fisheries, 2019

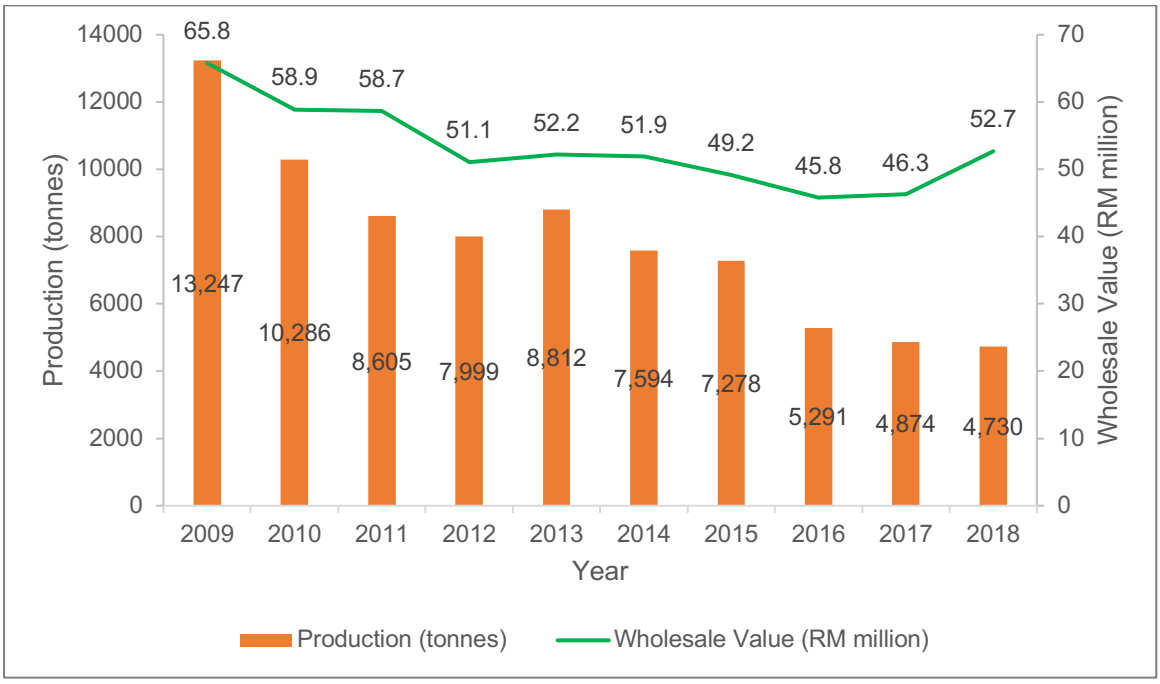

Figure 3-32: Aquaculture Production (Tonnes) and Wholesale Value (RM Million) at Port Dickson, 2009 – 2018 (Source: *Port Dickson District Department of Fisheries, 2010 – 2019)*

3.10 Conclusion

There are few locations like Port Dickson, that can offer a span of unique fisheries/marine habitats, oceanographic and economic features. The review of the literature presented in this chapter confirms that despite the relatively short length of the Port Dickson coastline (60 km), the geomorphology is the most varied and diverse of the west coast of Peninsular Malaysia (Chung and Yin, 1970), being characterized by rocky coasts usually fronted by a laterite platform extending into the sea (24% of its shoreline), beaches (33%) and mangroves (43%) (NAHRIM, 2008). The shoreline is distinguished by two significant headlands that clearly delineate the coastline into discrete ecotypes. Elsewhere these features tend to dominate large stretches of shoreline, they do not coexist in proximity with other features as they do in PDD, making a comparative assessment of their respective influences difficult.

Tourism demand had led to development of beach resorts, changes in beach nourishment and the discharge of raw sewage, all of which has led to changes in beach vegetation. Urban development borders the coast and includes manufacturing, agriculture, and energy industries.

These have all led to differing hydro-ecological conditions along the coastline. There are moderate coral reef resources, seaweed, and other seagrass communities, essential to the support of diverse species of fish. There was even marine megafauna of conservation importance such as dolphins, the Painted Terrapin (*Batagur borneoensis*) and the Dugong (*Dugong dugon*), though latter two are no longer found there (Gopinath *et al*, 2000).The fishing industry is essentially artisanal, and fishing is at specific fishing grounds or at shoals. There is also aquaculture activity being carried out at the shoreline. Furthermore, PDD is a coastal district that borders one of the busiest shipping lanes in the world, the Straits of Malacca exposing the coastline to the many risks of shipping pollution.

Recreational fisheries in PDD does not arise by accident but from a range of factors which have resulted in the integration of the activity within the wider socio-ecology of the area. PDD's short shoreline provides a unique opportunity to understand how heterogeneity of geomorphology affects marine habitat type and distribution, and how these in turn relate to heterogeneity in recreational and artisanal fisheries. The key issue here would be to understand the natural capital of an estate (marine or coastal) and the manner in which that capital is utilised. Simply looking at utilisation patterns without considering the manner in which this natural capital contributes to its sustainability is perverse in that it neglects the role of the overall landscape that supports recreational fisheries.

The findings of the study can be extrapolated, either in whole or in part, to other areas that have similar geomorphic features, economic and habitat values. It is not easy to quantify the value of natural capital. One proxy is the value of PDD's fisheries industry (excluding recreational fisheries) as whole that is sustained by the natural capital in PDD. This amounts to about 0.05% of total landings for the country (Department of Fisheries, 2019) notwithstanding PDD's shoreline is about 1.28% of the country's coastline. PDD's total fisheries production (inclusive artisanal fishing and aquaculture) in 2018 amounted to 5,400 tonnes valued at RM61.5 million (**Table 3-10**).

Table 3-10: Summary of Fisheries and Aquaculture Information in Port Dickson, 2018

Fisheries and Aquaculture	Landing/ Production	Wholesale Value
Artisanal Fishing	670 tonnes	RM8.81 million
Aquaculture		
Freshwater Culture	4,109.63 tonnes	RM37.23 million
Mariculture	620.59 tonnes	RM15.45 million
Total	**5,400.22 tonnes**	**RM61.49 million**

Source: Department of Fisheries, 2019

CHAPTER 4: ASSESSMENT OF ECONOMIC CAPITAL OF RECREATIONAL FISHERIES INDUSTRY IN PORT DICKSON AND NATURAL CAPITAL SUPPORTING IT.

4.1 Introduction

Clearly recreational fisheries exist within the context of an economic and social structure that ties with a natural capital that supports it. It does not exist in isolation of these factors. The lack of detailed data prevents a more comprehensive assessment of industry from a national or regional standpoint. Case studies are provided in Chapter 1 but lack resolution as to elements of the suggested landscape, much less to the metric that is expected to support it. This lack of resolution comes from the fact that natural capital studies for Malaysia tend to be broad based and lack specificity (Md. Anwar et al., 2013).

In contrast, this chapter provides an assessment of the economic and natural capital of the recreational fisheries industry in Port Dickson District (PDD). It focuses on the outcome of Phase 1 study of this thesis which was a baseline assessment of recreational fisheries in Port Dickson as described in detail in **Chapter 3**. As pointed out in **Chapter 1**, the baseline becomes important because there are no official records of recreational fishing sites in PDD, much less on the number or ethnic profile of the fishers that utilised them or the commercial activities that depended on them. Fisheries habitat data was also thin, with the only consolidated data being from Gopinath et al. (2000).

Sub- phase 1A looked at the *status* of the industry as we whole and involved ground surveys using a questionnaire that was designed to elicit baseline information from recreational fishers (both boat and shore-based) as well as other associated stakeholders. The data and discussion from this exercise appears in **Section 4.2** and the subsections that follow and covers locational information (points from which recreational fishing is carried out) as well as socio-economic data (including ethnicity and income cohorts) of fishers that were polled at each landing point. This baseline becomes critical in understanding the socio-economic backdrop to boat-based recreational fishing (which is the focus of this thesis and which is addressed in detail in **Chapter 5**). Google Earth, coupled with GPS data collected during the survey in this study, were used to generate a spatial recreational fisheries profile of the shoreline (specifically recreational fishing grounds, and recreational fisheries landing points) as these relate to marine biodiversity and fisheries as well as the locations of fisheries habitats (coral reefs, mangroves, and sea grasses).

Sub- phase 1B looked at the *known* natural capital of PDD's water to establish its relationship to recreational fishing patterns. The data on the known habitats were found to be limited based on their outcome of this sub-phase and is detailed in **Chapter 3**, while its relationship to recreational fisheries is discussed in **Section 3.7.1**.

In Phase 1C of the study was the appraisal of marine habitats that apparently supported recreational fishing in PDD's waters. The appraisal included that of published data, visual assessments but also of perceptions of recreational fishers with respect to their presence, particularly of submerged habitats, many of which had not been fully identified or investigated. The data appears in **Section 4.2**. To verify perceptions of recreational fishers of these habitats, especially those that were previously unrecorded, investigations on two sample submerged habitat sites identified by recreational fishers, one in the north of PD and the other in south, were investigated to validate these perceptions. The data and discussion from this exercise appears in **Section 4.3** while the detailed outcome of the investigations appear in **Appendix 1**.

It is important to note sampling I undertook did not amount to being detailed appraisal of the totality of submerged habitats in PDD's waters – only to indicate their presence and quality in specific sample sites in relation to recreational fisheries activity. The idea of this exercise was to underscore the importance of understanding the value of the natural capital in relation to the sustainability of the economic capital which relies on it and the ability of recreational fishing to provide this understanding.

4.2 Profile of Recreational Fishers and Stakeholders in Port Dickson

The absence of institutions relating to recreational fisheries has meant that there are no records of even basic data, such as location and profiling of recreational fishing sites. Obtaining this data would need to precede any meaningful assessment and quantification of recreational fishing effort in the District. The first attempt at inventorying recreational fisheries sites in the District was undertaken by Gopinath et al. (2010) and Gopinath et al. (2013) who identified 11 sites recreational fishing sites and 14 recreational fisheries sites in the District.

However, the number of sites appears to have been an underestimate in both studies. Recreational fishing in PDD has a broad profile. In addition to coastal areas and open marine waters, the activity is also pursued in the estuarine zones of the several rivers that run through the district. These include the Sepang (which constitutes the district's northern boundary with Selangor state) and Jimah rivers in the north part of Port Dickson district and the Linggi river, which constitutes its southern boundary with Melaka state.

Important participants in the industry included boat owners that have large sea going yachts moored at the District's one functioning marina (**Figure 4-1**), more modest boat owners that own skiffs that operate from boatels (a waterside facility equipped to house individually owned boats) (**Figure 4-2**), as well as others who simply fished from the shoreline (**Figure 4-3**), offshore recreational fishing platforms (**Figure 4-4**), jetties and revetments (**Figure 4-5**) or even an artificial riverine saline lagoons (**Figure 4-6**).

Figure 4-1: Upmarket Boating Marina in Port Dickson

Figure 4-2: Mid- market Boatel in Port Dickson

Figure 4-3: Shore Based Fishing, Port Dickson Town

Figure 4-4: Offshore Recreational Fishing Platform, Lukut, Port Dickson

Figure 4-5: Recreational Fishing from a Disused Artisanal Fishing Jetty, Port Dickson

Figure 4-6: Artificial Riverine Lagoon, Pengkalan Durian, Port Dickson

4.2.1 Recreational Fisheries Sites: Location Overview

The various locations were established through discussions with recreational fishers and tackle shops, both within and outside the District. Data collected during this phase of the study included the site name, geolocation, distance from nearest township, distance from PD town and infrastructure available at recreational fishing points, baitworm retailers.

The data indicated that there were 30 sites, of which nine were located within estuaries, while 21 were along the shoreline or at the sea. Of the estuarine locations, one (Pengkalan Durian) was an artificial lagoon, significantly upstream of the Linggi River, though still within reach of the saline intrusion of the river but not widely known. A full listing of the various fishing sites (recreational and artisanal) their attendant infrastructure and geographical character is provided in **Table 4-1** to **Table 4-3** and exemplified graphically in **Figure 4-7** and **Figure 4-8**.

Of the 30 fishing landing points, four (13%) were dedicated recreational fishing jetties, five (16%) were offshore platforms similarly dedicated to recreational fishing, and two were on nearshore islands (7%). All these were dedicated for static casting. Where boat-based fishing was concerned, there was only one (3%) jetty (P2R) dedicated for recreational fishing. Sites such as the One World Marina (P12S) and the Seaview Centre (P20S) simply offered facilities such as slipways and did not actively promote the activity.

In summary, dedicated infrastructure for recreational fishing was found only in 39% of the sites surveyed. The balance 61% consisted of artisanal fisheries jetties, beachfronts and coastline protection infrastructure used opportunistically for recreational fishing. Notwithstanding that, it is pertinent to point out that while most of the infrastructure was publicly funded for artisanal fishing, there has been some investment, both private and public, in recreational fishing infrastructure, including the construction of stand-alone fish platforms (5) and fishing jetties (6), two of which have been constructed at offshore islands.

Of the dedicated recreational fisheries infrastructure, two fishing jetties (P2R and P7S) and one fishing platform (P7S) were built by local government agencies. The other fishing platforms were built by the private sector. Recreational fishing jetties in the Kuala Lukut cluster (P25R, P26S, P27R, P28R, P29S) (**Table 4-1;** Error! Reference source not found.) were built by the private sector and regional cooperative investment in non-dedicated recreational fisheries infrastructure have been by both by individual entrepreneurs as well as government agencies. Where the marinas are concerned (Admiral Cove Marina and PD World Marina), private sector investment has been very significant (Jimmy Yeow, Bonvest Sdn. Bhd., pers.comm., 11th October 2016). The Admiral Cove marina supported recreational boating as a whole and boat-based fishing is seen as subset of that activity (Simon Theseira, Simpson's Marine, pers.comm., 5th September 2016).

Table 4-1: Recreational Fishing Points, their Geographical Location and Infrastructure in Port Dickson

Code	Site Name	Environment	Location (Lat/Long)	Infrastructure
Recreational Fishing Sites				
P1R	Pengkalan Durian	Linggi River	2° 28.292' N; 102° 01.415'	Wooden platform/Pond banks
P2R	Pengkalan Kempas	Linggi River	2° 26.903' N; 102° 01.08' E	Artisanal Jetty
P3R	Tg. Agas	Linggi River	2° 23.887' N; 101° 58.957' E	RF Jetty
P4S	Kg. Teluk	Sea	2° 23.925' N; 101° 56.530' E	Artisanal fishing Jetty
P5S	Kg. Teluk	Sea	2° 24.565' N; 101° 56.434' E	Offshore Platform
P6S	Kg. Balak	Sea	2° 25.504' N; 101° 55.520' E	Artisanal fishing Jetty
P7S	Pulau Asam	Sea	2° 25.228' N; 101° 55.132' E	Offshore Platform
P8S	Pulau Asam	Sea	2° 25.207' N; 101° 55.102' E	RF Jetty
P9S	Teluk Pelanduk	Sea	2° 25.131' N; 101° 53.141' E	Artisanal fishing Jetty
P10S	Pulau Perjudi	Sea	2° 24.860' N; 101° 53.866' E	Island
P11S	Pantai Nelayan Teluk Kemang	Sea	2° 27.747' N; 101°51.065' E	Slipway/beachfront
P12S	One World Marina	Sea	2° 28.342' N; 101° 50.835' E	Breakwater
P13S	Admiral Cove Marina	Sea	2° 28.580' N; 101° 50.760' E	Marina
P14S	Pulau Burung	Sea	2° 29.446' N; 101° 50.347' E	Revetment
P15S	Pantai Bagan Pinang	Sea	2° 30.536' N; 101° 49.708' E	Beachfront
P16S	Pantai Pejabat Daerah	Sea	2° 31.393' N; 101° 48.449' E	Shoreline Revetment
P17S	PD Waterfront	Sea	*From* 2° 31.337' N; 101° 48.220' E *To* 2° 31.262' N; 101° 47.822' E	Shoreline Revetment
P18S	Kg. Gelam	Sea	2° 32.092' N; 101° 47.678' E	Beachfront
P19S	Shell Jetty	Sea	2° 32.472' N; 101° 47.918' E	Shoreline Revetment
P20S	Seaview Centre	Sea	2° 32.290' N; 102° 47.844' E	Slipway/beachfront
P21S	Pantai Gemok	Sea	2° 32.740' N; 102° 47.919' E	Groyne
P22R	Kuala Lukut	Lukut Kecil River	2° 33.695' N; 101° 49.596' E	Artisanal fishing jetty
P23R	LKIM Jetty	Lukut Besar River	2° 34.876' N; 101° 47.371' E	Artisanal fishing jetty
P24R	Bukit Palong	Lukut Besar River	2° 35.197' N; 101° 49.596' E	Artisanal fishing jetty

Code	Site Name	Environment	Location (Lat/Long)	Infrastructure
P25R	Kuala Lukut (Koperasi)	Lukut Besar River	2° 34.976' N; 101° 47.412' E	Recreational fisheries jetty
P26S	Kuala Lukut (Koperasi)	Sea	2° 33.758' N; 101° 47.272' E	Offshore Platform
P27R	Kuala Lukut (Mahmod)	Lukut Besar River	2° 34.767' N; 101° 47.224' E	Recreational fisheries jetty
P28S	Kelong Mahmod Tengah	Sea	2° 34.190' N; 101° 46.235' E	Offshore Platform
P29S	Kelong Mahmod Tepi	Sea	2° 35.614' N; 101° 45.729' E	Offshore Platform
P30R	Bukit Pelandok	Sea	2° 38.331' N; 101° 43.097' E	Artisanal fishing jetty
Artisanal Fishing Jetties (No Recreational Fisheries)				
F1	Sg. Rambai	Sea	2° 35.902' N; 101° 46.201' E	Artisanal fishing jetty
F2	Bakar Arang	Sea	2° 36.271' N; 101° 45.448' E	Artisanal fishing jetty
Townships				
TI	Linggi		2° 29.011' N; 102° 00.722' E	
T2	Pengkalan Kempas		2° 26.903' N; 102° 01.08' E	
T3	Pasir Panjang		2° 25.586' N; 101° 51.364' E	
T4	Teluk Kemang		2° 27.099' N; 101° 51.364' E	
T5	Port Dickson		2° 31.415' N; 101° 47.789' E	
T6	Lukut		2° 33.940' N; 101° 49.593' E	
T7	Chuah		2° 36.210' N; 101° 46.026' E	
T8	Bukit Pelandok		2° 38.702' N; 101° 44.702' E	
Baitworm (Polychaetes) Retail				
B1	Sri Rusa		2° 29.802' N; 101° 50.354' E	
B2	Tanah Merah Site C		2° 31.317' N; 101° 48.171' E	
B3	Kuala Lukut Besar		2° 34.834' N; 101° 47.146' E	
B4	Kuala Lukut Besar (Mahmod Jetty)		2° 34.876' N; 101° 47.371' E	

Code	Site Name	Environment	Location (Lat/Long)	Infrastructure
Tackle Retail				
G1	Port Dickson		2° 31.549' N; 101° 47.863' E	
G2	Bukit Palong		2° 35.485' N; 101° 49.350' E	
G3	Lukut Town		2° 33.940' N; 101° 49.593' E	
Tackle Rental				
R1	Kuala Lukut Besar (Mahmod Jetty)		2° 34.876' N; 101° 47.371' E	
R2	Pengkalan Kempas		2° 26.903' N; 102° 01.08' E	

Table 4-2: Recreational Fishing Points by Physical Location and Activity Type – Port Dickson

Code	Site Name	Activity Undertaken	Distance from PD Town	Orientation from PD Town	Nearest Township	Distance to Nearest Township
P1R	Pengkalan Durian	Static casting	42km	South	Linggi	1 km
P2R	Pengkalan Kempas	Static casting	37km	South	Pengkalan Kempas	0 km
P3R	Tg. Agas	Static casting	36km	South	Pasir Panjang	6km
P4S	Kg. Teluk	Boat based fishing	30km	South	Pasir Panjang	1.5km
P5S	Kg. Teluk	Static casting	30km (road);	South	Pasir Panjang	
P6S	Kg. Balak	Static casting	28km	South	Pasir Panjang	1 km
P7S	Pulau Asam	Static casting	30k (road);	South	Pasir Panjang	
P8S	Pulau Asam	Static casting	30k (road);	South	Pasir Panjang	
P9S	Teluk Pelanduk	Static casting	30km	South	Teluk Kemang	8km
P10S	Pulau Perjudi	Static casting	30km	South	Teluk Kemang	8km
P11S	Pantai Nelayan Teluk Kemang	Boat based fishing Static casting		South	Teluk Kemang	0 km
P12S	One World Marina	Static casting	13km	South	Teluk Kemang	1.2km
P13S	Admiral Cove Marina	Boat based fishing	10km	South	Teluk Kemang	3km
P145	Pulau Burung	Static casting	7.7km	South	Port Dickson	7.7km
P15S	Pantai Bagan Pinang	Static casting	5km	South	Port Dickson	5km
P16S	Pantai Pejabat Daerah	Static casting	0.5km	South	Port Dickson	0.5km
P17S	PD Waterfront	Static casting	0km	Town Centre	Port Dickson	0km
P18S	Kg. Gelam	Boat based fishing	1.7km	North	Port Dickson	1.7km
P19S	Shell Jetty	Static casting	2.5km	North	Port Dickson	1.5km
P20S	Seaview Centre	Boat based fishing	0.5km	North	Port Dickson	0.5km
P21S	Pantai Gemok	Static casting	0.6km	North	Port Dickson	0.6km
P22R	Kuala Lukut	Boat based fishing	7.1km	North	Lukut	4.7km
P23R	LKIM Jetty	Static casting	8km	North	Lukut	6km
P24R	Bukit Palong	Boat based fishing	7.7km	North	Lukut	2.6km

Code	Site Name	Activity Undertaken	Distance from PD Town	Orientation from PD Town	Nearest Township	Distance to Nearest Township
P25R	Kuala Lukut (Koperasi)	Static casting	18.6km	North	Chuah	7.8km
P26S	Kuala Lukut (Koperasi)	Static casting		North	Chuah	7.8km
P27R	Kuala Lukut (Mahmod)	Static casting Boat based fishing		North	Chuah	7.9km
P28S	Kelong Mahmod Tengah	Static casting				7.9km
P29S	Kelong Mahmod Tepi	Static casting		North	Chuah	
P30R	Bukit Pelandok	Static casting	33.3km	North	Bukit Pelandok	1.3km
Artisinal Fishing Jetties (No RF)						
F1	Sg. Rambai	Boat based fishing	25.4km	North	Chuah	3km
F2	Bakar Arang	Boat based fishing	27.1km	North	Chuah	1.7km

Table 4-3: Recreational Fishing Points by Associated Commercial Activity and Access

Code	Site Name	Road Access	Utilities		Commercial Activity	
			Electricity	Water	Restaurants	Others
P1R	Pengkalan Durian	Dirt track - 1km; Paved - 1.4km	None	None	None	None
P2R	Pengkalan Kempas	Off PD - Melaka coastal trunk road	None	None	Tea stall	None
P3R	Tg. Agas	Paved access off Tg, Agas - Kuala Linggi Road	Available	Available	Available	Parking
P4S	Kg. Teluk	Paved access off Pasir Panjang- Kg. Teluk Road	Available	Available	Available	Parking
P5S	Kg. Teluk	Off Kg. Teluk	Available	Available	Available	Parking at PNK Kg. Teluk
P6S	Kg. Balak	Partly paved access off PD - Melaka coastal trunk road	Available	Available	None	None
P7S	Pulau Asam	Off Kg. Balak	None	None	None	Staging Point at Kg. Balak
P8S	Pulau Asam	Off Kg. Teluk				
P9S	Teluk Pelanduk	Paved access off PD - Melaka coastal trunk road	Available	Available	Limited	Parking
P10S	Pulau Perjudi	Paved access off PD - Melaka coastal trunk road	Available	Available	Limited	Parking
P11S	Pantai Nelayan Teluk Kemang	Paved access off PD - Melaka coastal trunk road	Available	Available	Available	Limited parking; boatel
P12S	One World Marina	Unpaved access off PD - Melaka coastal trunk road	None	None	None	None
P13S	Admiral Cove Marina	Paved access off PD - Melaka coastal trunk road	Available	Available	Available	Parking; accommodation
P145	Pulau Burung	Paved access off PD - Melaka coastal trunk road	Available	Available	None	Parking
P15S	Pantai Bagan Pinang	Partly paved access off PD - Melaka coastal trunk road	Available	Available	Available	Parking; accommodation
P16S	Pantai Pejabat Daerah	Unpaved access off town centre	None	None	None	Parking
P17S	PD Waterfront	Pave access from town centre	Available	Available	Available	Parking; accommodation
P18S	Kg. Gelam	Paved access	Available	Available	None	Limited parking
P19S	Shell Jetty	Paved access off PD - Seremban coastal trunk road	None	None	None	Limited parking
P20S	Seaview Centre	Paved access	Available	Available	None	Limited parking

Code	Site Name	Road Access	Utilities		Commercial Activity	
			Electricity	Water	Restaurants	Others
P21S	Pantai Gemok	Paved Access	None	None	None	Limited parking
P22R	Kuala Lukut	Paved access off PD - Seremban coastal trunk road	Available	Available	Available	Limited parking
P23R	LKIM Jetty	Paved access off PD - Seremban coastal trunk road	None	None	None	None
P24R	Bukit Palong	Paved access from PD - Sepang road	Available	Available	Available	Available
P25R	Kuala Lukut (Koperasi)	Paved access from PD - Sepang road	Available	Available	Available	Available
P26S	Kuala Lukut (Koperasi)	Paved access from PD - Sepang road				
P27R	Kuala Lukut (Mahmod)	Paved access off PD - Sepang Road	None	None	None	Available
P28S	Kelong Mahmod Tengah	Paved access off PD - Sepang Road	None	None	None	Available
P29S	Kelong Mahmod Tepi	Paved access off PD - Sepang Road	None	None	None	Available
P30R	Bukit Pelandok	Paved access from PD -Sepang road	Available	Available	Available	Available

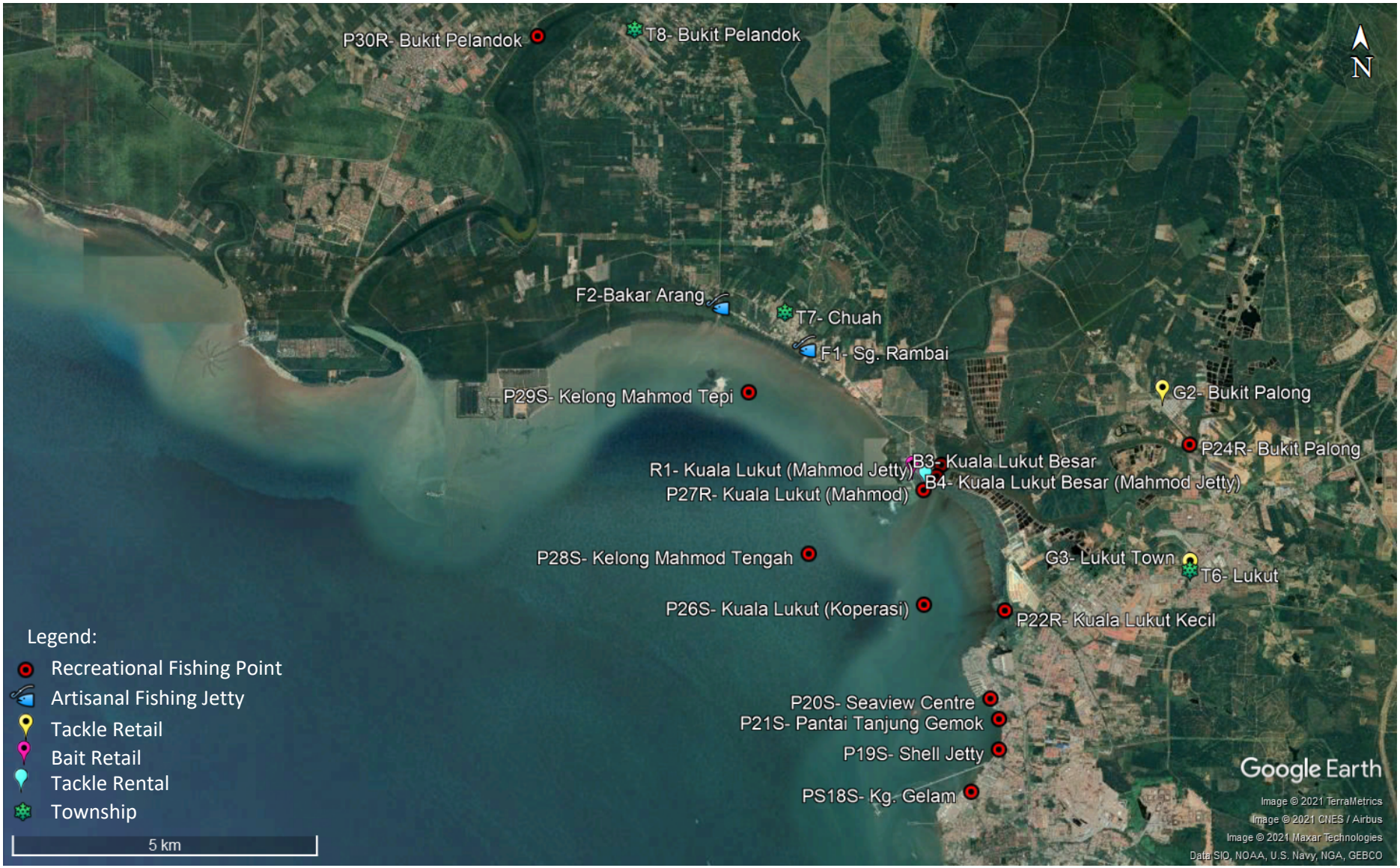

Figure 4-7: Recreational Fisheries Locations in Port Dickson (North) (*Source: Modified from Google Earth*)

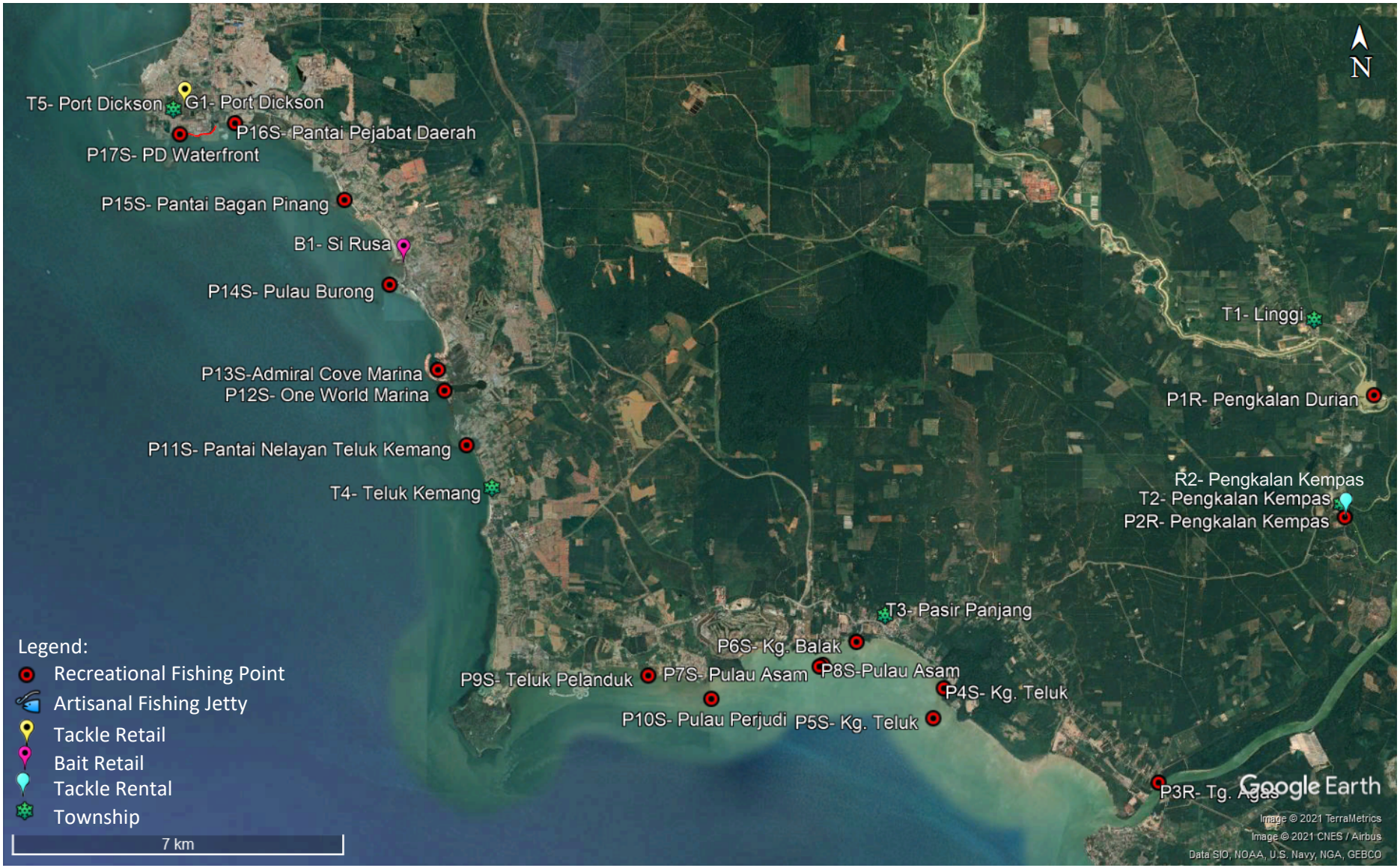

Figure 4-8: Recreational Fisheries Activities in Port Dickson (South) (*Source: Modified from Google Earth*)

4.2.2 Access

Almost all the sites identified had access to paved roads mainly through the PD – Melaka coastal highway (Route 2). Other were accessible through state roads, though the quality of these roads was variable. Only 3 sites (P1R and P12S) had dirt tracks leading to the fishing sites.

4.2.3 Proximity to Townships

Though Port Dickson town is the largest urban enclave in the district, there are 7 other smaller townships as well. All these townships, however, come under the jurisdiction of the Port Dickson Municipal Council (*Majlis Perbandaran Port Dickson* or MPPD). The location of the various fishing sites in relation to Port Dickson town and the nearest township appears in **Table 4-2**. Almost all the recreational fishing sites identified were reasonably close to either PD town or its townships, the most distant being Teluk Pelanduk, which was 8km from the Teluk Kemang township. The proximity to the townships was considered since recreational fishers purchased supplies (such as food and disposables) from these townships.

4.2.4 Supporting Infrastructure

Physical structures

The quality of infrastructure of the various recreational landing points varied according to the site. Almost all were of concrete or rock revetment based. Wooden jetties were employed only in Kuala Lukut cluster (P25R, P26S, P27R, P28R, P29S). The offshore platforms were largely made of wood as well with their supports consisting of *nibong* (*Oncosperma tigilarium*) poles. The exception was P7S, which was constructed using concrete piles. All needed repair or maintenance; the private jetties in the Kuala Lukut cluster being the best maintained. Outside the jetties in the Kuala Lukut cluster, none of the others had roofing to protect fishers from inclement weather.

Some 11 (36%) did not have electricity or freshwater supply, while none had dedicated toilets. Toilets were available where there were restaurants adjacent to the fishing sites (more in relation to this below) but these were maintained for the restaurant's customers rather than for the recreational fishers.

Restaurants

Of the 30 recreational fishing points, only 11 had restaurants that supported recreational fishers in the sense they were located immediately adjacent to the recreational fishing jetties themselves and best poised to benefit from their presence. The balance did not, which is not to say that restaurants and shops in nearby townships did not benefit from

their presence, since the cuisine at the landing points may not have been the same as in the townships.

Baitworms

There was a significant baitworm fishery in the District, and 4 vendors were recorded (a typical baitworm stall appears in **Figure 4-9**). Izwandy et al. (2012) reported that two species, all polychaetes from the family Nereididae, are harvested i.e. *Namalycastis rhodochorde* and *Perinereis cf. nuntia.*). Both species have a wide natural distribution along the west coast of Peninsular Malaysia).

The vendors reported that the worms were harvested at low tide where the baitworms bury themselves in the sand and mudflats. There are two (2) methods that the collectors used to collect the baitworms. Collectors either attract them to the surface by using a combination of rice water (i.e. water that is drained off after rice is cooked) and *belacan*, a local shrimp paste made with *Acetes* shrimp or they dig them out directly using a hoe. Baitworms are then spaded out and packed in plastic bags and sold for RM5-10 per bag. As part of this study, 4 bags of the bait worms were procured from vendors and analysed. However, only a single species was identified from the first 3 bags i.e. *Marphysa* sp. with composite weight of 22.07g. The last bag contained *Onuphis* sp. with composite weight of 28.69g. A major problem in identification was that the worms were mutilated during harvest (**Figure 4-10**).

We did not collect detailed data on the baitworm fishery. The activity is unlicensed and there is no monitoring of the numbers harvesting baitworms or the volume being harvested. Practically anyone with a spade or a *cangkul* (hoe) could undertake harvesting of the worms Operators of the four stalls identified in this study undertook the activity on a part time basis. All four were temporary roadside stalls and opened only during weekends or long holidays when demand was most intense. Though the vendors undertook the activity as a livelihood, it was supplemental to other income sources (Maggi, baitworm vendor, Sg. Rusa, pers.comm., 11th Oct 2016). Interviews with two of the operators indicate that bait worm harvests have declined since the mid – 1990s. The decline was attributed by them to overfishing (of the worms) but no formal study has been undertaken to confirm this.

Figure 4-9: Baitworm Stall in Port Dickson

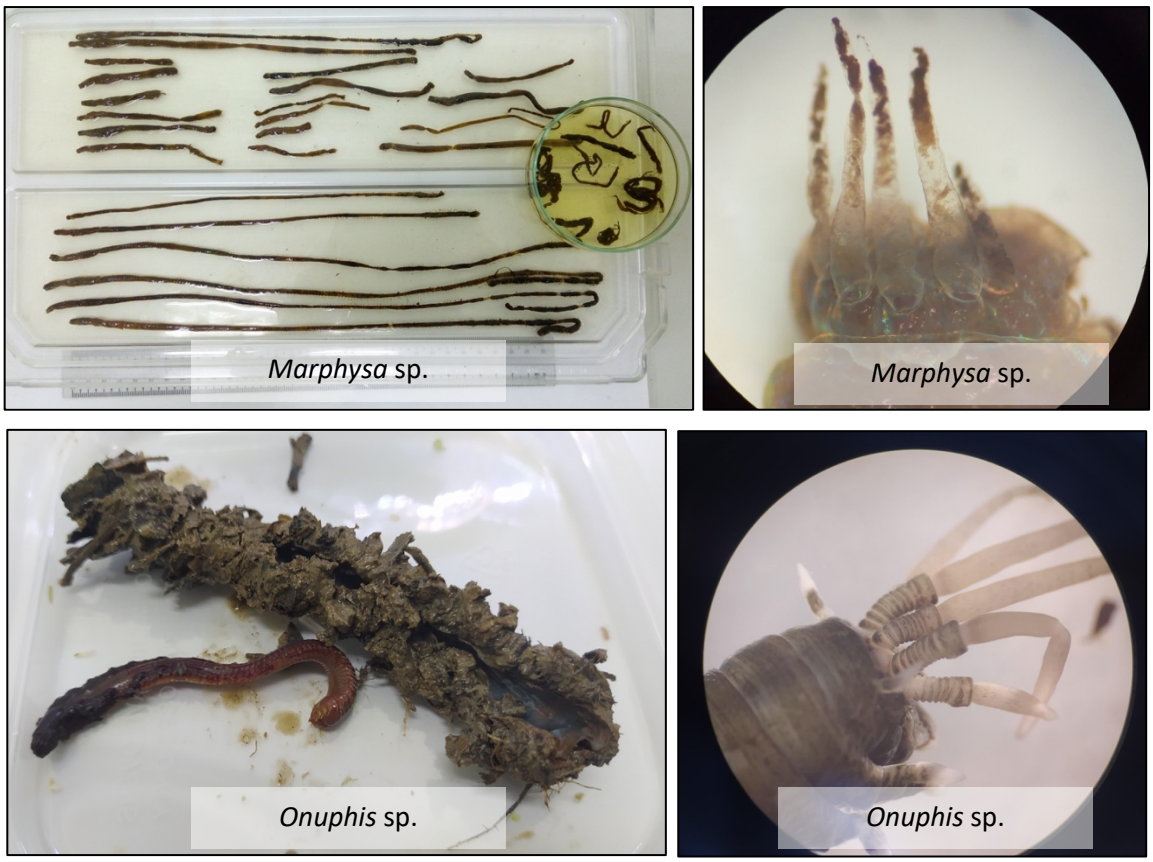

Figure 4-10: Baitworms Harvested in Port Dickson

Tackle – Retail & Rental

There were three shops that sold fishing tackle as a primary activity. One was very large (could be regarded as angling supermarket) (**Figure 4-11**), while the other two were smaller but still dedicated to selling angling equipment and related paraphernalia. In addition, there were two vendors that offered rental of fishing tackle. Both were recorded in either end of the district (R1 and R2).

Figure 4-11: Angling Supermarket in Port Dickson

4.2.5 Socio Economic Profile on Recreational Fishers in Port Dickson

Socio-economic data of fishers collected during this preliminary phase of the study appears in **Table 4-4** to **Table 4-7**. A total of 223 recreational fishers throughout the district were polled. However, not all respondents were forthcoming about some of the more personal information (such as income levels) and their origins. Where possible, proxies such as occupational level, was used to indicate socio-economic status were collected. However, where origin (where the fishers came from) was concerned, the issue was much more difficult, with only 217 respondents providing information on their origins. Data captured was thus confined to whether the fishers were from within or without PDD.

The difficulty of obtaining more detailed information was probably because there was the relatively short time spent with the respondents. A longer time enabling a more personal rapport to be established may have enabled more data to elicited from the respondents concerned.

Table 4-6 is on the gender distribution of the fishers polled. Recreational fisheries in Port Dickson is clearly a male-dominated activity. Of the 223 polled, 214 (96%) were males. Only 4% of women polled accompanied their husbands or male chaperones in fishing. The data, however, included those women actually fishing and not others, who simply offered companionship or looked after accompanying children.

The analysis of age distribution in age data in **Figure 4-12** indicates that there were significantly more fishers in the age ranges of 20-40 and 41-60 compared with the older or younger age distribution classes (P=Kruskall Wallis, P< 0.001), when comparing all sites with most recreational fishers polled (194 or 87%) coming from the two middle age range cohorts. Similarly, comparing age cohorts for riverine only and sea-based only sites (4.13), indicate that both sites follow the same age distribution pattern for recreational fishers, with significantly greater number of fishers being in the middle age cohorts for both riverine and sea based fishers (Kruskall Wallis, P=0.004 and P<0.001, respectively).

It is pertinent to point out that within the 20-40 age cohort combined, most of the respondents were within the 35 – 40-year age sub-cohort, something that was taken into account in the preparation of questionnaires for the Phase 2 of the study. The older cohort group (>60 years) and, to a lesser extent, the younger cohort group (<20 years) tended to gravitate towards the more urban locations, close to townships such as Linggi, Port Dickson or Lukut (**Figure 4-13**). This may be due to the unwillingness to be too far from urban conveniences for those within these cohort groups.

Table 4-4: Number of Recreational Fishers by Landing Point and Age Cohort

Code	Site Name	Environment	Date Collected	No of Respondents			
				Age cohort (years)			
				<20	20-40	41-60	>60
P1R	Pengkalan Durian	Linggi River	24/12/15	1	5	1	-
P2R	Pengkalan Kempas	Linggi River	24/12/15	1	2	2	-
P3R	Tg. Agas	Linggi River	24/12/15	1	13	5	1
P4S	Kg. Teluk	Sea	24/12/15	-	6	-	-
P5S	Kg. Teluk	Sea	25/12/15	-	3	1	-
P6S	Kg. Balak	Sea	25/12/15	-	5	-	-
P7S	Pulau Asam	Sea	21/11/15	-	-	5	-
P8S	Pulau Asam	Sea	21/11/15	-	4	3	-
P9S	Teluk Pelanduk	Sea	31/12/15	-	3	-	-
P10S	Pulau Perjudi	Sea	31/12/15	-	-	7	-
P11S	Pantai Nelayan Teluk Kemang	Sea	31/10/15	-	5	5	-
P12S	One World Marina	Sea	31/12/15	-	-	3	-
P13S	Admiral Cove Marina	Sea	31/10/15	-	-	12	-
P145	Pulau Burung	Sea	24/12/15	1	5	3	-
P15S	Pantai Bagan Pinang	Sea	24/12/15	1	5	3	-
P16S	Pantai Pejabat Daerah	Sea	24/12/15	-	2	-	-
P17S	PD Waterfront	Sea	05/12/15	-	5	1	-
P18S	Kg. Gelam	Sea	02/01/16	-	5	1	-
P19S	Shell Jetty	Sea	01/04/16	2	2	2	1
P20S	Seaview Centre	Sea	31/10/15	5	5	-	6
P21S	Pantai Gemok	Sea	27/02/16	-	3	-	-
P22R	Kuala Lukut	Lukut Kecil River	21/04/16	-	4	2	2
P23R	LKIM Jetty	Lukut Besar River	24/01/16	-	2	9	1
P24R	Bukit Palong	Lukut Besar River	24/01/16	-	-	4	-

Code	Site Name	Environment	Date Collected	No of Respondents			
				Age cohort (years)			
				<20	20-40	41-60	>60
P25R	Kuala Lukut (Koperasi)	Lukut Besar River	26/04/16	-	1	-	-
P26S	Kuala Lukut (Koperasi)	Sea	26/4/16	-	4	4	-
P27R	Kuala Lukut (MahMod)	Lukut Besar River	24/12/15	-	4	2	-
P28S	Kelong Mahmod Tengah	Sea	23/01/16	-	7	5	-
P29S	Kelong Mahmod Tepi	Sea	23/01/16	-	-	9	3
P30R	Bukit Pelandok	Sepang River	24/12/15	-	-	5	3
Total				**12**	**100**	**94**	**17**

Table 4-5: Number of Recreational Fishers by Landing Point and Ethnicity

Code	Site Name	Environment	Date Collected	No of Respondents			
				Ethnic Group			
				Malay	Chinese	Indians	Others
P1R	Pengkalan Durian	Linggi River	24/12/15	7	-	-	-
P2R	Pengkalan Kempas	Linggi River	24/12/15	2	3	-	-
P3R	Tg. Agas	Linggi River	24/12/15	20	-	-	-
P4S	Kg. Teluk	Sea	24/12/15	6	-	-	-
P5S	Kg. Teluk	Sea	25/12/15	4	-	-	-
P6S	Kg. Balak	Sea	25/12/15	5	-	-	-
P7S	Pulau Asam	Sea	21/11/15	4	1	-	-
P8S	Pulau Asam	Sea	21/11/15	4	2	1	-
P9S	Teluk Pelanduk	Sea	31/12/15	3	-	-	-
P10S	Pulau Perjudi	Sea	31/12/15	7	-	-	-
P11S	Pantai Nelayan Teluk Kemang	Sea	31/10/15	6	3	-	1
P12S	One World Marina	Sea	31/12/15	3	-	-	-
P13S	Admiral Cove Marina	Sea	31/10/15	2	6	2	2
P145	Pulau Burung	Sea	24/12/15	9	-	-	-
P15S	Pantai Bagan Pinang	Sea	24/12/15	9	-	-	-
P16S	Pantai Pejabat Daerah	Sea	24/12/15	2	-	-	-
P17S	PD Waterfront	Sea	05/12/15	6	-	-	-
P18S	Kg. Gelam	Sea	02/01/16	5	-	-	1
P19S	Shell Jetty	Sea	01/04/16	5	2	-	-
P20S	Seaview Centre	Sea	31/10/15	8	8	-	-
P21S	Pantai Gemok	Sea	27/02/16	3	-	-	-
P22R	Kuala Lukut	Lukut Kecil River	21/04/16	7	1	-	-
P23R	LKIM Jetty	Lukut Besar River	24/01/16	10	1	1	-
P24R	Bukit Palong	Lukut Besar River		-	3	1	-

Code	Site Name	Environment	Date Collected	No of Respondents			
				Ethnic Group			
				Malay	Chinese	Indians	Others
P25R	Kuala Lukut (Koperasi)	Lukut Besar River	26/4/16	1	-	-	-
P26S	Kuala Lukut (Koperasi)	Sea	26/4/16	8	-	-	-
P27R	Kuala Lukut (Mahmod)	Lukut Besar River	24/12/15	6	-	-	-
P28S	Kelong Mahmod Tengah	Sea	23/01/16	12	-	-	-
P29S	Kelong Mahmod Tepi	Sea	23/01/16	12	-	-	-
P30R	Bukit Pelandok	Sepang River	24/12/15	6	2	-	-
Total				**182**	**32**	**5**	**4**

Table 4-6: Number of Recreational Fishers by Landing Point by Gender and Occupation

Code	Site Name	Environment	Date Collected	No of Respondents				
				Gender		Occupation		
				Male	Female	GS	PS	Others
P1R	Pengkalan Durian	Linggi River	24/12/15	7	-	2	4	1
P2R	Pengkalan Kempas	Linggi River	24/12/15	5	-	-	4	1
P3R	Tg. Agas	Linggi River	24/12/15	16	4	8	2	10
P4S	Kg. Teluk	Sea	24/12/15	6	-	4	2	-
P5S	Kg. Teluk	Sea	25/12/15	4	-	4	-	-
P6S	Kg. Balak	Sea	25/12/15	5	-	-	5	-
P7S	Pulau Asam	Sea	21/11/15	4	1	-	5	-
P8S	Pulau Asam	Sea	21/11/15	7	-	-	7	-
P9S	Teluk Pelanduk	Sea	31/12/15	3	-	3	-	-
P10S	Pulau Perjudi	Sea	31/12/15	6	1	-	7	-
P11S	Pantai Nelayan Teluk Kemang	Sea	31/10/15	10	-	-	10	-
P12S	One World Marina	Sea	31/12/15	3	-	-	3	-
P13S	Admiral Cove Marina	Sea	31/10/15	10	2	-	12	-
P145	Pulau Burung	Sea	24/12/15	9	-	6	3	-
P15S	Pantai Bagan Pinang	Sea	24/12/15	9	-	6	3	-
P16S	Pantai Pejabat Daerah	Sea	24/12/15	2	-	2	-	-
P17S	PD Waterfront	Sea	05/12/15	6	-	2	4	-
P18S	Kg. Gelam	Sea	02/01/16	6	-	2	4	-
P19S	Shell Jetty	Sea	01/04/16	7	-	-	7	-
P20S	Seaview Centre	Sea	31/10/15	16	-	8	5	3
P21S	Pantai Gemok	Sea	27/02/16	2	1	-	2	1
P22R	Kuala Lukut	Lukut Kecil River	21/04/16	8	-	1	6	1
P23R	LKIM Jetty	Lukut Besar River	24/01/16	12	-	1	10	1
P24R	Bukit Palong	Lukut Besar River	24/01/16	4	-	-	4	-

Code	Site Name	Environment	Date Collected	No of Respondents				
				Gender		Occupation		
				Male	Female	GS	PS	Others
P25R	Kuala Lukut (Koperasi)	Lukut Besar River	26/04/16	1	-	-	1	-
P26S	Kuala Lukut (Koperasi)	Sea	26/04/16	8	-	-	-	8
P27R	Kuala Lukut (Mahmod)	Lukut Besar River	24/12/15	6	-	4	2	-
P28S	Kelong Mahmod Tengah	Sea	23/01/16	12	-	2	10	-
P29S	Kelong Mahmod Tepi	Sea	23/01/16	12	-	-	12	-
P30R	Bukit Pelandok	Sepang River	24/12/15	8	-	2	4	2
Total				**214**	**9**	**57**	**138**	**28**

GS *Salaried Government Servants*

PS *Salaried Private Sector Workers*

Other *Businessman, retirees, RM3000 - RM5000*

Table 4-7: Number of Recreational Fishers by Landing Point and Origin

Code	Site Name	Environment	Date Collected	No. of Respondents	
				Origin	
				Within Port Dickson	Outside Port Dickson
P1R	Pengkalan Durian	Linggi River	24/12/15	5	2
P2R	Pengkalan Kempas	Linggi River	24/12/15	-	5
P3R	Tg. Agas	Linggi River	24/12/15	-	20
P4S	Kg. Teluk	Sea	24/12/15	-	6
P5S	Kg. Teluk	Sea	25/12/15	-	4
P6S	Kg. Balak	Sea	25/12/15	-	5
P7S	Pulau Asam	Sea	21/11/15	-	5
P8S	Pulau Asam	Sea	21/11/15	-	7
P9S	Teluk Pelanduk	Sea	31/12/15	-	3
P10S	Pulau Perjudi	Sea	31/12/15	-	7
P11S	Pantai Nelayan Teluk Kemang	Sea	31/10/15	-	10
P12S	One World Marina	Sea	31/12/15	3	-
P13S	Admiral Cove Marina	Sea	31/10/15	-	12
P145	Pulau Burung	Sea	24/12/15	9	-
P15S	Pantai Bagan Pinang	Sea	24/12/15	9	-
P16S	Pantai Pejabat Daerah	Sea	24/12/15	2	-
P17S	PD Waterfront	Sea	05/12/15	-	6
P18S	Kg. Gelam	Sea	02/01/16	-	6
P19S	Shell Jetty	Sea	01/04/16	6	1
P20S	Seaview Centre	Sea	31/10/15	10	-
P21S	Pantai Gemok	Sea	27/02/16	3	-
P22R	Kuala Lukut	Lukut Kecil River	21/04/16	-	8
P23R	LKIM Jetty	Lukut Besar River	24/01/16	7	5
P24R	Bukit Palong	Lukut Besar River	24/01/16	-	4

P25R	Kuala Lukut (Koperasi)	Lukut Besar River	26/4/16	-	1
P26S	Kuala Lukut (Koperasi)	Sea	26/4/16	-	8
P27R	Kuala Lukut (Mahmod)	Lukut Besar River	24/12/15	-	6
P28S	Kelong Mahmod Tengah	Sea	23/01/16	-	12
P29S	Kelong Mahmod Tepi	Sea	23/01/16	-	12
P30R	Bukit Pelandok	Sepang River	24/12/15	2	6
Total				**56**	**161**

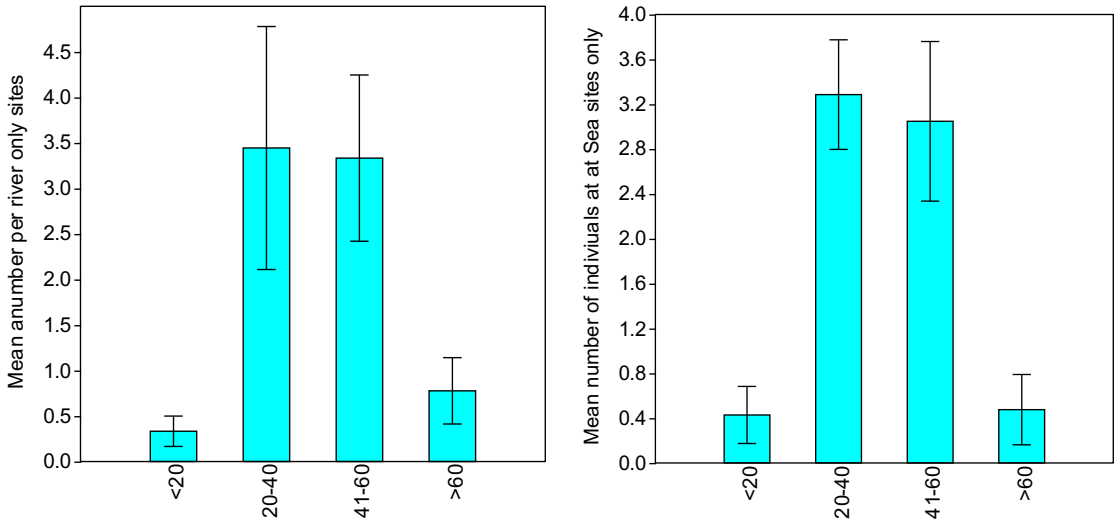

Figure 4-12: Mean Age Class Distribution for River Landing Point and Marine Landing Points

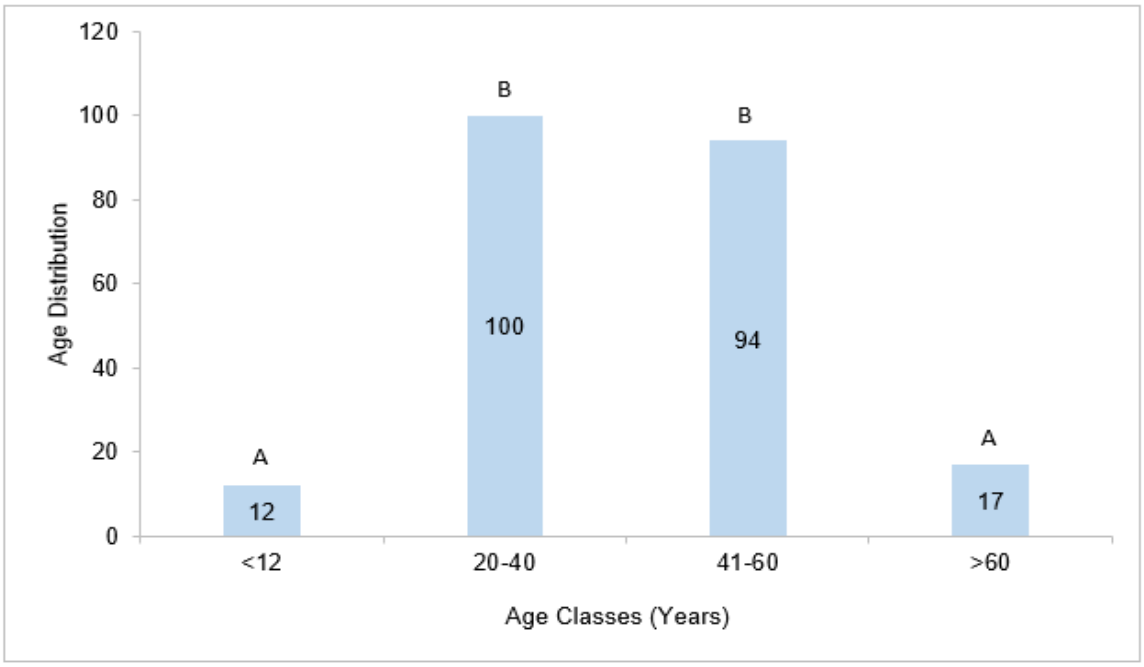

Figure 4-13: Total Age Range Distribution of Recreational Fishers in Port Dickson. Post- hoc Dunn's Test Indicates Significant Differences (P<0.001) as Indicated with Lettering

From an ethnic standpoint (**Figure 4-14**), most recreational fishers were Malays (182 respondents or 81%), followed by Chinese (14%) and Indians and Others (which included those from the Borneo states of Sabah/ Sarawak, other minorities, and foreigners). However, the ethnic distribution was not evenly spread out among all fish landing points. While Malays clearly dominated the land based and offshore platform locations, non-Malay participation were seen in boat-based locations such as Pantai Nelayan, Teluk Kemang, Admiral Cove and Seaview Centre. The ethnic distribution described here, suggests that there are cultural variances relating to the basic question of why recreational fishers fish i.e. their primary motivation to fish, and what are their specific drivers that would lead to this ethnic bias in engendering a geographic separation. The initial data acquired during this initial phase of this study suggested that the motivation to undertake recreational fishing is not a simplistic '*I enjoy the nature of the open sea',* kind of answer(s). Instead, the ethnic drive for some communities to enjoy recreational fisheries more than others pointed to a deeper cultural imperative.

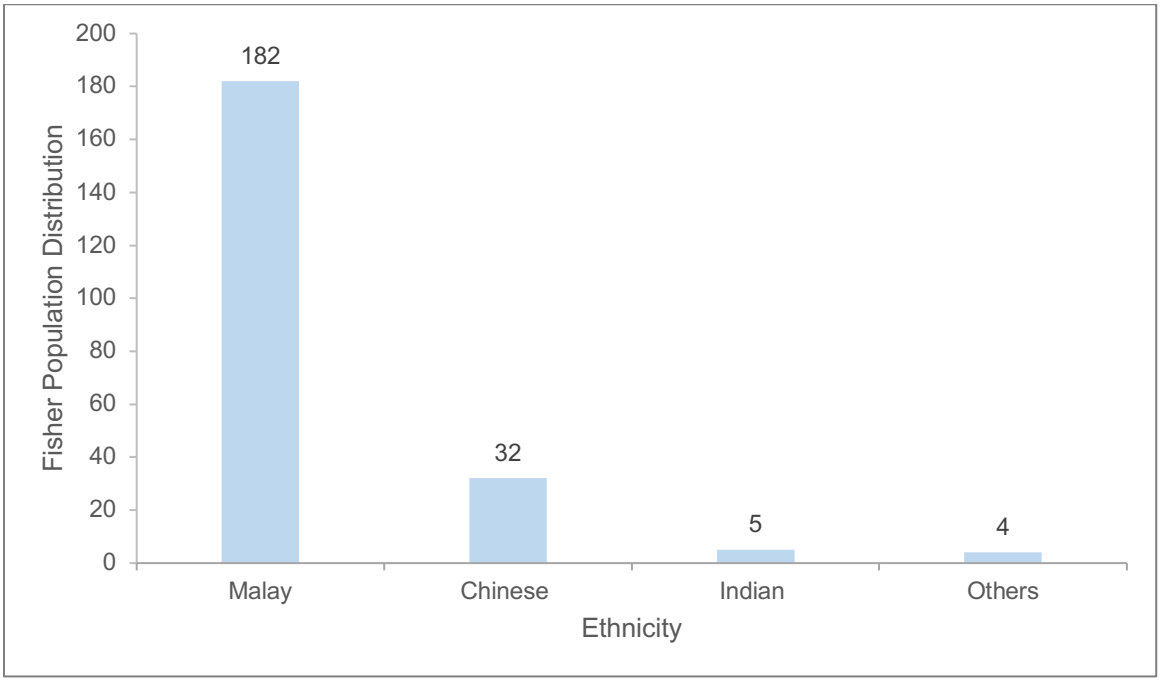

Figure 4-14: Ethnic Distribution of Recreational Fishers in Port Dickson

The fishers were generally reluctant to reveal their incomes; hence, the focus in data collection was on their occupations, from which their monthly incomes were inferred. **Table 4-6** shows that the majority (138 or 62%) were salaried workers in the private sector. Most were at sub-professional or technician levels, except for boat-based locations, which attracted more professional and executive level clientele, especially in the case of the Admiral Cove marina, which has high quality boating accompanied by appropriate accommodation and restaurant facilities. A small number (57 or 26%) of respondents worked in the public sector, their occupational levels largely mirroring those from the private sector. Most were static casting fishers and there was a noticeable absence of public sector fishers in the boat-based locations. Where the data on origins of the recreational fishers is concerned, **Table 4-7** shows that the majority of respondents (74%) were from outside Port Dickson district (mainly the towns of Seremban and Nilai as well as the Klang Valley) indicating proximity to a resource may not necessarily induce local communities to make use of them for recreational purposes.

A comparison of selected socio-economic metrics across riverine and marine sites using median values (**Table 4-8**) shows no significant difference in these metrics, with p-values for the Mann-Whitney U statistic ranging from 0.37 to 0.85. This suggests that average age, the preponderance of Malays and male, the percentage from outside PDD, the average inferred income and occupational distributions among fishers are not different between riverine and marine sites. The percentage of fishers from outside PDD in each location was also not linearly related to average age at the location (**Figure 4-15**). However, the percentage of fishers from outside PDD in each location was significantly related to average inferred income at each location (**Figure 4-16**).

The results tell us that who the fishers are (average age, gender, ethnicity) does not differ much across location and that most locations see fishers from outside PDD. Furthermore, locations with mostly fishers from outside PDD had higher incomes. Recreational fisheries in PDD thus appears to be integral to its attractions as a domestic tourism site.

Table 4-8: Comparing Selected Socio-Economic Characteristics Across Riverine and Marine Locations: Medians and Mann-Whitney U Test Statistics

Description	River	Marine	Mann-Whitney U Statistic	p-values
Number of locations	9	21		
Average Age, median	36.67	35.71	104	0.65
Percent Malay, median	100	100	85	0.80
Percent Outside PDD, median	100	100	95	0.37
Average Income, median	3250	3500	80	0.53
Percent Male, median	100	100	97	0.85
Percent Private Sector Employees	75	83.33	90	0.85

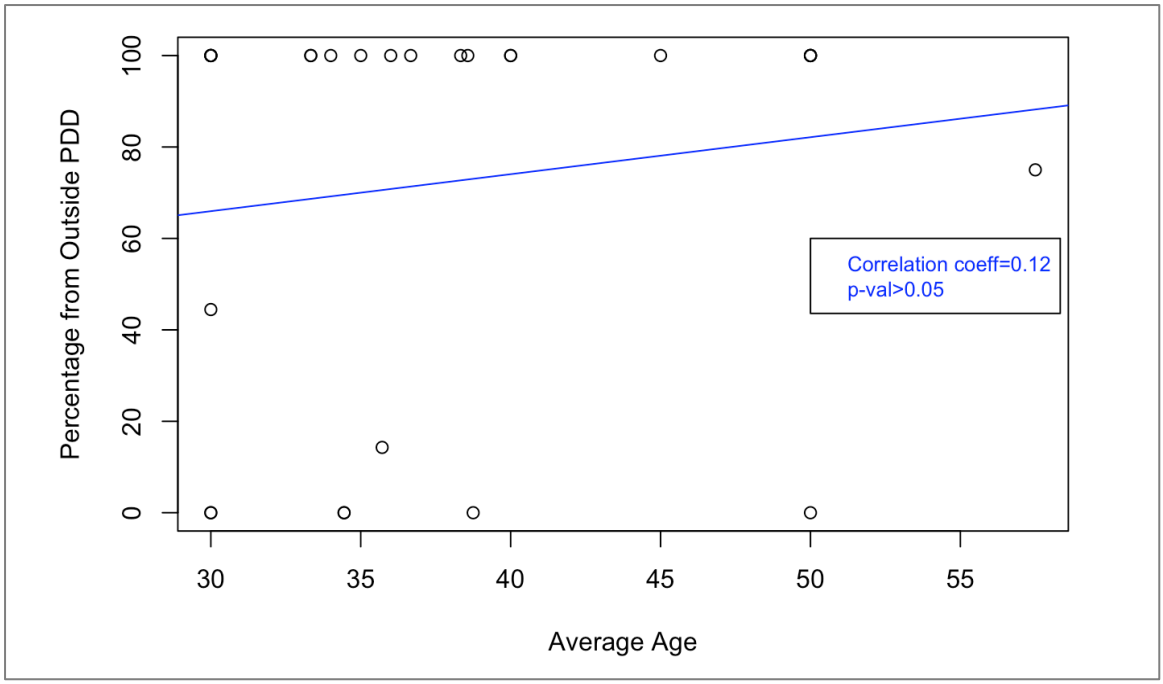

Figure 4-15: Scatterplot of Locations Showing Percentage from Outside PDD against Average Age

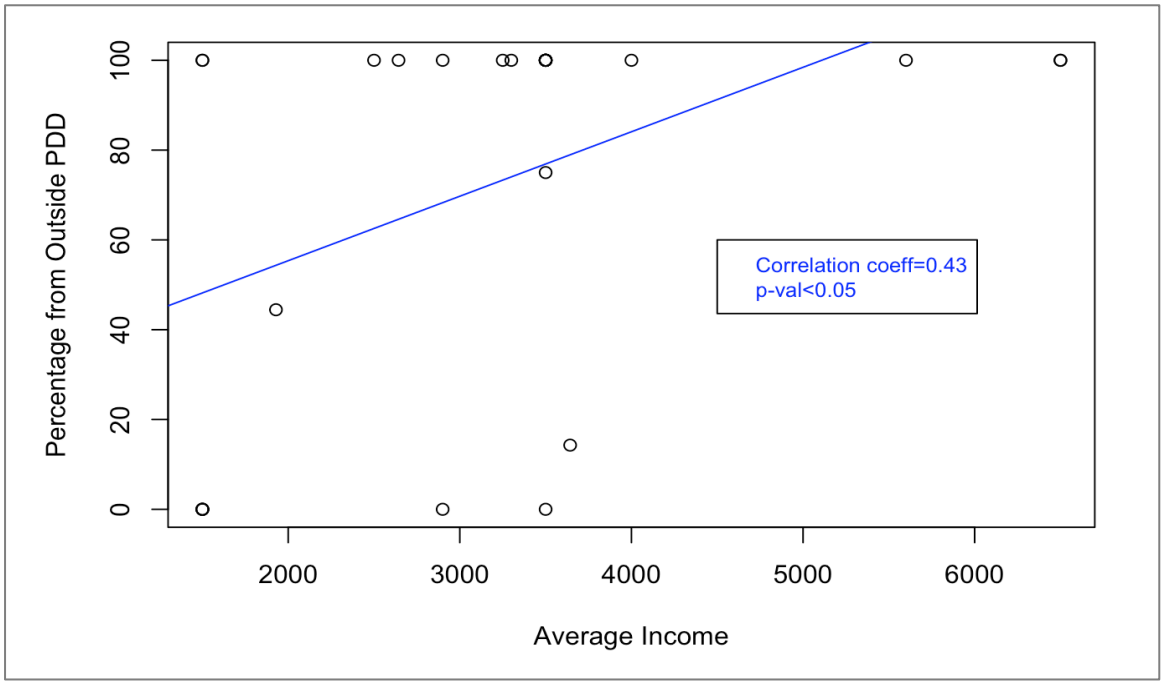

Figure 4-16: Scatterplot of Locations Showing Percentage from Outside PDD against Average Income

4.2.6 Habitat Preferences of Recreational Fishers in Port Dickson

Where fishing predispositions are concerned, fishers (whatever their motivation) do not fish randomly but target areas that have habitats supporting the aggregation of their target species. This predisposition is behind the more recent management concepts such as Ecosystem Based Fisheries Management (EBFM) and Ecosystem Approach to Fisheries Management (EAFM) that mainstreams habitat protection as a central plank of fisheries management and comes in contrast with traditional approaches that viewed it exclusively from the standpoint fisheries biology (Hiew, 2013). Recreational fishers in Port Dickson instinctively target fish resources on this basis.

Discussions with recreational fishers and their predispositions with respect to their favourite locations (known locally as “honey holes”) suggest that that there are far more fisheries habitats than that has been reported thus far (Gopinath et al*.,* 2000). The relationship of these habitats with recreational fisheries is palpable. Most fishers were able to identify the presence of habitats (though not their nature i.e. what they were) as a major factor in the choice of recreational fishing sites. The main natural habitats supporting both artisanal and recreational fisheries In PDD appears to be mangroves and accompanying mudflats, seagrass meadows and coral reefs (Gopinath et al., 2000).

Both recreational as well as artisanal fishers gravitate towards these habitats as they influence both the target species (which vary according to habitat type) as well as the health of their stocks. Where boat based recreational fishers were concerned, shipwrecks were also an important choice of fishing locations (Thim Chan, Recreational Fisheries Boater, 2017). As the Straits of Malacca has historically been one of the most navigated waterways in the world (Mohd Rusli, 2020), the presence of shipwrecks, known and unknown, would have acted as important refugia. The more intrepid boat based recreational fishers ventured into the Traffic Separation Zone in the Straits of Malacca, especially areas where dense populations of fish are found (Thim Chan, Recreational Fisheries Boater, pers. comm., 2017). However, it is unclear whether these ‘honeypots’ are entirely attributable to habitats, natural or otherwise, alone. For instance, most artisanal fishermen do not venture into the Traffic Separation Zone due to safety and security reasons and it may well be that the stocks within the zones are comparably underfished.

The relationship between habitat and target species is more complex in recreational as compared to commercial/artisanal fisheries. In commercial fisheries, the targets are those with significant market value. While market value does play a role in the choices of recreational fishers, subjective values such as challenge is also important.

The example of the yellowfin tuna in Semporna was cited as such an example in **Chapter 1**. The issue of target species is clearly related to habitat. While based on existing literature, there has been no comprehensive mapping of the fisheries habitats in the District's waters, data from fishers suggested both south and north Port Dickson had distinct catch profiles where recreational fishing was concerned, the middle point roughly being the promontory of Tanjung Tuan (**Figure 3-30**). The northern sites appeared to appeal to fishers interested in euryhaline and mangrove related species such as groupers *(Epinephelus* spp.), sea bass (*Lates calcarifer*), snappers (*Lutjanus* spp.), croakers (Sciaenidae), grunts (Pomadasyidae) and plotosid catfish (Plotosidae). In the south, while this was also the case in some landing points, there was a greater focus on deeper water fish such as the Indian Threadfin (*Leptomelanosoma indicum*) which is a reef fish, trevally (Carangidae) and Ariid catfish (Aridae). Where the Pengkalan Kempas landing point was concerned, the giant freshwater prawn (*Macrobrachium rosenbergii*) was an important mainstay.

This preponderance in target species choice dovetails with the habitat profile of PDD. Much of the recreational fishing north of Port Dickson town were based on euryhaline estuarine and mangrove-dependent species such as the sea bass (*Lates calcarifer*) and groupers (*Epinephelus* spp.), though some of these species can be found further offshore as well depending on their maturity class. The role of mangroves (Chong, 2007), seagrasses (Aziz et al., 2001) and coral reefs (Burke et al., 2011) in sustaining these species have long been explored and established. Mangroves, being a semi-terrestrial habitat (at least at low tide), were relatively easy to evaluate in terms of presence and extent. Data on mangroves was sourced from the Port Dickson Integrated Shoreline Management Plan (NAHRIM, 2008).

The data lapse appeared was with respect to submerged habitats that are not so easily assessed. Some of these are natural (mudflats, seagrasses, and coral reefs), while others were incidentally man-made (such as shipwrecks), data for which, for most part, had to be sourced from the Marine Department, Peninsular Malaysia. However, the data from the Marine Department has been only from 1970s and only then those that pose a navigation hazard (Dr. Capt. Ibrahim Mohd., Marine Navigational Specialist, Universiti Putra Malaysia, pers.comm., 19th Oct. 2018).

Discussions with recreational fishers and their predispositions with respect to their favourite locations, as well as artisanal fishermen, suggest that that there are far more habitats, natural and man-made than that have been reported thus far in the literature, Discussions with anglers indicate that these habitats fall into two categories:

- Natural habitats, such as coral reefs and seagrasses
- Artificial habitats, specifically shipwrecks. These were in deeper waters in the Traffic Separation Lane of the Straits of Malacca, where depths ranged from 70 – 90m.

A detailed appraisal of all the fisheries habitats in the District's waters were adjudged to be beyond the scope of this thesis, notwithstanding the fact that they influence the behaviour of recreational (an artisanal) fishers. Based on the feedback from recreational fishers who were interviewed during Phase 1 of the study as well as anecdotal information from artisanal fishermen and my visual appraisal, the association of the various recreational fisheries sites their possible supporting habitats is provided in **Table 4-9**. The habitats were proximate to the landing points concerned or targeted by recreational fisheries operating from/on them.

Offshore sites were less easy to assess in terms of their natural capital. Though these were alluded to by recreational fishers, but they lacked detailed data. It is important to note that the table does not intend to draw a linear linkage between the landing points, their landings, and the habitats. The table only provides a perspective on how natural capital can affect, directly or indirectly, the behaviour of fishers and fishermen.

To verify the perceptions of recreational fishers, particularly as they related to submerged habitats, I undertook detailed studies at two sample sites, identified by the fishers who were surveyed, for which there was no previously published data. Focus was on natural habitats since these had some degree of sustenance and did not degrade with time. The detailed outcomes of these studies are provided in **Appendix 9,** both of which indicate marine habitats of importance from fisheries standpoint. The outcomes indicate that there is a variety of uncharted submerged habitats that are resilient enough to sustain despite the development pressures of PDD's coastline. More important, the appraisal indicated that recreational fisheries patterns and honey holes/local knowledge are important proxies for the identification of fisheries habitats quality/type of conservation importance.

Table 4-9: Recreational Landing Point in Relation to Supporting Fisheries Habitats

Code	Site Name	Environment	Date Collected	Habitat Type			
				Mangroves	Seagrass	Reefs	Shipwrecks
P1R	Pengkalan Durian	Linggi River	24/12/15	+	-	-	-
P2R	Pengkalan Kempas	Linggi River	24/12/15	+	-	-	-
P3R	Tg. Agas	Linggi River	24/12/15	+	-	-	-
P4S	Kg. Teluk	Sea	24/12/15	+	-	-	-
P5S	Kg. Teluk	Sea	25/12/15	+	-	-	-
P6S	Kg. Balak	Sea	25/12/15	+	-	-	-
P7S	Pulau Asam	Sea	21/11/15	+	-	+	-
P8S	Pulau Asam	Sea	21/11/15	-	-	+	-
P9S	Teluk Pelanduk	Sea	31/12/15	+	-	+	-
P10S	Pulau Perjudi	Sea	31/12/15	+	-	+	-
P11S	Pantai Nelayan Teluk Kemang	Sea	31/10/15	+	-	+	+
P12S	One World Marina[1]	Sea	31/12/15	+	+	+	+
P13S	Admiral Cove Marina[2]	Sea	31/10/15	+	+	+	+
P145	Pulau Burung	Sea	24/12/15	-	-	+	-
P15S	Pantai Bagan Pinang[1]	Sea	24/12/15	-	-	+	-
P16S	Pantai Pejabat Daerah[1]	Sea	24/12/15	+	-	+	-
P17S	PD Waterfront[1]	Sea	05/12/15	+	-	+	-
P18S	Kg. Gelam	Sea	02/01/16	+	+	+	-
P19S	Shell Jetty	Sea	01/04/16	-	+	+	-
P20S	Seaview Centre	Sea[2]	31/10/15	+	+	+	+
P21S	Pantai Gemok	Sea	27/02/16	+	-	-	-
P22R	Kuala Lukut	Lukut Kecil River	21/04/16	+	-	-	-
P23R	LKIM Jetty	Lukut Besar River	24/01/16	+	-	-	-
P24R	Bukit Palong	Lukut Besar River	24/01/16	+	-	-	-
P25R	Kuala Lukut (Koperasi)	Lukut Besar River	26/4/16	+	-	-	-

Code	Site Name	Environment	Date Collected	Habitat Type			
				Mangroves	Seagrass	Reefs	Shipwrecks
P26S	Kuala Lukut (Koperasi)	Sea	26/4/16	+	-	-	-
P27R	Kuala Lukut (Mahmod)	Lukut Besar River	24/12/15	+	-	-	-
P28S	Kelong Mahmod Tengah	Sea	23/01/16	+	-	-	-
P29S	Kelong Mahmod Tepi	Sea	23/01/16	+	-	-	-
P30R	Bukit Pelandok	Sepang River	24/12/15	+	-	-	-

Note: + : related, - : not related

4.3 Conclusion

From the findings above, it appears clear that there is a significant level of recreational fishing along PDD's coastline, though static fishing (using casting) was the major recreational fishing activity pursued in Port Dickson waters. Most of the boat-based services were located in the PDD South, stretching from Pengkalan Kempas to Admiral Cove. Though there are boat ramps in PD town, these did not provide dedicated services to cater for recreational fishers. Boaters simply paid for their use. This could be because of the shipping activity around the port in PD made it unsafe for small recreational boats.

Nonetheless, it does not entirely explain why there is so much focus on boat based recreational fishing in the southern part of the district. One possibility was the presence of fisheries habitats that attracted fishers for a different experience from that of PDD North. The habitats in the north were mainly of mudflat, seagrass meadows and mangroves that supported a different species or cohort profile while the reef base open waters of the southern coast PDD attracted a different type of recreational fishers. The same possibility impinged on the convenience of marine access. The presence of mudflats would have meant that access to offshore waters would have only been possible during high tide.

The data above suggests that habitats, whether natural or artificial, are crucial to establish patterns of fisheries capture. Infrastructure and access was important but not a compelling factor. Though most recreational fisheries relied on infrastructure developed for artisanal fishers, some artisanal fishing points (F1 and F2) did not support recreational fishing activity (**Table 4-1**). The same two sites had access that was neither obvious nor convenient. What is compelling is that recreational fishing continued to carried out in the waters off these points. Neither access nor infrastructure could override their resource appeal.

Based on the findings of the Phase 1 study, the focus of Phase 2 of the study, which specifically dealt with boat-based fishing, was framed. Phase 2 is discussed in greater detail in **Chapter 5**.

However, the most most important finding of Phase 1 is that the data indicates that recreational fishers and their fishing patterns can act as indicators of submerged habitats that are yet unchartered. This is crucial information to fisheries scientists on what makes a fishery work. Recreational fishers have an incentive to sustain the health of these habitats and possibly represent an educated and informed population that can advocate for it. This needs to be explored further in future studies.

CHAPTER 5: BOAT BASED RECREATIONAL FISHING IN PORT DICKSON

5.1 Introduction

While previous chapter provided a backdrop to the recreational fisheries industry as a whole, this chapter zooms into boat-based fishing in PDD and its ecological, social and economic impact. The objective of to the provide an assessment of boat based fishing practices and their economic impact. The data to enable this assessment was part of Phase 2 of this study. To reiterate, a modified ethnographic approach was undertaken where interviews with both fishers as well as boat operators were undertaken, and the data populated in a pre-planned questionnaire format before data analysis. However, I administered the questionnaire in an informal conversational form, capturing the necessary data as required.

Boat based fishing represents the more socio-economically important component of recreational fisheries in the country. This is because, for most part, it involves coastal communities, particularly fishermen, who have the fishing and navigational skills to facilitate recreational fishers. The activity was sufficiently lucrative that many have modified their fishing boats to comply with safety standards, providing life jackets and other equipment. Boat based recreational fishing can thus be a catalyst for further development of the fisheries industry, providing supplementary income to artisanal fishermen, at the same time forcing them to comply to maritime safety standards, that they hitherto they did saw no reason for.

The data was derived from five (5) boat-based landing points in PDD that provided dedicated boat based recreational fisheries services. It excluded those points where boat rentals were made available by fishermen to recreational fishers on an opportunistic basis i.e. they did not offer a dedicated service.

It also did not include sites that used by individuals on occasion. For instance, it did not include the use of the P12S Marina site, which had an abandoned boat ramp from where recreational activity was undertaken on a sporadic basis by individual boaters who owned their own vessels. As the ramp was not being managed by anyone, it was impossible to predict when and how it was used. Access to the ramp was through a dirt track and given the difficulty of hauling boat trailers under such circumstances, it is likely that its use was sporadic. The same issues also did not include the data from the Seaview Centre (P20S). This point only provided a managed boat ramp for individual boaters to go to sea.

The financial accrual in this case was not boat rental but use of the boat ramp by boat owners. Boats using the ramp could be fishing but could also indulge in cruising and other sea-based activities. Post 2017, traffic at the ramp came to a stop and thus did not have a major role in the district's recreational fisheries sector.

The five locations were found to be dedicated towards providing boat services for angling either on a full or part time basis. Almost all were in the southern coast of PPD, reasons for which have been speculated earlier (**Chapter 4**). These were Pengkalan Kempas (P2R), Kuala Linggi (P3R), Admiral Cove (P13S), Teluk Kemang (P11S), Pulau Burung (P14S). Though these five points catered to recreational fishers (at least during the times at which the survey was carried out), there was a diversity of services that were available at each point, and more importantly, they catered for a widely differing socio-economic spectrum. There were significant differences in the nature of the environment, the species targeted, the kind of services offered, the fishing grounds and socio-economic profile of the fishers using them. Generalisations of recreational fishing activity would thus have to focus on those parameters that transcend these differences.

The major characteristics of the various landing points involved were as follows.

a) Pengkalan Kempas (P2R) – This was essentially a riverine fishery landing point, which had more (but officially unrecognised) importance as recreational fisheries point.

b) Admiral Cove (P13S) – This was a commercial marina from which there is an organised recreational fisheries service. There were no fishermen operating from this point.

c) Tanjung Agas (P3R); Teluk Kemang (P11S); Pulau Burung (P14S) – These were artisanal fisheries landing points that supported recreational fisheries activity.

The locations of these points are provided in **Figure 5-1** below. The discussion of these locations below is based on data collection procedures described in Appendix **Section 2.4, Chapter 2**.

Section 5.1 below provides a profile of each location. We examined boat capacity, fishers, type of fishing gear used, and type of fish caught, leading to identification of characteristics that are unique to each location. Fishers were profiled by ethnic group, gender, and age group. Although fishers were asked about motivation, they were unable to clarify this beyond vague references to a combination of "stress relief", "relaxation", "enjoying nature" and such. These were not so different among locations, so an overview of the comments on motivation is reviewed in the next chapter.

Section 5.2 provides a comparison of these locations, focusing annualised financial value, and the impact of locations on fishing effort. **Section 5.3** provides a summary and conclusion to the chapter.

The data on which some of these comparisons have been made appear in **Appendix 10**.

Figure 5-1: Staging Points for Boat-based Angling

5.2 Profile of Boat Based Landing Points Sampled

5.2.1 Pengkalan Kempas (2º 26.903'N, 101º 1.080'E)

Pengkalan Kempas is a riverine fishing landing point located within the upper saline intrusion zone of the Sg. Linggi, lying approximately 11 km upstream of the river's estuary. Though originally a major riverine port and the focal point of Sumatran Minangkabau migration and trade into the state of Negeri Sembilan (evidence of which is in an outdoor museum adjoining the hamlet that bears its name), it had since been reduced to a minor artisanal fishery landing point. Pengkalan Kempas is not the uppermost recreational fishing point in the Sg. Linggi. That privilege belongs to Sg. Timun, which has also been developed for recreational boating. However, Sg. Timun is in the adjoining Rembau district and out of the spatial scope of this study.

Artisanal fishing is still carried out to this day in Pengkalan Kempas. The Department of Fisheries (unpublished) data indicated that there were 15 licensed boats and 18 licensed fishermen registered at the base, of which only 6 were active (Ah Yong, Head, Fishermen's Unit, Pengkalan Kempas, pers.comm., 2017). However, my survey indicated that there were over 90 boats moored at the point, many with roofs (unlike dedicated fishing boats), indicating their use for a more demanding clientele.

Assuming unlicensed fishermen accounted for five times the licensed fishermen (Ah Yong, Head, Fishermen's Unit, Pengkalan Kempas, pers.comm., 2017), that would still account for only 45 boats. That means that the rest would have catered for other river users. All 90 boats, however, are available for hire by recreational fishers. Rental rates for boats ranged from RM60 – 300/day depending on the size of the boats. Most of the fleet consists of small boats and larger boats were limited in number.

Approximately 80% were small boats (i.e. *sampans* or skiffs with a maximum carrying capacity of 4 persons) and about 20% larger boats (boats that can carry 6 persons or more). In the absence of detailed data on the number of boats carrying passengers, and assuming that there are 90 boats in the fleet (most of which do so illegally), an average rental rate is calculated at RM84/boat per day. This figure is based on a rate of RM60 per small boat and a median rate of RM180 for a bigger boat.

The target species, both by artisanal and recreational fishers, was the giant prawn (*udang galah* or *Macrobrachium rosenbergii*) that is found in relative abundance in the river (**Figure 5-2A**). The prawn commands a premium price locally (RM100/kg for males 100g and above, where they are known as *jingga*). Where recreational fishers were concerned, the animal is challenging to catch with hook-and-line due to its ventral mouth, though other fish, particularly estuarine species such as Plotosid catfish (*Arius* spp.),

Snappers (*Lutjanus* spp.), Chacunda Gizzard (*Anodontostoma chacunda*) and Asian Sea Bass (*Lates calcarifer)* are also caught. There were also juvenile marine species such as the Wolf Herring (*Chirocentrus dorab*). However, these finfish tended to be secondary to the giant prawn (**Figure 5-2B-C**).

Two major differences distinguish Pengkalan Kempas from others in this survey. Firstly, it supports only riverine fishing, most boats moored there being too small to go out to sea. Since I began the survey, however, a 10m boat capable of sea travel has been moored at the site, indicating a demand from serious anglers. However, at the time of writing, the primary focus was still on riverine fishing and the giant prawn. Secondly, there was an involvement of families accompanying the male fishers (**Figure 5-2D**).

Figure 5-2: Fishing Activities at Pengkalan Kempas. A: Fisher with Large Male *M. rosenbergii*; B: Chacunda Gizzard (*Anodontostoma chacunda*) Catch; C: Asian Sea Bass (*Lates calcarifer*) Catch; D: Families Accompanying Fishers

Discussions with seven (7) family groups during the course of the survey indicated the major reason for this was the relatively easy access (cars can park almost at the edge of the riverbank), low rental cost for the boats and the presence of a restaurant at the landing site where food and beverages could be readily ordered. The more compelling reason cited (particularly by the women) was the relatively short trip duration of 8 -12 hours. The short duration related to the fact that none of the boats had toilet facilities (a characteristic that is found in other recreational fishing boats as well) and long trips can be difficult for women and children, who must sit perched on the side of their boats to do the necessary. It is important that this very critical consideration is probably behind the male domination of the boat-based fisher population.

Fishing gear used by recreational and artisanal fishers vary considerably. Artisanal fishers employ a range of gear types including cast nets, gill nets, vertical traps (or pods) and to a limited extent, horizontal traps (called locally as *duka*). The use of the *duka* is not endorsed by the Department of Fisheries but there are individuals that employ it. Recreational fishers use hook-and-line, but a major difference at this landing point has been the use of weighted lines to ensure a baited leader line sits at the bottom of the river with small hooks (Kaki Pancing, 2014). This is because the giant prawns are bottom feeders with a ventral mouth part that requires the prawn to mount the bait. Not all fishers are successful at this technique and thus ending up snaring fish as well.

It is pertinent to point out that, while the primary road link connecting Pengkalan Kempas with the rest of townships in Port Dickson was realigned few years ago and, in the process, side-lined the hamlet from mainstream north-south road traffic, it has continued to prosper with its sole public car park filled during the weekend and supporting a shop selling recreational fishing supplies. In short, Pengkalan Kempas continues to thrive on a stand-alone economic base that has nothing to do with being a highway stop or an artisanal fishing base.

The fact that there are only 6 active fishermen means that artisanal fishing has little impact on its economic life. The major economic driver is recreational fishing without which the hamlet would have died economically long ago. A summary of the sampling data and its analysis appears in **Table A.10-2** to **Table A.10-4**. **Table A.10-2** and **Table A10-3** refer to the data actually collected during the various sampling runs, while **Table A.10-4** represents an extrapolation of the sampled date on an annualised basis. **Table A.10-2** represents data obtained in 59 sampling days, representing 15% of the total calendar year of 395 days that were the focus of this thesis. The sub-sampling of public holidays and school holidays were limited because they were erratic in the sampling calendar.

Their variable frequency means that a longer time period would be required to obtain the kind of data resolution on the subject that would make sense where these weekday types were concerned.

Table A.10-2 also confirms that within the angling community, Malays and other indigenous groups were far more predisposed towards recreational fisheries in Pengkalan Kempas. Most were mid-level functionaries in Government and the private sector and there was significant level of family involvement in the activity. Weekday anglers matched the number of weekend anglers possibly because of the anytime access afforded to the site.

The annualised financial value of the fishing effort was estimated at RM426,887, of which only rental income (RM113,580) or 26%, was directly accrued to the local boating community. The others financial inputs were not site specific and accrued to others elsewhere within the economic environment. Not many of these were in Pengkalan Kempas itself. For instance, there is no fuel kiosk in the hamlet, the nearest being in Linggi town. Depending on where the fishers came from, fuel costs would have accrued to other players in the regional economy.

An intriguing part of **Table A.10-2** to **Table A.10-4** is that the CPUE values are higher during regular weekdays (WD/R) than non-regular weekdays and weekends, and almost equal to weekend public holidays (WE/R). It is unclear why this is the case. A major factor could be that anglers during the weekdays actually do fishing, while the weekend trips are more family based and focused on relaxation and sight-seeing. Data specific on this possibility was not captured during the course of this study.

5.2.2 Tanjung Agas (2º 23.887'N, 101º 58.957'E)

Unlike Pengkalan Kempas, this landing point is far less egalitarian. It is an artisanal fishery landing point and most the smaller fishermen operating from this point take advantage of weekend surge in recreational fishing to transport fishers to the four footings of the Tanjung Agas – Kuala Linggi Bridge located astride this point, to undertake static casting, charging RM10 for a to-and-from trip. The data in this chapter does not consider this part of the scope of this study since the focus here is on dedicated services for boat-based fishers (as opposed to a short ferrying service).

Boat based fishing is undertaken by six (6) dedicated fishing boats that have been modified for the purpose. None of them were licensed by the Marine Department, though some had fishing licenses. In short, the activity is undertaken illegally. The focus of boat-based fishers operating from this site is offshore, particularly in the Traffic Separation Lane, where artisanal fishing is prohibited.

Where Pengkalan Kempas is open to all, the Tanjung Agas boat services are limited to those who pre-book their services. They cater for a very different demography, mostly mid-level executives from the Klang Valley (and a minority from Melaka) that are well-heeled and willing to spend on the cost and time involved in angling. The same demography was not observed in Pengkalan Kempas, where most fishers were perceived as being lower down the corporate or administrative pecking order such as technicians or support personnel. The demography also influenced the kind of gear that was employed. Rods were of high quality, while closed faced reels and multiplier reels were common. Both reels are designed for large animals and long line payouts.

The fishing grounds also varied significantly. Though the landing point was located with the Sg. Linggi estuary, Tanjung Agas fishers eschewed riverine and coastal fishing. Fishing was undertaken offshore within deeper waters, in the reefs off the southern coast of Port Dickson and at abandoned shipwrecks that act as aggregating devices. Most anglers apparently targeted demersal species such as groupers, sea bass and snappers though pelagic were caught as well. Unlike the fishers in Pengkalan Kempas, the Tanjung Agas fishers were interested in size and fighting capacity, and not on conventional market value.

The summary of the data captured during the survey appear in **Table A.10-5** to **Table A.10-7** represents data obtained in 52 sampling days, representing 13% of the total calendar year of 365 days that is the focus of this thesis. Discussions with one of the boat owners indicated that they worked only on an appointment basis i.e. they did not have a rack rate and did not cater for walk-ins. The system appeared to work with most weekends seeing bookings.

Where the socio-economic aspects of the fishing point were concerned, it is significant to note that all anglers were Malay Muslims (**Table A.10-6**). The absence of other communities in the boat rental profile in this location was explained by the fear among boat owners that non-Muslims would bring aboard alcohol and non – *halal* foods. The main age group was within the 40-55-year cohort. This would reflect the senior and junior management levels at both in public as well as private service. Gender profile of recreational fishers was totally male. None of the boats were suitable for female hygiene needs.

Annualised extrapolations of fish landed by fishers as in **Table A.10-7** indicated that the total fishing effort at this point amounted to 4,278 person days. The direct revenue in terms of rental costs amounted to RM474,000.

However, these costs included fuel and labour, which the Pengkalan Kempas boat owners were not burdened with. Total catch volume was estimated at 3.1 tonnes valued at RM0.124 million. CPUE rates varied from 1.08 kg/person-day for Regular Weekdays to 0.74kg/person-day per for Public Holidays. This was consistent the reduced recreational fishing effort during weekdays and extra fishing effort during public holidays.

Larger fish are generally slaughtered and distributed to the various anglers in each group (**Figure 5-3**). Surplus fish were given to the restaurant at the landing point for lunch for the anglers or anyone else. During the survey, no effort was observed to sell the fish, either whole or in part (**Figure 5-4**). Only non-consumable parts of the fish (such as offal) was discarded. The rest was consumed.

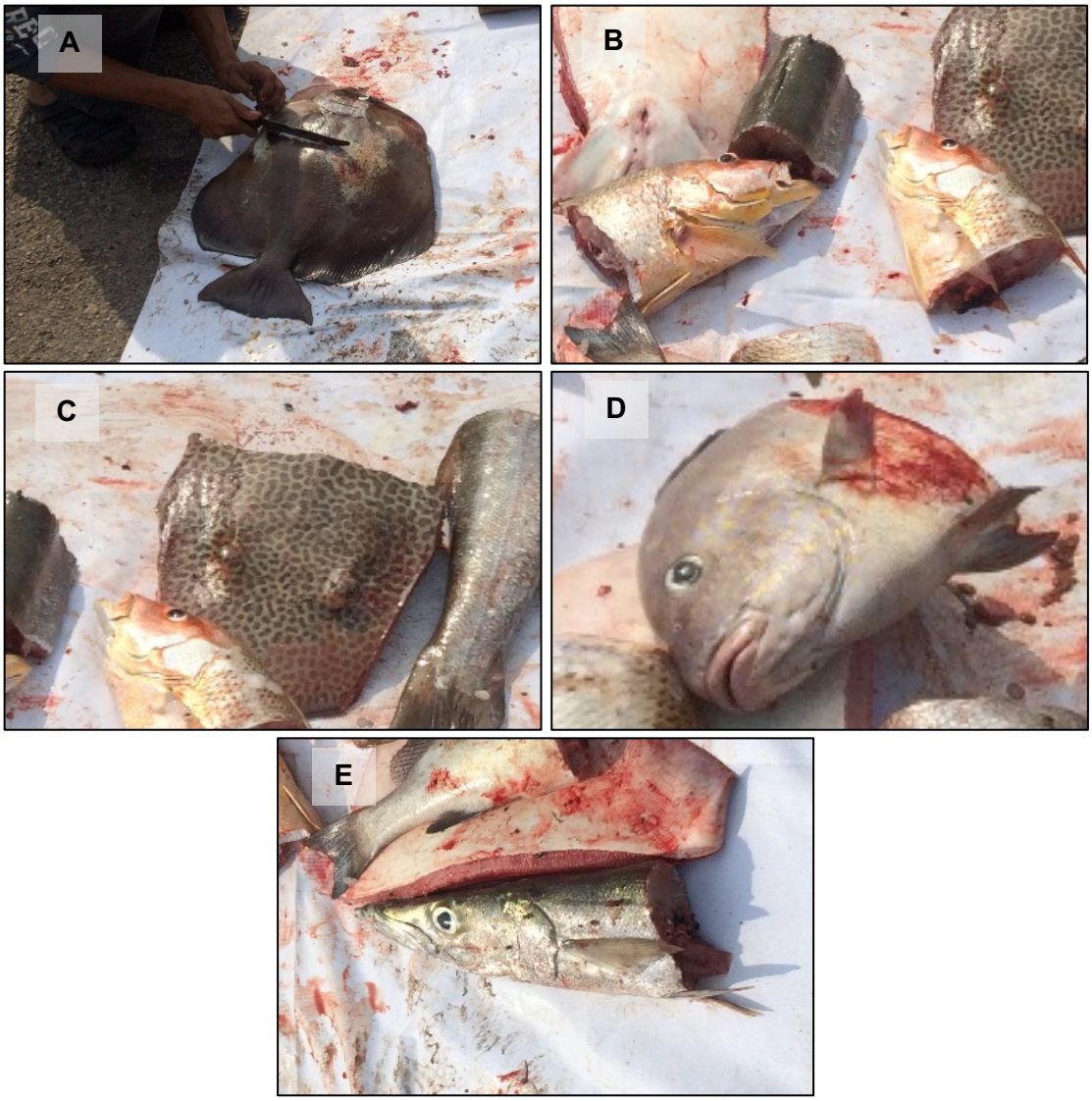

Figure 5-3: Fish Caught Slaughtered to be Distributed. A: Longfin Batfish (*Platax teira*); B: Snapper (*Lutjanus* sp.); C: Stingray (*Himantura* sp.); D: Painted Sweetlips (*Diagramma picta*); E: Barracuda (*Sphyraena* sp.)

Figure 5-4: Recreational Fisheries Catch at Tanjung Agas. Catch of Stingrays (Dasyatidae), Bamboo Shark (Hemiscylliidae), Snapper (*Lutjanus* spp.) and Queenfish (*Scomberoides commersonnianus*)

Figure 5-5: Fishing Gear Used at Tg. Agas

5.2.3 **Teluk Kemang** (2º 27.722'N, 101º 51.086'E)

Teluk Kemang (or more specifically *Kampung Nelayan Teluk Kemang* or Teluk Kemang Fishing Village) was originally a small fishing village in the northern edge of Teluk Kemang beach. With its evolution of the beach front as a major visitor destination in Port Dickson, the local Fishermen's Unit took advantage of the situation to establish a boatel to hold recreational boats, both owned by local fishermen as well as outsiders (**Figure 5-6**).

As with all boatels, rental is charged on the storage of the boats notwithstanding the fact that the boats may not have been utilised by its owners, most especially during the days the survey was carried out. Hence, the survey focused on those going out for recreational fishing. The boats used for recreational fishing were generally well equipped where safety regulations were concerned. Some were licensed by the Marine Department, though the absence of a regulatory requirement for owner-operator boats meant some boats did not bother with a formal license.

There were also boats that were rented out by the Fishermen's Unit using boats that they did not actually own. In short, the boatel effectively acted as recreational fisheries timeshare operation.

Figure 5-6: Boatel at Teluk Kemang

The presence of the boatel did not prevent individual boat owners from using the landing point to launch vessels that they towed to site. Not using the boatel facilities, they simply launched their boats from the beach using local manpower.

Rental was based on a 12-hour (morning – evening) or 24-hour (morning to morning next day) schedule depending on client needs. The data collected worked on this complex rental schedule. The 12-hour trips were largely within local waters, while the 24-hours trips intruded into the Traffic Separation Lane. Due to the need to navigate commercial shipping, the 24-hour rentals invariably involve the more skilled boatmen from the local community. Boats utilised local fishermen as guides and boat operators (these were compulsory where the boat was owned/operated by the unit) or, optionally, by individual boat owners.

The complexity of ownership and rental patterns have been glossed over in the data collected from this landing and simplified by using rental cost as a proxy for all boat-based activity, since it either represented a real or an opportunity cost. The summary of the activity appears in **Table A.10-8** to **Table A.10-13** and are discussed in detail later in this same section.

Angling success is highly valued in the landing point with fishermen willing to actively discuss the activity. The largest fish are displayed as trophies (**Figure 5-7**). These trophies do not resemble their counterparts in North America, where the fish is stuffed and mounted in whole using taxidermic techniques. In Teluk Kemang, only the tails of the fish (the parts of the fish that are least consumed) are dried out and displayed together with information on the angler, the date of catch and size of the fish, making identification problematical. However, the fact that these fish were featured as trophies suggested that angling was of a major esteem value to the community there.

Figure 5-7: Trophies of Fish Caught at Teluk Kemang. Mixed of Ebek (*Alectis* spp./ *Carangiodes* spp.) and Tenggiri (*Scomberomorus* spp.)

A summary of my survey data revealed that 12-hour rentals involved 159 anglers with an estimated fishing effort of 239 person days (**Table A.10-8**). Catch was generally low, ranging from 1 – 2kg (**Table A.10-9**). Discussions with the anglers indicated that the low catch was because the boats did not stray far from the shoreline. There was also the tendency to consume part of the catch (which consisted of smaller fish) on board. In contrast with the previous landing points, the angling population for the 12-hour rental were more ethnically more diverse, with 8% consisting of Chinese anglers. The great majority, however, remained Malay. Extrapolated over a year, 12-hour rentals involved 2,639 person-days, while financial accruals to local economy amounted to RM109,900 in terms of boat rental. A total of RM16,324 for bait and RM45,854 for transport (**Table A.10-10**), was also estimated. Catch value amounted to RM20,930, which was only 12% of the financial outlay. The balance can be inferred as a willingness-to-pay cost, and re-emphasis the point that the value of recreational fishing cannot be linked to direct financial accrual.

For the 30-hour rentals, the survey captured 164 anglers with an estimated fishing effort of 615 person days (**Table A.10-11**), suggesting that this timeframe is far more attractive as compared to the 12-hour rentals. Catch was much higher, ranging from 3 – 4kg (**Table A.10-12**). The fish were also larger, with most boats fishing in the Traffic Separation Zone. The angling population for the 30-hour rental were more ethnically more diverse with almost half (43% consisting of Chinese anglers). Extrapolated over a year, 30-hour rentals involved 7,036 person-days while financial accruals to local economy amounted to RM206,600 in terms of rent, RM17,126 for bait and RM48,256 for transport (fuel, toll, etc) (**Table A.10-13**). Catch value amounted to RM55,164, which was only 20% of the financial outlay. The balance can be again inferred again as a willingness-to-pay cost.

5.2.4 Admiral Cove (2º 28.580'N, 101º 50.760'E)

Admiral Cove is a name of recent vintage. Originally, it was the holiday resort for Malayan Railway but was since privatised as a marina-based resort called Admiral Cove. Admiral Cove is a sophisticated public marina that offers a range of services to the yachting community, whether related to recreational fishing or otherwise. The data in this section came from the one operator from Admiral Cove that focused on recreation fishing.

The difference in this landing point is its exclusivity. Admiral Cove is equipped with hotel-type accommodations, a comfortable jetty infrastructure, and qualified English-speaking boatmen, etc. The operator also maintained a comfortable vessel fleet licensed with the Marine Department and compliant with all international safety standards. The boats, however, still did not have proper toilets, which as pointed out earlier, which represented a major constraint for the participation of women in boat-based recreational fishing.

The difference of the Admiral Cove operation is its sophistication. Its operator targeted anglers in the Klang Valley through personal marketing and the Internet and promised a risk-free licensed operation with boats that provided comfortable and sophisticated surroundings catering for those who eschewed the risk of undertaking their hobby from rickety fishing boats that neither have the kind of on-board facilities they are used to nor the legal/insurance coverage they desired. On-board consumption of alcohol and non – *halal* food was also not an issue.

Figure 5-8: View of Admiral Cove Marina

The sophistication of the boats used in this enterprise enabled it to chart and identify major locations of boat-based angling. The boat came equipped with echo-sounders and GPS that could digitally capture major recreational fishing points (also known as honey holes). These locations were captured in a digital image and mapped in **Figure 5-9**. The distribution of the "honey holes" are largely confined to the south of the Tanjung Tuan promontory. Boat based fishing north of the promontory appears limited.

This appears to tie in with the marine habitat profile of the district as described in **Chapter 4**. The northern half of the district is characterised by sand beaches and mangroves. Mangroves support smaller, euryhaline species such as shrimp and fish such *Lates* spp. and *Lutjanus* spp. Thus, it would make sense if the focus in this latter region would be on nearshore and coastal species, which would invite a similar recreational profile.

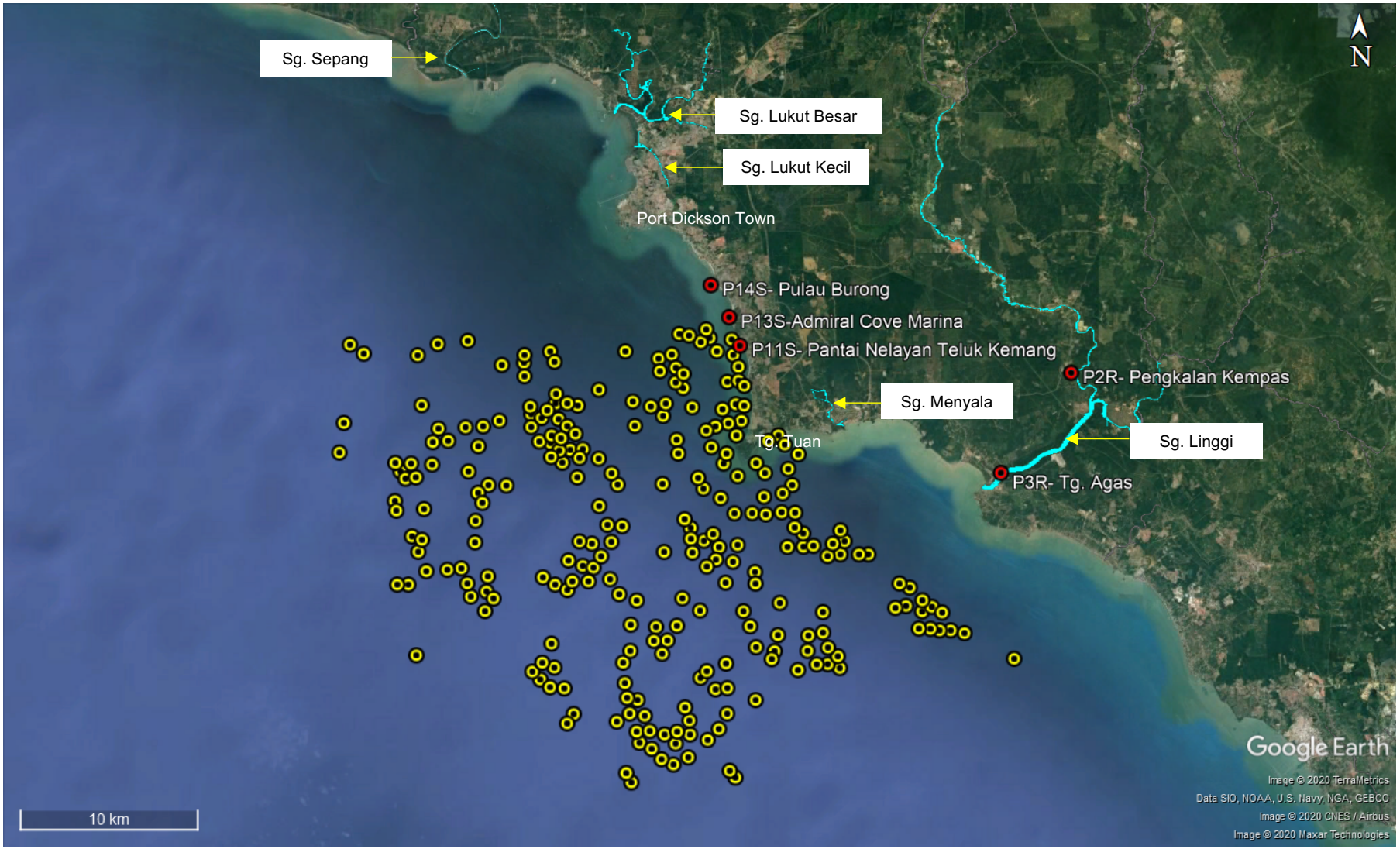

Figure 5-9: Locations of Admiral Cove Based Boat Angling

On the other hand, the habitat profile south of Tanjung Tuan was substantially different, consisting of coral reefs and related habitats. The waters off this part of Port Dickson's coastline is also influenced by the Sg. Linggi, a river that is substantially larger than the Sg. Sepang and Sg. Lukut Besar, the major waterways in the north of the District. I transposed the habitat surveys that I carried out in **Chapter 4** on the angling locations in **Figure 5-9.** The result (**Figure 5-10**) underscores the importance of these habitats in terms of recreational fisheries value.

Focus of the 30-hour recreational fishing was on large fish (**Figure 5-10**) that offered primarily value as challenge. Smaller fish were caught but either discarded, consumed, or used as bait fish. However, catch size was a function not just of location in the District's southern waters but also the distance, with larger fish being hauled from the deeper waters of the Traffic Separation Lane, as well as the targets set by the fishers involved. Large fish, as those in **Figure 5-10E**, are not quality table fish and need to be slaughtered to provide consumable pieces before being disposed.

A summary of the survey data for 12-hour fishers involved 270 anglers with an estimated fishing effort of 419 person days is presented in **Table A.10-14**. Reported catch generally ranged from 1 – 7kg (**Table A.10-15**), which was broadly the same as for Teluk Kemang fishers. In contrast with the previous landing points, the angling population was dominated by Chinese anglers. The marketing strategy of the operator (targeting more affluent, middle class anglers from the Klang Valley, and allowing alcohol and non-*halal* food on board) was probably a major factor in this ethnic predisposition. Extrapolated over a year, the activity from 12-hour recreational fishing from Admiral Cove involved a fishing effort of 1,051 person-days, while financial accruals to local economy amounted to RM105,900 in terms of rent, RM4,200 for bait and RM14,500 for transport (**Table A.10-16**). Catch value amounted to RM38,800, which was 3% of the financial outlay for the participants.

The 30-hour fishers (**Table A.10-17**) involved 228 anglers with an estimated fishing effort of 855 person days (reported catch generally ranged from 16 – 20kg) (**Table A.10-18**), which was broadly the same as for Teluk Kemang fishers. Again, in contrast with the previous landing points, the angling population was dominated by Chinese anglers. Extrapolated over a year, the activity from 30-hour recreational fishing from Admiral Cove involved a fishing effort of 2,456 person-days, while financial accruals to local economy amounted to RM94,412 in terms of rent, RM3,500 for bait and RM11,900 for transport (**Table A.10-19**). Catch volume was estimated at 2.3 tonnes, but this is most likely an underestimate. Weights and volumes were based on perceptions and not actual quantitative measurements.

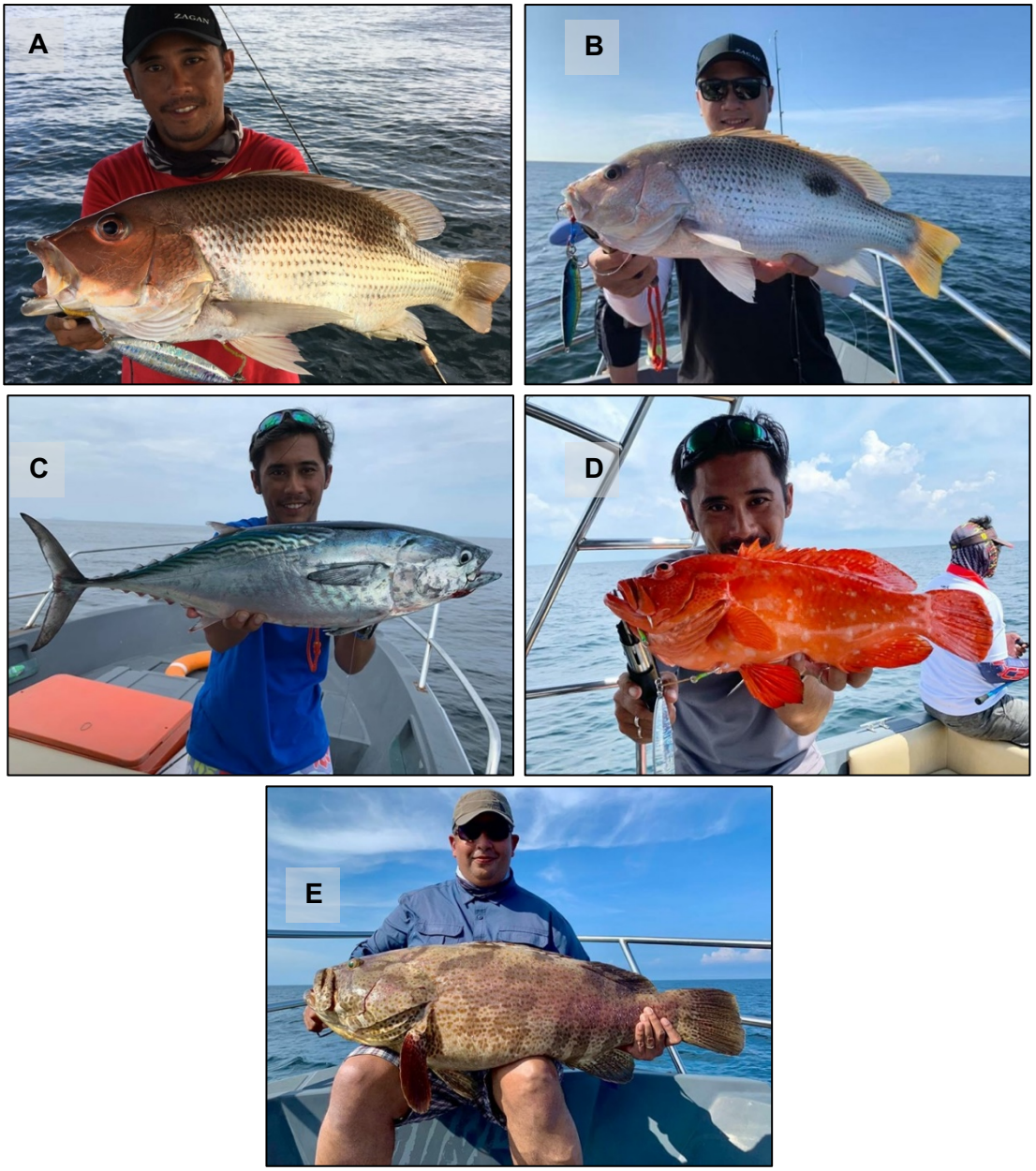

Figure 5-10: Recreational Fisheries Catch at Admiral Cove. A & B: John's Snapper (*Lutjanus johnii*); C: Black Skipjack (*Euthynnus affinis*); D: Tomato Hind (*Cephalopholis sonnerati*); E: Orange-spotted Grouper (*Epinephelus coioides*)

(Source: Images courtesy of Thim Chan)

There was apparently a high level of discards that is not reflected in these figures. Catch value was estimated to have amounted to RM117,300, which was 6.8% in excess of the financial outlay of RM109,800.

5.2.5 **Pulau Burung** (2º 29.547'N, 101º 50.210'E)

Boat based fishing from Pulau Burung is from a beachfront close to the island after which the site is named. The older name for the beachfront is *Batu 4* (4th mile) in reference to its distance from Port Dickson town. Given the fact that metrication in the 1970s had made that description totally irrelevant, the beach is now referred to as the Pantai Pulau Burung, or more recently, as Pantai Cahaya Bulan.

The Pulau Burung beachfront is the northernmost point at which boat-based fishing services are found in the District. There are services offered in Bagan Pinang (just 500 m from the Pulau Burung beachfront) but the boats involved came largely from Pulau Burung.

The Pulau Burung site is probably the most non-descript site that was polled. There is no jetty and fishers need to launch boats from the shore. There were over 26 boats beached along the beachfront, of which six were fishing boats while the rest were personally owned. There was only one that was licensed to carry paying passengers. The main feature of the site was that it catered for overnight fishers. Outside of the one licensed boat, all the others were basic vessels (sampans). None matched the sophistication of the boat operating from Admiral Cove. The absence of a jetty meant that recreational fishing focused on days where high neap and spring tides prevailed (**Figure 5-11**).

Figure 5-11: Recreational Boating and Fishing Fleet at the Pulau Burung Beach

The main feature of this landing point was to cater for fishers who wanted to do night fishing. These would be those who came in on a Friday evening and fished till the following Saturday or alternatively on Saturday night to Sunday morning. This came in contrast with fisher populations of the other landing points that undertook fishing during the day and at night when doing at 24hr fishing expedition.

The fisher population here was also the most difficult to be polled since they came in at irregular times. Fishing grounds were equally as opaque. Most fishing was reportedly offshore but how far out was not available. This was understandable. The boats were not supposed to carry passengers and did not have GPS to specify fishing locations.

The angling population was entirely by Malay anglers (**Table A.10-21**), who had a working relationship with the boat owners. During the survey, no non-Malay anglers were observed using boat services. Extrapolated over a year, the activity from Pulau Burung involved a fishing effort of 1,295 person-days, while financial accruals to local economy amounted to RM160,000 in terms of rent, RM9,300 for bait and RM25,100 for transport (**Table A.10-22**). Catch value amounted to RM13,100.

5.3 Comparative Relationships Between Landing Points

An analysis of the data above using the Kruskal-Wallis test was undertaken to examine patterns across the landing points that were surveyed. The variables employed included the average age per location based on mid-points of each age cohort of fishers, the fishing effort (standardized on an 8-hour day), the cost incurred per boat for an 8-hour day, the average weight of catch per boat on an 8-hour day and the gross income per landing point based on the number of boats hired out.

Differences across locations were examined for selected characteristics. The specific variables were:

- Average age per location, based on mid-points of age groups;
- Fishing effort (an average of fishing effort for 12 hours and 30 hours);
- Cost per boat per 8-hour day (standardized in line with the 8-hour day for fishing effort);
- Weight, average weight of catch for 12 hours and 30 hours); and
- Gross boat income for each landing point per 8-hour day (income of boat owners based on cost per boat and number of boats rented).

Figure 5-12 to **Figure 5-16** are boxplots showing the distributions of these five variables. Some of the characteristics have no variation in some locations. **Table 5-1** present the results of the Kruskal-Wallis tests and the post-hoc tests for these characteristics using letters. All the five characteristics show that there was at least one significant difference across the locations.

The analysis indicates that the median average age is lowest at Pengkalan Kempas, highest at Admiral Cove and Teluk Kemang, while fishing effort lowest at Pulau Burung and highest at Teluk Kemang. Boat rental costs were lowest at Pengkalan Kempas and highest at Tanjung Agas. The weight of catch lowest at Pengkalan Kempas and Teluk Kemang and highest at Tanjung Agas. While this dovetails with observed fishing patterns, it is important to note that the value of the giant prawn targeted at Pengkalan Kempas is significantly higher than the fish caught offshore from Tanjung. Agas.

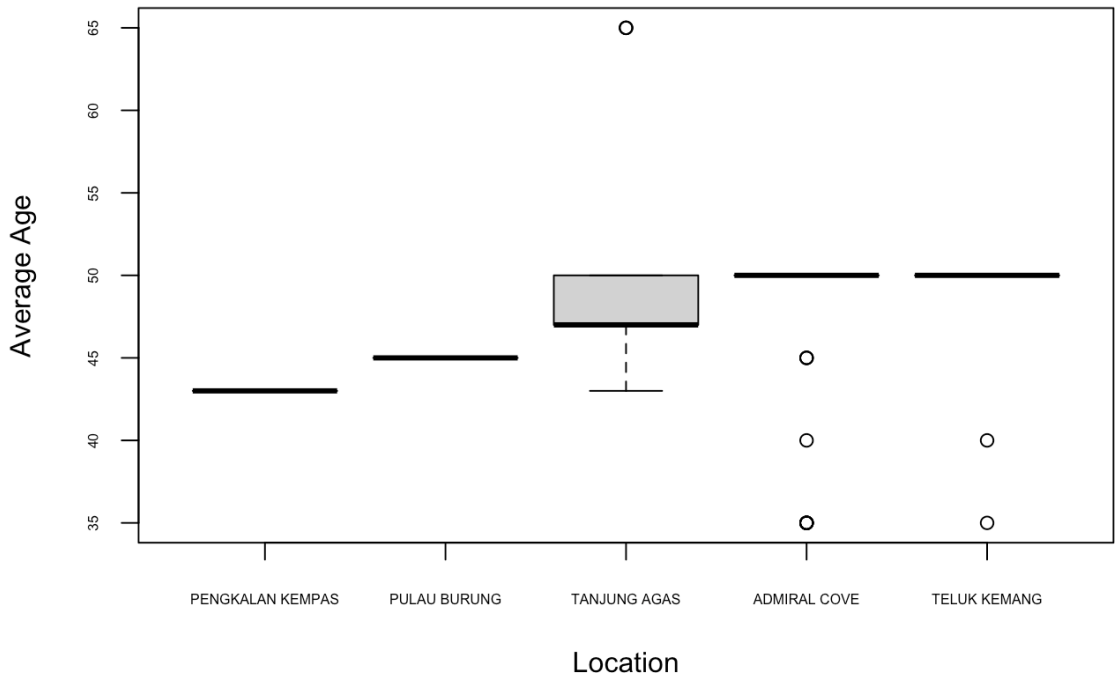

Figure 5-12: Boxplot of Average Age by Location

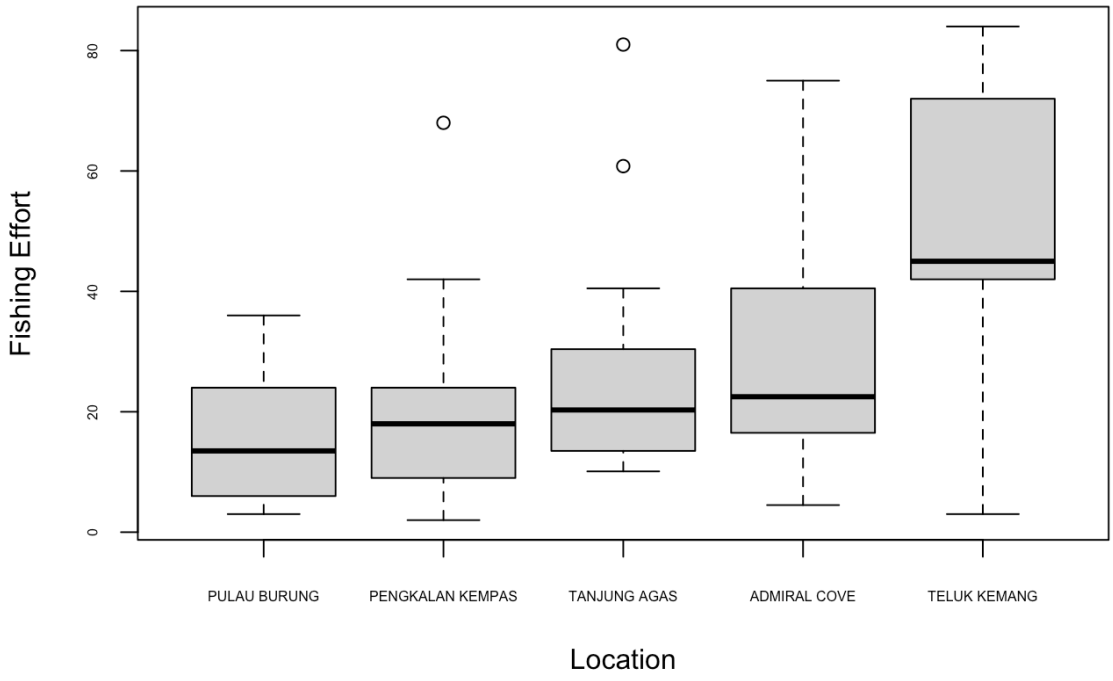

Figure 5-13: Boxplot of Fishing effort per 8-Hour Visitor Day by Location

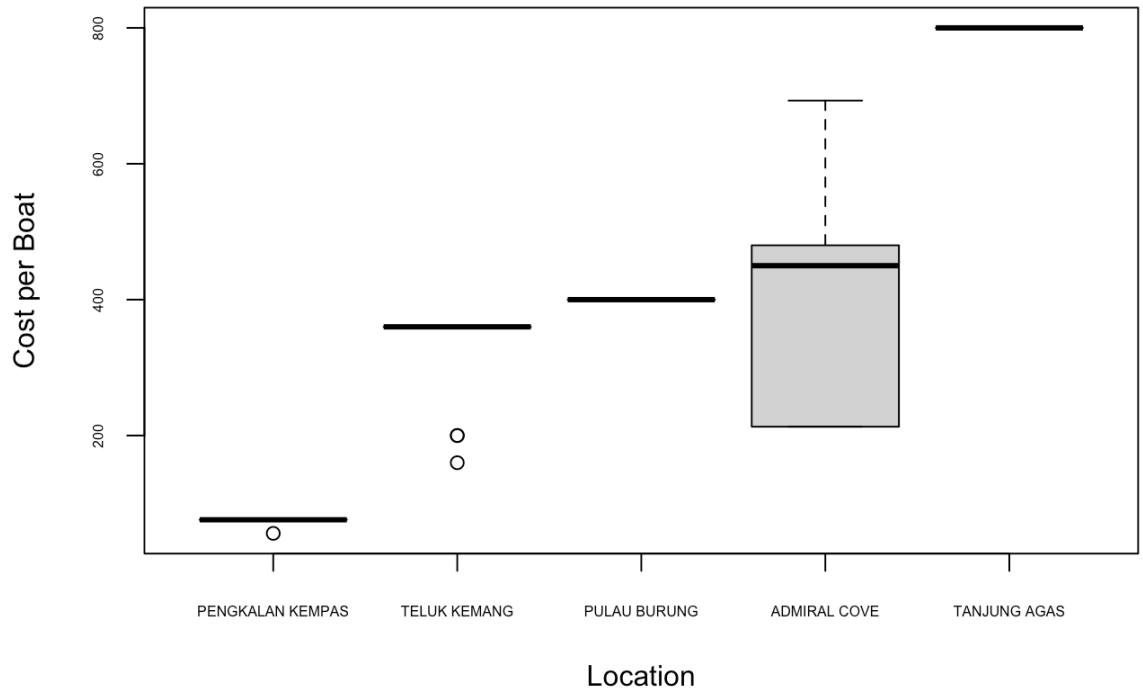

Figure 5-14: Boxplot of Cost of Boat per 8-Hour Visitor Day by Location

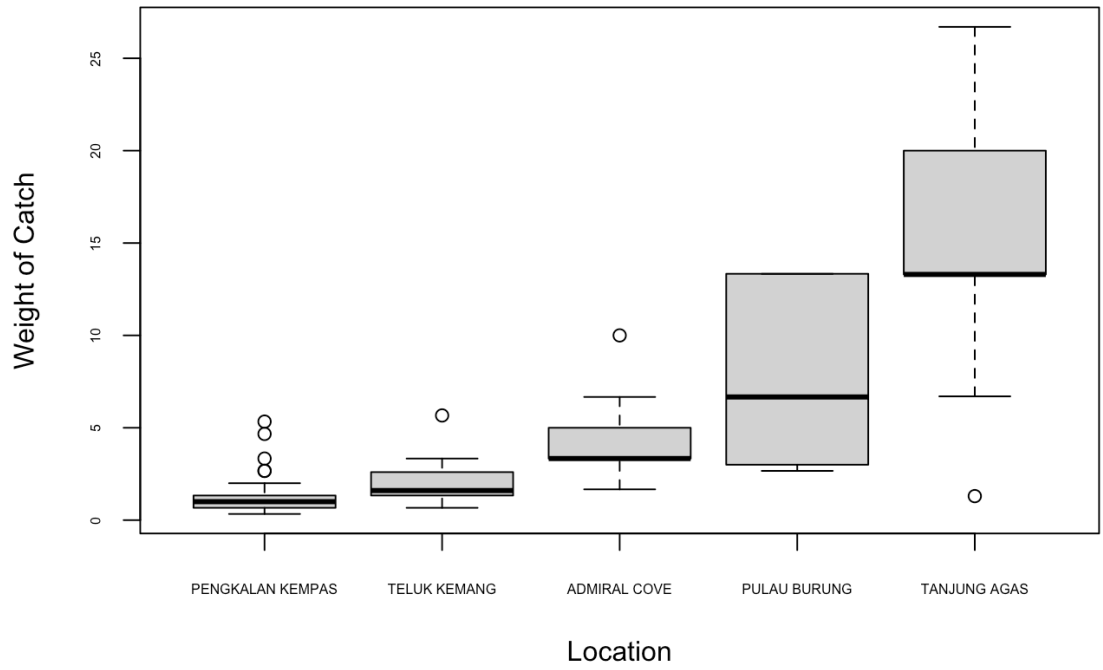

Figure 5-15: Boxplot of Weight per Catch per 8-Hour Visitor Day by Location

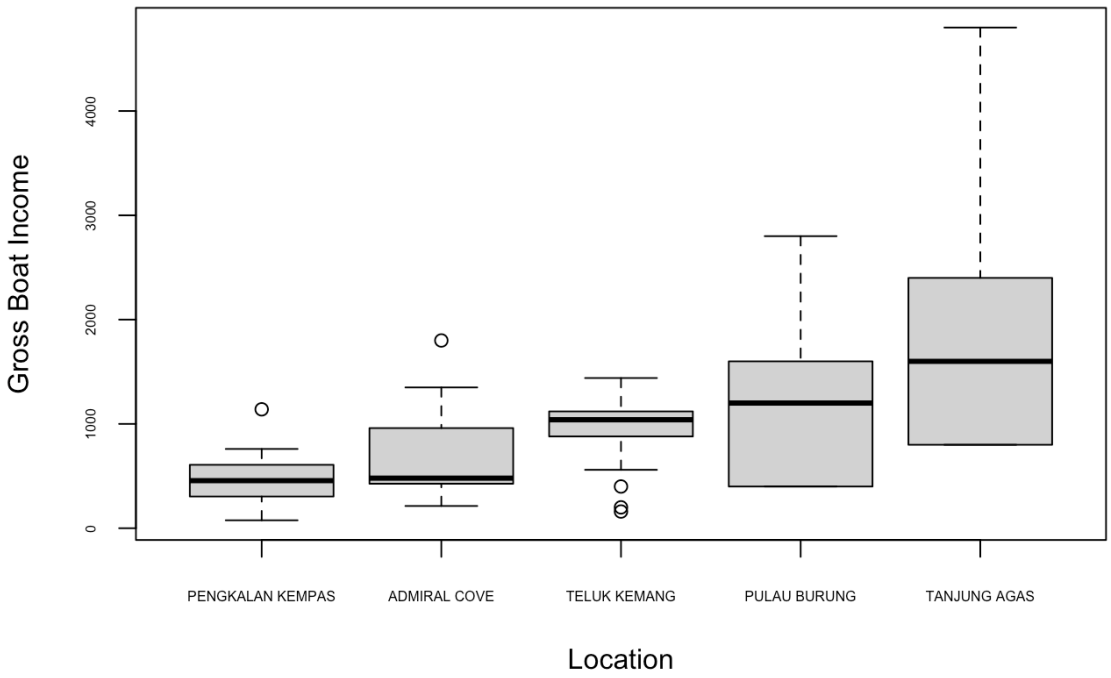

Figure 5-16: Boxplot of Income per Boats per 8-Hour Visitor Day by Location

Table 5-1: Selected Characteristics Across Locations: Medians, Kruskal-Wallis Tests and Post-hoc Test Results

Description	Admiral Cove	Pengkalan Kempas	Pulau Burung	Tanjung Agas	Teluk Kemang	Kruskal-Wallis Statistic
Average_Age, Median	50^{A}	43^{B}	$45^{A,B}$	$47^{A,D}$	$50^{A,D}$	79.70*
Fishing Effort, Median	22.5^{A}	18.0^{A}	13.5^{A}	20.3^{A}	45.0^{B}	23.33*
Boat Rental-Cost, Median	450^{A}	76^{B}	400^{A}	800^{C}	360^{A}	124.39*
Weight of Catch, Median	3.33^{A}	1.00^{B}	$6.67^{A,C}$	13.30^{C}	1.60^{B}	104.66*
Boat-Rental-Income, Median	480^{A}	456^{A}	$1200^{A,C}$	$1600^{B,C}$	1040^{A}	58.49*

* Indicates that the Kruskal-Wallis test statistic significant at $p<0.05$. Letters indicate significance for Dunn's post-hoc tests at alpha=0.05

The lowest income per boat was at Admiral Cove and Pengkalan Kempas and highest at Tanjung Agas. Teluk Kemang had the highest fishing effort, older age-group, weight of catch lower, among lower boat cost, but boat rental income was higher than other others due to increased fishing effort. Tanjung Agas had the highest boat cost, weight of catch highest, boat-rental income highest, average age lower but not significantly different from Teluk Kemang, fishing effort significantly lower than Teluk Kemang.

So, between Tanjung Agas and Teluk Kemang, age and ethnic profiles are not different, but the recreational fisher soico-economy was different. Tanjung Agas recreational fishers, in contrast to Teluk Kemang, had more sophisticated equipment, looking for bigger catch.

5.4 Conclusion

A summary of my survey data indicated that there was a significant variation between various landing points, particularly in terms of the socio-economic profile of the fishers who patronised them, but not so much in terms of their ethnicity. Extrapolated over a year, boat fishing in Port Dickson involved 10,066 anglers with a total fishing effort of 23,048 person-days (**Table 5-24**). The catch amounted to 8.3 tonnes per boat valued at RM0.3 million. Though this expenditure accrued to the general national economy, rental value accounted for 80% of the total financial outlay and would have gone directly to the communities that benefited from them.

The survey respondents reported an annualised catch volume of 8,310 kg arising from the survey valued at RM0.377 million (**Table 5-24**). Allowing for the fact that the average catch was 177 kg per boat and the estimated 3,345 boats were involved, the total recreational fisheries catch would have amounted to 592 tonnes.

Value per kg of fish caught by recreational fishers was estimated at RM45.36/kg as compared with RM13.14/kg for artisanal fishers. There could be two major reasons for this. Recreational fish catch is not traded and its perceived value by recreational fishers do not consider transactional costs with commercial buyers who artisanal fishermen must deal with. The other important reason is that recreational fisher target high value fish and discard low value fish or use them as bait fish. This is clear in the catch data of some locations described in **Chapter 5,** capture of small pelagic (particularly *Sardinella* spp.) was reported but these fish were not landed by recreational fishers but were consumed or used as bait fish. From an industry point of view, the total value of the fisheries industry (excluding recreational fisheries but including aquaculture) indicates a value of RM11.38/kg.

It is important to note that the recreational fisheries values above are probably an underestimate. Fishermen at other landing points do rent out their boats to specific customers, while some have their own vessels to undertake angling. Where the former is concerned, boat rental for recreational fishing is limited in number, sporadic in frequency and, as a consequence, difficult to assess. The same applies for the latter as well, with the additional caveat that private boat owners have no compulsion to report the personal use of their vessels to any authority.

Our estimates come in contrast to the 2018 artisanal fisheries catch of 670 tonnes (**Table 3-10**). The data indicates that boat based recreational fisheries catch is not far removed from artisanal fishing catch. In short, current management of PDD's fisheries resources is seriously bereft of an understanding of the total uptake by the various stakeholders who utilise it. For instance, small fish, such as the Indian Mackeral (*Rastreilliger kanagurta)* were caught but were discarded, consumed, or used as bait fish. Larger (1.5kg and above) fish such as cobia (*Rachycentron canadum*) were caught (though not targeted) for their fighting quality, though they had a poor market value (9/kg) (Department of Fisheries, 2018). It is pertinent to note that these fish do not appear in the official fisheries landings for Port Dickson.

Fisheries statistics from the Department of Fisheries concentrate on commercial fish species sought by artisanal fishermen for their value, while fish is more sought after by anglers due to its fighting value is not. In short, the current fisheries statistics do not reflect the entirety or nature of catch in PD waters.

In these calculations, the Pengkalan Kempas fishery is a riverine fishery and must be treated separately from the others. It varies in terms of target species, gear utilisation, fishing period and socio-economic profile of the fisheries. The motive to fish appears to be driven, not by the fighting a physical challenge the Giant Prawn can offer, but from outwitting it from its bottom habitats.

The other landing points, all of which focus on marine catch, which have a greater degree of homogeneity in the profile of fishers and target species are concerned. However, even here there is a difference between recreational fishers and artisanal fishermen. Offshore, the main catch incentive appeared to be the fighting challenge marine fish can potentially provide. The focus was thus on focus was on large fish. Species such as the cobia were reported by recreational fishers but do not appear in the list of species caught by artisanal fishermen as recorded by the Department of Fisheries. This is a major shortcoming of the DoF's assessments of the fisheries resource in PDD waters.

There are apparently species being harvested from the that resource that is not being reflected in its management regime. The situation for this appears to be the fact that while the fighting quality of the cobia is a draw for recreational fishers, its poor marketability for the table fish market makes it unattractive to artisanal fishers. However, this means that the resource management of Port Dickson's waters is serious bereft of the kind of data that would be necessary to ensure its sustainable management.

Based on the data that was collected from the survey, Malays made the up the largest ethnic group in the fisher population, making up at total 70% of the total number of fishers polled. However, Chinese participation dominated in the more organized landing points at Teluk Kemang and, particularly, Admiral Cove (**Table A10-25**).

Though Tanjung Agas also offered similar services, the demography of its users appeared to be more focused on upper income Malays (**Table A10-25**). Discussions with fishers indicted that this ethnic bias in recreational fishing was because of the rural background that many of the more senior fishers had, where fishing from rivers and rice fields was a valued *shariah* – compliant juvenile pursuit, an experience that was in the process of being transferred to their children. However, if this is the case, then the future of recreational fisheries in the hands of a generation that had been brought up surrounded by mobile technology is suspect.

Both Teluk Kemang as well as Admiral Cove staging points offered quality services, more comfortable boats and were willing to go further afield to fish. Their costs with were higher than that the other staging points (with the exception of Tanjung Agas). The fishers who patronised these points were also largely from the Klang Valley, representing a demographic what was generally more educated and sophisticated. Clearly for this demographic, cost was less of a concern as compared to than the quality of fishing experience. In contrast, the demographic that congregated at Pengkalan Kempas and Pulau Burung were made up largely from the Negeri Sembilan hinterland and consisted mainly of those at sub-professional levels. Thus, the willingness-to-pay equation varied among the landing points.

The activity was male-dominated, and women do not normally go fishing. The presence of women (and accompanying children) was only seen in one landing point i.e. Pengkalan Kempas. The apparent reason for this is the lack of on-board toilet facilities in all boats that limited their participation. The family orientation of Pengkalan Kempas can be attributed to the limited fishing time involved, the ease with which boats could be boarded and more importantly, the boat owners do not necessarily accompany the visiting group providing a degree of privacy.

The main age cohort of fishers was between 35 – 50 years (**Table A10-25**). This would represent a cohort that was employed (and thus had the disposable income) and was not (or only partly burdened) with later age costs. Younger persons were present only as accompaniment to adults, while adults over 60 were also a rarity. One discussion that I had with a senior aged fisher (not boat based) on his motivation indicated that he took to fishing to get out of a contentious home environment rather than for the fishing itself. When his grandchildren came visiting, he did not bother with fishing i.e. the Malaysian family-based culture points to a situation where recreational fishing, for the most part, is subordinate to social and familial demands. The demands of living on old age pension and the need to care for grandchildren means that older fishers simply may not have time or financial resources to sustain a significant presence in the fisher population.

CHAPTER 6: CONCLUSION

6.1 Introduction

As exemplified in the objectives of this thesis, the three dimensions of recreational fishing encompasses its socio-economic profile, its economic impact and its environment and resource concerns. It is critical to point out, though, that these issues are closely related and complicated by the fact was that the same resource is also exploited by artisanal fishermen operating in Port Dickson District (PDD) waters. To reiterate, the term “artisanal” is used to describe fishers who operate traditional gears such drift nets and who are owner-operators of their vessels. There is no commercial fishing undertaken in PDD. To distinguish between these two populations, the term “fishers” was used to describe those pursuing the activity of fishing for recreation and “fishermen” for those who undertook fishing as a livelihood.

In the Malaysian context, the study objective focused on recreational fishers and their motivation, why they fished where they do and what the social, economic, and environmental dimensions of the activity was. Fishers could be shore or fishing platform based (using static casting) or boat based, using casting or trolling. Their methods would depend on the species and the sizes that are targeted and would have differing social, economic, and environmental impacts. It is pertinent to note, that the same data challenges faced recreational management regimes in developed countries. However, the major challenge in the Malaysian context is the absence of a licensing regime that could determine who is a recreational fisher, how often they fish and their impact on a finite resource. A review of the diverse methods used to get that information identified the appropriate unit of fishing effort as the primary matric in the assessment of recreational fisheries landings and value.

This thesis did not attempt to identify a national recreational fishing population or participation rate. There was no data that would have enabled such an approach. Instead, the focus on PDD was expected to serve as a template for recreational fisheries assessments elsewhere. PDD was chosen for its proximity to the Klang Valley and Seremban, the most developed region in the country and preliminary studies that indicated recreational fisheries to be a major facet of its marine resource use.

Thought the research undertaken during the course of this study has revealed numerous novel findings for PD’s boat based recreational fisheries including the presence of submerged habitats that hitherto had not been reported, fishing “honey pots” that point to more such habitats that have yet to be mapped, species that are targeted by recreational fishers that are not part of the current fisheries statistical collection and volume and

landings of recreational fishing catch that almost matches or exceeds that of the artisanal fishing catch.

However, novel as these findings are, they open the door to other questions such what is the totality of the recreational fishing catch in PDD taking into account static casting, the impact of baitworm populations harvested for the industry and details and mapping of the natural capital that support these values and their resilience in the face of economic development. These questions are outside the scope of this thesis, yet beg to be answered if recreational fisheries in PDD, or for that matter, in the region is to be pursued in a sustainable manner. The study also indicated that the coastal geomorphology and geology of the PDD would potentially affect its oceanography and habitat values. All the factors coalesce to support recreational fisheries activity in PDD's waters. In short, recreational fisheries can be seen as a proxy of a plethora of interrelated natural capital inputs that sustains the PDD environment. These limitations represent challenges that need to be addressed in a further studies.

As a consequence, the objectives of the thesis covered the natural capital of PDD that supported the activity, a review of PDD's recreational fisheries industry and its character as a whole and the economic, ecological and social impact of one component of that industry i.e. boat based fishing. The outcomes of this thesis are summarised below.

6.2 Character of Port Dickson Coastline

PDD is a very geologically, hydrologically, and ecologically diverse district with corresponding natural capital assets that support a small, but socially significant, fisheries industry. Habitat assets included coral reefs, sea grass meadows and seaweeds beds, though much of these have not been fully charted or described. There is no information on the district's terrestrial geomorphology with its nearshore and coastal habitats, though there is presumably a seamless linkage between the two. The coastal zone of PDD can be divided by headlands into a northern zone, characterised by mudflats and mangroves, a central zone of sand beaches and a southern zone of mixed submerged habitats. This has led a broad variety of marine biodiversity prevailing over a narrow stretch of shoreline. The role of headlands in acting as separators for these discrete ecotypes means that a plethora of inter-related factors are responsible for this diversity, including that of geology, hydrology and biology. My study points this out since recreational fishing patterns reflects this diversity but it can only act as a proxy. Together with observational inputs, the manner in which PDD's coastal ecology is diversified by its geomorphology is entirely empirical. It warrants a more detailed, multi-disciplinary study that can look at the multiplicity of factors that contrive to make PPD coastline what it is.

6.3 Industry Backdrop – Recreational Fishing Industry in Port Dickson

Both shore-based fishing (static casting) as well as boat-based fishing is carried out in PDD's waters. Thirty recreational landing points were recorded, including commercial marinas, offshore fishing platforms, a man-made riverine lagoon and artisanal fishing jetties. Most, however, relied on fishing jetties developed for artisanal fishermen.

However, some artisanal fishing points (F1 and F2) did not support recreational fishing activity, particularly where access was neither obvious nor convenient, despite being in areas that could potentially support nearshore fish populations. Recreational fishers were mainly within the 20-60 age cohort. From an ethnic standpoint (**Figure 4-14**), most recreational fishers were Malays (182 respondents or 81%), followed by Chinese (14%) and Indians and Others (which included those from the Borneo states of Sabah/ Sarawak, other minorities, and foreigners). However, the ethnic distribution was not evenly spread out among all fish landing points. While Malays clearly dominated the land based and offshore platform locations, non-Malay participation were seen in boat-based locations such as Pantai Nelayan Teluk Kemang and Admiral Cove.

The majority of fishers (138 or 62%) were salaried workers in the private sector. Most were at sub-professional or technician levels, except for boat-based locations, which attracted more professional and executive level clientele. The majority of respondents (74%) were outside Port Dickson district (mainly the towns of Seremban and Nilai as well as the Klang Valley) indicating proximity to a resource does not necessarily induce local communities to make use of them for recreational purposes.

6.4 Boat Based Fishing in Port Dickson

Of the 30 landing points in PDD, 5 (17%) catered for boat-based fishing. Most of the boat-based services were located in the PDD South, stretching from Pengkalan Kempas to Admiral Cove. Though there were boat ramps in Port Dickson town, these did little to support dedicated services for recreational fishers. This could be because of the shipping activity around PD port would have made it unsafe for small recreational boats.

Nonetheless, it does not entirely explain why there was so much focus on boat based recreational fishing in the southern part of the district. The more likely reason would have been the presence of fisheries habitats that attracted fishers for a different experience from that of PDD north. The habitats in the north were mainly of mudflat, seagrass meadows and mangroves that supported a different species or catch profile while the reef based open waters of the southern coast PDD attracted a different type of recreational fisher. The data above suggest that habitats, whether natural or artificial, are crucial to establish patterns of fisheries capture.

The feedback from data indicates that recreational fishers and their fishing patterns can act as indicators of submerged habitats that are yet unchartered. This is crucial information to fisheries scientists on what makes a fishery work. Recreational fishers have an incentive to sustain the health of these habitats and represent an educated and informed population that can advocate for it.

6.4.1 Economic Dimensions of Boat Based Recreational Fishing

Extrapolated over a year, boat fishing in Port Dickson involved 10,066 anglers with a total fishing effort of 23,048 person-days. Their various expenditures amounted to RM1,490,062, though not all of this accrued entirely to the District economy. However, rental value accounted for 80% of the total financial outlay and would have directly benefited the communities that provided these boat services.

The survey respondents reported an annualised catch volume of 8,310kg arising from the survey valued at RM0.377 million. Allowing for the fact that the average catch was 177 kg per boat and the estimated 3,345 boats were involved, the total recreational fisheries catch would have amounted to 592 tonnes valued at RM26.85 million as compared to the artisanal fishermen catch of 670 tonnes valued at RM8.81 million. It is clear that that boat-based recreational fishing catch was almost the same (89%) as artisanal fishing landings, while its economic value was 3 times higher.

Value per kg of fish caught by recreational fishers was estimated at RM45.36/kg as compared with RM13.14/kg for artisanal fishers. There could be two major reasons for this. Recreational fish catch is not traded and its perceived value by recreational fishers does not consider transactional costs with commercial buyers who artisanal fishermen must deal with. The other important reason is that recreational fishers target high value fish and discard or consume low value fish or use them as bait fish. This is clear in the catch data of some locations described in **Chapter 5**, where the capture of small pelagic (particularly *Sardinella* spp.) was reported but not landed. From an industry point of view, the total value of the fisheries industry (excluding recreational fisheries but including aquaculture) indicated a value of 11.38/kg.

It is important to note that the recreational fisheries values above are probably an underestimate. Fishermen at other landing points do rent out their boats to specific customers, while some individuals have their own vessels to undertake angling. Where the former is concerned, boat rental for recreational fishing is limited in number, sporadic in frequency and, as a consequence, difficult to assess. The same applies for the latter as well, with the additional caveat that private boat owners have no compulsion to report the personal use of their vessels to any authority.

The Kruskal-Wallis tests and the post-hoc tests indicate there is at least one significant difference across the locations. The median average age was lowest at Pengkalan Kempas, highest at Admiral Cove and Teluk Kemang, while fishing effort lowest at Pulau Burung and highest at Teluk Kemang. Boat rental costs were lowest at Pengkalan Kempas and highest at Tanjung Agas, while the weight of catch lowest at Pengakalan Kempas and Teluk Kemang and highest at Tanjung Agas.

Teluk Kemang reported the highest fishing effort, older age-group, weight of catch lower, among lower boat cost, but boat rental income higher than other others due to increased fishing effort. Tanjung Agas reported the highest boat cost, weight of catch highest, boat-rental income highest, average age lower but not significantly different from Teluk Kemang, though fishing effort was significantly lower than Teluk Kemang. Recreational fishers operating from Tanjung Agas, in contrast to Teluk Kemang, had more sophisticated equipment and looked for bigger catch.

6.4.2 Environmental and Resource Dimensions of Recreational Boat Based Fishing

The survey respondents reported an annualised catch volume of 8,310kg arising from the survey valued at RM0.377 million. Allowing for the fact that the average catch was 177 kg per boat and the estimated 3,345 boats were involved, the total recreational fisheries catch would have amounted to 592 tonnes. This comes in contrast to the 2018 artisanal fisheries catch of 670 tonnes (**Table 3-10**).

In short, the volume of boat based recreational fisheries catch alone is not far removed from artisanal fishing catch. As pointed out earlier, the estimates for the bota-based recreational fisheries catch is probably an underestimate. It is also pertinent to note that the recreational fishing catch excludes uptake by shore-based fishers. In short, there is every possibility that the recreational fishing catch far exceeds that of the artisanal fisheries catch.

6.5 Management and Institutional Issues

Data collection by the Department of Fisheries is based on the assumption that fishermen can be categorised as artisanal and commercial fishermen. The categorisation is based on gear with fishermen operating drift gill nets, portable traps, vertical long lines, etc being identified as artisanal and trawls/purse seines being categorised as commercial. Recreational fishing gear is not licensed and legally not identified as gear, not identified by law and no data is collected for its impact.

Such a distinction does not apply to recreational fishers. They largely use a single gear (rod-and-line) and it does not operate on a traditional artisanal or commercial economic model. The management of industry cannot work on a commodity basis as it does for artisanal and commercial fisheries. The management approach to sustaining or developing the industry must thus be fundamentally different and there has been a historical neglect of recreational fisheries. This was underscored by the fact that in Port Dickson, dedicated infrastructure for recreational fishing was found only in 39% of the sites surveyed. The balance 61% consisted of artisanal fisheries jetties, beachfronts and coastline protection infrastructure used incidentally for recreational fishing. Having said that, there is a nexus at which both the commodity-based artisanal/commercial fisheries and the service based recreational fisheries conjoin and this is the fact that both rely on the same resource.

Only the uptake from artisanal fishermen are considered in fisheries statistics of Port Dickson yet the data on boat based fishing indicate a catch volume that almost matches that. Taken together with shore-based fishing, recreational fishing catch volumes a value may well exceed that of artisanal fisheries catch. Current management of PDD's fisheries is thus seriously bereft of an understanding of the total resource uptake by the various stakeholders who utilize it.

Fishermen complain consistently of declining resources and reduced CPUE. The standard response to this has been is that the coastal fishery has been "overfished" (Gopinath and Puvanesuri, 2006). While this may be true, the data in this thesis suggests fishermen may not be entirely at fault for the situation. Proper resource management demands that the total pressure on a resource be assessed in its entirety.

The fact that recreational fishermen are harvesting species not reflected in the official statistics points to a major shortcoming in the management database. There is also a poor recognition of the importance of recreational fishing in economies of fishing communities. Hamlets such as Pengkalan Kempas would have died an economic death if it just relied on artisanal fisheries (6 licensed fishermen). However, it has continued to thrive, with a fleet of over 90 boats, because of recreational fishing.

While the primary fisheries management agency in the country i.e. the Department of Fisheries has a set-up for commercial and artisanal fishermen, it appears currently ill-equipped both in basic understanding of recreational fisheries industry as well as the lack of dedicated staff in enabling its management. The data I have collected in this thesis indicates the complexity of recreational boat-based fishing in Port Dickson and my findings indicate there are several major disconnects from the current management regimes that

flow into the existing institutional structure. It is pertinent to emphasise that the data cited and analysed in this thesis can but only represent a sub-set of the recreational fisheries activity in Port Dickson District. It does not cover shore-based fishing, whether from the actual shoreline or from offshore fishing platforms.

This is not an insignificant consideration. It is likely that the total volume of catch from recreational fisheries well exceeds that of the artisanal catch This means that the pressure on the fisheries resource is seriously underestimated. In short, recreational fisheries and its impact on resources cannot be considered insignificant in terms of its management. Malaysia has come to a point where it a major issue in marine fisheries management, yet it is to be mainstreamed in fisheries stock assessment. Recreational fishers are generally more educated, and more important, not dependent on the fisheries resource as a livelihood option. They can offer data in terms of habitats, seasonal patterns and others that may not be readily obtainable from fishermen, who have taken these patterns for granted.

Yet this human resource has not been tapped on. What is needed is a system that sees recreational fishing as ranking *pari passu* with other sectors of the fisheries industry (commercial fishing, artisanal fisheries, fish processing), with its own demands, character, and human resources. This thesis indicates that the individual character of boat-based recreation fisheries as exists in PDD has not been fully taken into account in the management of its marine capital.

REFERENCES

Ahmad Ainudin, N., Awang Noor, A. G., Faridah Hanum, I., Kamziah, A. K., Zaiton, S., and Bakti Hasan, B. (2020). Total economic valuation of Kuala Perlis mangrove. In: Tariq Mubarak, H., Wan Mohd Shukri, W. A., Wan Tarmeze, W. A, Rosazlin, A. and Ismail, P. (eds.). *Proceedings of the National Seminar on Mangrove and Coastal Forest 2019* (pp. 189 - 200). 10 & 11 September 2019. Park Avenue Hotel, Sg. Petani, Kedah. Institut Penyelidikan Perhutanan Malaysia (FRIM), Kementerian Tenaga Dan Sumber Asli (KeTSA).

Ahmad, I. (1995). Rumpai laut Malaysia. Dewan Bahasa dan Pustaka (Language and Literary Agency Malaysia), Kuala Lumpur. 200p.

Allan, J. D., Abell, R, Hogan, Z., Revenga, C., Taylor, B. W., Welcomme, R. L., and Winemiller, K. (2005). Overfishing of inland waters. *Bioscience, 55,* 1041–1051. doi: 10.1641/0006-3568(2005)055[1041:OOIW]2.0.CO;2

Allen, G. R., and Steen, R. (1999). *Indo-Pacific Coral Reef Field Guid*e. Tropical Reef Research, Singapore. 378p. ISBN-13: 978-9810056872.

Anon. (2009). Technical Report: Economic Impact of Recreational Sea Angling in Scotland. Government of Scotland. Edinburg. 263p. ISBN: 978 0 7559 90689

Anuar, H.B., M.I Sharuddin and S. Chamhuri (2013) Natural Capital as Inclusive Wealth for Malaysia: A review. Advances in Environmental Biology 7 (1): 3181 -3187

Arlinghaus, R., and Cooke, S. J. (2009). Recreational fisheries: socioeconomic importance, conservation issues and management challenges. In Dickson, B., Hutton, J., and Adams, W. M. (eds.). *Recreational Hunting, Conservation and Rural Livelihoods: Science and Practice.* Blackwell Publishing Ltd. ISBN: 978-1-405-16785-7

Arlinghaus, R., Cooke, S. J., Coleman, F. C., Figueira, W. F., Ueland, J. S., and Crowder, L. B. (2005). Global impact of recreational fisheries. *Science, 307*, 1561–1562. doi: 10.1126/science.307.5715.1561

Asmida, I., Noor Akmal, A. B., Ahmad, I., and Sarah Diyana, M. (2017). Biodiversity of macroalgae in Blue Lagoon, the Straits of Malacca, Malaysia and some aspects of changes in species composition. *Sains Malaysiana, 46* (1), 1-7. http://dx.doi.org/10.17576/jsm-2017-4601-01.

Awang, M, Jaafar, A. B., Abdullah, A. M. Ismail., M., Hassan, M. N., Abdullah, R., Johan, S., and Noor, H. (2000). Air Quality in Malaysia: Impact, management issues and

future challenges. *Respirology, 5,* 183 – 196. doi: 10.1046/j.1440-1843.2000.00248.x

Ayob, M. (1970). Beach survey at Port Dickson, West Malaysia. *Geographica (Journal of the Department of Geography, and Geographical Society, University of Malaya), 6,* 91-96.

Aziz, A., Japar Sidik, B., and Muta Harah, Z. (2001). Fishes associated with seagrass habitat. In: Japar Sidik, B., Aziz, A., Tan, S. G., Daud, S. K., Jambari, H. A., and Sugiyama, S. (eds.). *Proceeding of the MASDEC-JICA Project Workshop 2000: Aquatic Resources and Environmental Studies of the Straits of Malacca* (pp. 151-162). MASDEC, Universiti Putra Malaysia, Malaysia.

Barlow, C. G. (1981). *Breeding and larval rearing of Lates calcarifer in Thailand*. New South Wales Fisheries, Sydney, Australia.

Bohsack, J. A., and Bannerot, S. P. (1986). A Stationary visual census technique for quantitatively assessing community structure of coral reef fishes. *July NOAA Technical Report NMFS, 41,* 1-15. https://www.researchgate.net/publication/216900029_A_Stationary_Visual_Census_Technique_for_Quantitatively_Assessing_Community_Structure_of_Coral_Reef_Fishes

Borneo Post (2015, January 6). *WWF-Malaysia Supports Regulating Recreational Fishing*. Borneo Post Online. Retrieved November 20, 2020 from https://www.theborneopost.com/2015/01/06/wwf-malaysia-supports-regulating-recreational-fishing/

Bulthuis, D. A. (1987). Effects of temperature on photosynthesis and growth of seagrass. *Aquatic Botany, 27*, 27 – 40. https://doi.org/10.1016/0304-3770(87)90084-2

Burke, L., Reytar, K., Spalding, M., and Perry. A. (2011). Reefs at risk revisited. Washington, D.C., World Resources Institute (WRI), The Nature Conservancy, World Fish Center, International Coral Reef Action Network, UNEP World Conservation Monitoring Centre and Global Coral Reef Monitoring Network, 114p. ISBN: 978-1-56973-762-0

Chong, V. C. (2007). Mangrove-fisheries linkages- The Malaysian perspective. *Bulletin of Marine Science, 80* (3), 755 – 772.

Chung, S. K., and Yin, E. H. (1970). Regional geology: West Malaysia. Brief outline of the geology of West Malaysia. Annual Report Geological Survey of Malaya [for 1968],

53-67. (Reprinted, 1971, Annual Report Geological Survey of Malaysia [for 1969],45-59).

CIA (2017). *The World Factbook.* Central Intelligence Agency. Retrieved January 15, 2020, from https://www.cia.gov/library/publications/the-world-factbook/docs/profileguide.html.

Coleman, F. C., Figueira, W. F., Ueland, J. S., and Crowder, L. B. (2004). The impact of United States recreational fisheries on marine fish populations. *Science, 305* (5692),1958-1960. https://doi.org/10.1126/science.1100397

Cooke, S. J., and Cowx, I. G. (2004). The role of recreational fishing in global fish crises. *BioScience, 54*, 857–859. https://doi.org/10.1641/0006-3568(2004)054[0857:TRORFI]2.0.CO;2

Delbeek, J. C., and Sprung, J. (1994). *The Reef Aquarium- A Comprehensive Guide to the Identification and Care of Tropical Marine Invertebrates.* Ricordea Publishing Coconut Grove, Florida. Vol 1. 544p. ISBN-13: 978-1883693121

Department of Environment (2017). *Laporan kualiti alam sekeliling 2016*. Jabatan Alam Sekitar, Kementerian Sumber Asli dan Alam Sekitar. https://www.doe.gov.my/portalv1/en/info-laporan/laporan-jabatan-alam-sekitar/laporan-kualiti-alam-keliling/324265

Department of Environment, Land, Water and Planning (DELWP) (2019, August 16). Recreational fishing. Retrieved November 20, 2020, from https://www.water.vic.gov.au/waterways-and-catchments/recreational-fishing.

Department of Fisheries. (1991). Annual Fisheries Statistics (1990). Department of Fisheries, Malaysia. Ministry of Agriculture, Kuala Lumpur, Malaysia. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2002). Annual Fisheries Statistics (2001). Department of Fisheries, Malaysia. Ministry of Agriculture, Kuala Lumpur, Malaysia. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2020). Annual Fisheries Statistics (2019). Department of Fisheries, Malaysia. Ministry of Agriculture and Food Industry, Malaysia. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2010). Annual Fisheries Statistics (2009). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 308p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2011). Annual Fisheries Statistics (2010). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 342p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2012). Annual Fisheries Statistics (2011). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 334p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2013). Annual Fisheries Statistics (2012). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 302p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2014). Annual Fisheries Statistics (2013). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 334p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2015). Annual Fisheries Statistics (2014). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 279p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2016). Annual Fisheries Statistics (2015). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 280p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2017). Annual Fisheries Statistics (2016). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 280p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2018). Annual Fisheries Statistics (2017). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 240p. https://www.dof.gov.my/index.php/pages/view/82

Department of Fisheries. (2019). Annual Fisheries Statistics (2018). Department of Fisheries, Malaysia. Ministry Agriculture, Kuala Lumpur, Malaysia. 280p. https://www.dof.gov.my/index.php/pages/view/82

Department of Veterinary Services. (2016)- http://www.dvs.gov.my/dvs/resources/user_1/DVS%20pdf/Perangkaan%202014-2015/2014_2015/penggunaan_per_kapitaMuka_Surat_1-15.pdf

DHI (2016). Environmental impact assessment for the proposed reclamation and development of Kuala Linggi International Port (KLIP) at Kuala Linggi, Malacca, Malaysia. Unpublished.

Drainage and Irrigation Department (1997). *Muar River Flood Rehabilitation Study*. Drainage and Irrigation Department, Malaysia.

EAA. (2004) Recreational angling - Definition. A definition on recreational angling agreed by the European anglers alliance at the general assembly 2004 in Dinant, Belgium. http://www.eaa-europe.org/web/Frames/PFPositions/PositionList-EN.htmS.

English S., Wilkinson, C., and Baker, V. (1994). *Survey manual for tropical marine resources*. ASEAN-Australian Marine Science Project. Australian Institute of Marine Science, Townsville. ISBN: 0642202567 9780642202567

Enviro Exceltech Sdn. Bhd. (2020). Marine ecology monitoring for Tuanku Jaafar Power Stations (TJPS), Port Dickson, Negeri Sembilan. Report submitted to Department of Environment Negeri Sembilan.

Everhart, W. H., and Young, W. D. (1981). Principles of fishery science (3rd edition). Cornell University Press, Ithaca, New York. ISBN-13: 978-8189904975

Eyles, R. J. (1970). Physiographic implications of laterite in West Malaysia. *The Bulletin of Geologicla Society of Malaysia, 3,* 1-7

FAO (2009a). *Country Profile Fact Sheets: Fishery and Aquaculture Country Profiles, Malaysia, 20009*. Food and Agriculture Organizations of the United Nations. Retrieved November 20, 2020, from http://www.fao.org/fishery/facp/MYS/en

FAO. (2009b). The State of the World Fisheries and Aquaculture 2008. Food and Agriculture Organizations of the United Nations. Retrieved November 20, 2020, from http://www.fao.org/3/i0250e/i0250e00.pdf

FAO. (2012). FAO Technical Guideline for Responsible Fisheries, 13: Recreational Fisheries. Food and Agriculture Organizations of the United Nations. Retrieved November 20, 2020, from http://www.fao.org/3/i2708e/i2708e00.htm

FAO. (2014a). *Country Profile Fact Sheets: Fishery and Aquaculture Country Profiles, New Zealand, 2014.* Food and Agriculture Organizations of the United Nations. Retrieved November 20, 2020, from http://www.fao.org/fishery/

FAO. (2014b). The State of the World Fisheries and Aquaculture 2014. Food and Agriculture Organizations of the United Nations. Retrieved November 20, 2020, from http://www.fao.org/3/a-i3720e.pdf

FAO. (2016). The State of World Fisheries and Aquaculture 2016. Food and Agriculture Organizations of the United Nations. Retrieved November 20, 2020, from http://www.fao.org/3/i5555e/i5555e.pdf

FAO. (2020). The State of World Fisheries and Aquaculture 2020. Food and Agriculture Organizations of the United Nations. Retrieved November 20, 2020, from http://www.fao.org/3/ca9229en/ca9229en.pdf

Fonseca, M. S., and Kenworthy, W. J. (1987). Effects of current on photosynthesis and distribution of seagrasses. *Aquatic Botany, 27*, 59 - 78. https://doi.org/10.1016/0304-3770(87)90086-6

Friesen, S., Dunn, C., and Freeman, C. (2018). Decomposition as a regulator of carbon accretion in mangroves: a review. *Ecological Engineering, 114*, 173-178. https://doi.org/10.1016/j.ecoleng.2017.06.069.

Gan, S. H. (2006). *Flora dan biojisim pokok di Hutan Paya Bakau Mukim Pasir Panjang, Port Diskson dan Tanjung Tuan, Melaka*. BSc. Thesis. Universiti Kebangsaan Malaysia (unpublished).

Gao, L., and Hailu, A. (2011). An agent-based integrated model of recreational fishing and coral reef ecosystem dynamics for site closure strategy analysis. *19th International Congress on Modelling and Simulation*. Perth, Australia, 12–16 December 2011. http://mssanz.org.au/modsim2011

Garrison, T. S. (2005). *Oceanography: An invitation to marine science*. 5th Edition, Thomson Brooks/Cole, Australia. ISBN: 9781305105164.

Goh, A. H., and Sasekumar, A. (1980). The community structure of the fringing coral reef, Cape Rechado. *Malayan Nature Journal, 34*, 25-37.

Gopinath, N., and Ismail, A. K. (1990). Development of rrecreational fisheries in Malaysia. In Singh, T. (ed.). *Angling and Recreational Fisheries - A Another Avenue in Fisheries Development. Malaysian Fisheries Society Occasional Publication No. 4.* (pp. 3-10). Malaysian Fisheries Society, Serdang, Selangor.

Gopinath, N., and Puvanesuri, S. S. (2006). Marine capture fisheries. *Aquatic Ecosystem Health and Management, 9*(2), 215 - 226. http://dx.doi.org/10.1080/14634980600721086

Gopinath, N., Puvanesuri, S. S., and Norhayati, S. (2013). Marine recreational fisheries development in policy and planning: a case study for Port Dickson District, Negeri Sembilan. *Paper Presented at the PD2013 International Conference on Sustainable Development of Tropical Coastal Zones*, 5th – 6th September 2013, Port Dickson.

Gopinath, N., Yusoff, F. M., dan Shariff, M. (2000). Status of the marine environment off Port Dickson, Negeri Sembilan, Malaysia. In: Shariff, M., Yusoff, F. M., Gopinath, N., Ibrahim, H. M., and Nik Mustapha, R. A. (eds.). *Towards Sustainable Management of the Straits of Malacca* (pp. 45-59). Malacca Straits Research and Development Centre (MASDEC), Faculty of Science and Environmental Study, Universiti Putra Malaysia.

Granek, E. F., Madin, E. M. P., Brown, M. A., Figueira, W. F., Cameron, D. S., Hogan, Z., Kristianson, G., de Villiers, P., Williams, J. E., Post, J. R., Zahn, S., and Arlinghaus, R. (2008). Engaging Recreational fishers in management and conservation: global case studies. *Global Case Studies. Conservation Biology, 22*(5), 1125 - 1134. https://www.jstor.org/stable/20183507

Gray, D. L., Canessa, R. R., Keller, C. P., Dearden, P., and Rollins, R. B. (2011). Spatial characterization of marine recreational boating: Exploring the use of an on-the-water questionnaire for a case study in the Pacific Northwest. *Marine Policy, 35*, 286 – 298. doi: 10.1016/j.marpol.2010.10.005

Gunung Ganang Sdn. Bhd. (2011). Detailed environmental impact assessment for the proposed sanitary landfill at Tanah Merah, Port Dickson, Negeri Sembilan. Report submitted to Department of Environment.

Gupta, N, Bower., S. D., Raghavan, R., Danylchuk, J., and Cooke, S. J. (2015). Status of recreational fisheries in India: development, issues, and opportunities. *Reviews in Fisheries Science and Aquaculture, 23*(3), 291-301. doi: 10.1080/23308249. 2015.1052366.

Hamdan, O., Khali Aziz, H., Shamsudin, I., and Raja Barizan, R.S. (2012). *Status of Mangroves in Peninsular Malaysia*. Forest Research Institute Malaysia, Ministry of Natural Resources and Environment. 153p.

Hamdan, O., and Muhamad Afizzul, M. (2020). Extents and distribution of mangroves in Malaysia. In: Hamdan, O., Tariq Mubarak, H., and Ismail, P. (eds). *Status of Mangroves in Malaysia* (pp. 2-42). FRIM Special Publication No. 52. Forest Research Institute Malaysia, Ministry of Energy and Natural Resources. ISBN 978-967-2149-81-1.

Henry, G. W., and Lyle, J. M. (2003). The national recreational and indigenous fishing survey. final report to the fisheries research and development corporation and the fisheries action program. Project No. 1999/158. *NSW Fisheries Final Report Series No. 48.* ISSN 1440-3544.

Herfaut, J., Levrel, H., Thebaud, O., and Veron, G. (2013). The nationwide assessment of marine recreational fishing: A French example. *Ocean and Coastal Management, 78*, 121–131. doi:10.1016/j.ocecoaman.2013.02.026.

Hiew, K., Saad, J., and Gopinath, N. (2013). *Coral triangle initiative: ecosystem approach to fisheries management (EAFM): Country position paper - Malaysia*. Publication. Honolulu, Hawaii: The USAID Coral Triangle Support Partnership. http://www.coraltriangleinitiative.org/sites/default/files/resources/39_Review%20of%20Malaysian%20Laws%20and%20Policies%20and%20EAFM%20in%20Malaysia.pdf

Hillman, K., McComb, A. J., and Walker, D. I. (1995). The distribution, biomass and primary production of the seagrass *Halophila Ovalis* in the swan/ canning estuary, Western Australia. *Aquatic Botany, 51*, 1 - 54. https://doi.org/10.1016/0304-3770(95)00466-D

Hossain, M., Saberi, O., and Japar Sidik, B. (2001). Distribution of copper in the Sepang Mangroves Reserve Forest Environment, Malaysia. *Journal of Tropical Forest Science, 13*(1), 130 – 139.

Hydec Sdn. Bhd. (2008). Proposed island reclamation development at palm springs resort, mukim Pasir Panjang, Port Dickson District, Negeri Sembilan. Unpublished.

IGFA (2015). IGFA International Angling Rules. https://igfa.org/wp-content/uploads/2020/07/IGFA-International-Angling-Rules_May122020.pdf

Ihde, T. F., Wilberg, M. J., Loewensteiner, D. A., Secor, D. H., and Miller, T. J. (2011). The increasing importance of marine recreational fishing in the US: Challenges for management. *Fisheries Research, 108*, 268 – 276. https://doi.org/10.1016/j.fishres.2010.12.016

Izwandy, I., Glasby, C. J., and Aziz, A. (2013). Nereididae (Annelida: Ploychaeta) used as baitworms in Peninsular Malaysia. *Proceedings of the Conference for University Malaysia Terengganu Postgraduate (pp. 239 – 250)*, July 5-7, 2012, Kuala Lumpur. https://www.researchgate.net/publication/263132604_Nereididae_Annelida_Polychaeta_Used_as_Baitworms_in_Peninsular_Malaysia

Jabatan Perancangan Bandar dan Desa (JPBD). (2010). *National Physical Plan-2. Federal Department of Town and Country Planning*. Ministry of Housing and Local Government.

Jabatan Perancangan Bandar dan Desa (JPBD). (2015). *National Rural Physical Plan Preliminary Report*. Town and Country Planning Department, Malaysia, Kuala Lumpur. Ministry of Housing and Local Government.

Jamal, O. Mazrura, S., Mastura, M., and Md Khadzir, S. A. (2014). Transboundary smoke haze pollution in Malaysia: inpatient health impacts and economic valuation. *Environmental Pollution, 189c*, 194 -201. doi: 10.1016/j.envpol.2014.03.010

Japar Sidik, B. (1994). Status of seagrass resources in Malaysia. *In:* Wilkinson, C. R., Sudara, S. and Chou, L. M. (eds.). *Proceeding of the ASEAN-Australia Symposium on Living Coastal Resources. Vol. 1. Status Reviews* (pp. 283 – 289). Chulalongkorn University, 16 – 20 May 1994, Bangkok, Thailand.

Japar Sidik, B., Aziz, A., and Law, A. T. (1995). Inventory of seagrass beds in Malaysia. In: Japar Sidik, B. (ed.). *UNEP: EAS35 Malaysian Inventory of Coastal Watersheds, Coastal Wetlands, Seagrass and Coral Reefs* (pp. 43-79). Department of Environment, Ministry of Science, Technology and Environment, Kuala Lumpur.

Japar Sidik, B., Mutaharah, Z., Kanamoto, Z., and Mohd. Pauzi, A. (2001). Seagrass communities of the Straits of Malacca. In: Japar Sidik, B. Aziz, A., Tan, S.G., Daud, S. K., Jambari, H. A. and Sugiyama, S. (eds.). *Aquatic Resources and Environmental Studies of the Straits of Malacca: Current Research and Reviews* (pp. 81-98). Malacca Straits Research and Development Centre (MASDEC). University Putra Serdang, Malaysia.

Jarina, M. J. (2015). Diverse fishing operations of Setiu small-scale fishery. In: Faridah, M., Jamilah, M. S, Jarina, M. J., Rohani, S. (eds.) *Setiu Wetlands: Species, Ecosystems and Livelihoods, Edition: 1, Chapter: 2 (Livelihoods)* (pp. 177-198). Publisher: Penerbit UMT. https://www.researchgate.net/publication/285482703_Diverse_fishing_operations_of_Setiu_Small-scale_Fishery

Jasmin, S., Hiew, K., and Gopinath, N. (2012). *Review of Malaysian Laws and Policies in Relation to the Implementation of Ecosystem Approach to Fisheries Management in Malaysia*. Malaysia's National Coordinating Committee/United States Agency for International Development's Coral Triangle Support Partnership (CTSP). https://coraltriangleinitiative.org/sites/default/files/resources/39_Review%20of%20Malaysian%20Laws%20and%20Policies%20and%20EAFM%20in%20Malaysia.pdf. Honolulu, Hawaii: 88pp.

Jensen, H., Rindorf, A., Wright, P. J., and Mosegaard, H. (2011). Inferring the location and scale of mixing between habitat areas of lesser sandeel through information from the fishery. *ICES Journal of Marine Science, 68*(1), 43–51. https://doi.org/10.1093/icesjms/fsq154

Jones, F. (1995). *Hamlyn Basic Guide to Angling*. Hamlyn publications. London. 106p. ISBN-13 : 978-0600346999

Kaki Pancing, (2014, November 11). Fishing Tips Udang Galah. Retrieved August 15, 2018 from https://gilopancing.blogspot.com/2014/11/fishing-tips-udang-galah.html#.X_B6LtgzbIU

Kaufman, J. B., and Donato, D. C. (2012). *Protocols for the measurement, monitoring and reporting of structure, biomass and carbon stocks in mangrove forests.* Working paper 86, Centre for International Forestry Research. Bogor, Indonesia. https://www.cifor.org/publications/pdf_files/WPapers/WP86CIFOR.pdf

Kawamura, T., Tanaka, N., Nakashima, Y., Karino, K., and Sakai, Y. (2002). Reversed sex-change in the protogynous reef fish *Labroides dimidiatus. Ethology, 108*(5), 443 - 450. https://doi.org/10.1046/j.1439-0310.2002.00791.x

Kearney, R. E. (2002). Recreational fishing: value is in the eye of the beholder. In: Pitcher, T. J., and Hollingworth, C. (eds). *Recreational Fisheries: Ecological, Economic and Social Evaluation* (pp. 17-37). Blackwell Science, Oxford. doi: 10.1002/9780470995402.ch2

Khoo, K. H. (1991). Fishery in Malaysia: A case study of the sport fishery potential in Tasik Temenggor. In: Singh, T. (ed). *Angling and Recreational Fisheries. Another Avenue in Fisheries Development* (pp. 16-2). Malaysian Fisheries Society.

Lackey, R. T. (1975). Recreational fisheries management and ecosystem modelling. Presented at the *Symposium Comparison of Biological Predation and Fisheries Exploitation*. Aquatic Ecology Section of the Ecological Society of America and the American Fisheries Society, 26th Annual American Institute of biological Science Meeting of Biological Societies, Corvallis, Oregon. https://frec.vt.edu/content/dam/frec_vt_edu/research/fws/FWS-4-75.pdf

Law, A. T., Shazili, N. A., Yaakob, R., Liew, H. C., Saadon, M. N., and Shamsudin, L. (1991). Coastal oceanographic studies in the Straits of Malacca and South China Sea (in Port Dickson coastal waters). *Proceedings of the Seminar on National Intensification of Research in Priority Areas (IRPA) for the 5th Malaysia Plan*

(Strategic Sector), Ministry of Science, Technology and Innovation, Penang, Malaysia 200 pp.

Law, A. T., Kuan, C. Y., Jan, J. K., and Hong, S. (2002). Hydrocarbon and sewage pollution in the coastal waters of Port Dickson, Straits of Malacca. In: Yosuff, F. M., Ibrahim, K. M., Tan, S. G., Tai, S.Y., and Shariff, M. (eds.). *Tropical Marine Environment: Charting Strategies for the Millennium.* Serdang Publisher, Malaysia.

Law, A. T., Abdul Rashid, M. K., Tan, C. H., and Yuen, Y.S . (2000). Malacca Straits expedition cruise No. 1: Nitrogen and phosphorus distribution from Langkawi to Johore. In: Shariff, M., Yusoff, F. M., Gopinath, N., Ibrahim, H. M. and Nik Mustapha, R. A. (eds.). *Towards Sustainable Management of the Straits of Malacca* (pp. 351-364). Malacca Straits Research and Development Centre (MASDEC), Faculty of Science and Environmental Study, Universiti Putra Malaysia.

Lewin, W. C., Arlinghaus, R., and Mehner, T. (2006). Documented and potential biological impacts of recreational fishing: insights for management and conservation. *Reviews in Fisheries Science, 14*,4, 305-367. doi: 10.1080/10641260600886455.

Lloret, J., Garrote, A., Balasch, N., and Font, T. (2014). Estimating recreational fishing tackle loss in mediterranean coastal areas: potential impacts on wildlife. *Aquatic Ecosystem Health and Management, 17*(2), 179-185. https://doi.org/10.1080/14634988.2014.910070

Looi, L. M., and Chua, K. B. (2007). Lessons from the Nipah virus outbreak in Malaysia. *The Malaysian Journal of Pathology, 29*(2), 63-67. https://www.researchgate.net/publication/23698479_Lessons_from_the_Nipah_virus_outbreak_in_Malaysia

Lyle, J. M., Coleman, A. P. M., West, L., Campbell, D., and Henry, G. W. (2002). New large-scale survey methods for evaluating sport fisheries. In: Pitcher, T. J, and Hollingworth, C. E. (eds). *Recreational Fisheries: Ecological, Economic and Social Evaluation* (pp. 207 – 226). Blackwell Science, Oxford, UK. doi: 10.1002/9780470995402.ch15.

Lyons, J., Hickley, P., and Gledhill, S. (2002). An evaluation of recreational fishing in England and Wales. In: Pitcher, T. J., and Hollingworth, C. E. (eds). *Recreational Fisheries: Ecological, Economic and Social Evaluation* (pp. 144 - 155). Blackwell Science, Oxford, UK. doi: 10.1002/9780470995402.ch12.

Mahmoud, S. M, and Mitkees, H. (2017). Malaysia's vision 2020 and the role of leadership in economic development. *Asian Social Science, 13*(8), 49-58. doi: 10.5539/ass.v13n8 p49.

Mann, B. Q., Scott, G. M., Mann-Lang, J. B., Brouwer, S. L., Lamberth, S. J., Sauer, W. H. H., and Erasmu, C. (1997). An evaluation of participation in and management of the South African spear fishery. *South African Journal of Marine Science, 18* (1), 179-193. http://dx.doi.org/10.2989/025776197784161144.

Marine Department of Malaysia (2007). *ORD. 70/1952: Merchant Shipping Ordinance 1952, Incorporating latest amendments - Act A1316/2007*. Retrieved from https://www.marine.gov.my/jlm/halaman/senarai-akta-akta-dan-undang-undang-di-bawah-kawalan-jabatan-laut-malaysia.

Maunder, M. N., Sibert, J. R., Fonteneau, A., Hampton, J., Kleiber, P., and Harley, S. J. (2006). Interpreting catch per unit effort data to assess the status of individual stocks and communities. *ICES Journal Marine Science, 63*, 1373–1385. doi:10.1016/J.ICESJMS.2006.05.008

McCarthy, N. (2017, Jun 28). The Most Popular Spectator Sports Worldwide. Statista. Retrieved November 17, 2020, from https://www.statista.com/chart/10042/the-most-popular-spectator-sports-worldwide/

McDonald, J. H. (2014). *Handbook of Biological Statistics* (3rd edition). Sparky House Publishing, Baltimore, Maryland. http://www.biostathandbook.com/HandbookBioStatThird.pdf

McKenzie, L. J., Campbell, S. J., Vidler, K. E., and Mellors, J. E. (2007). *Seagrass-Watch: Manual for Mapping and Monitoring Seagrass Resources*. Seagrass-Watch HQ, Cairns. 114p.

Merchant Asia Sdn. Bhd. (2004). Preliminary Environmental Impact Assessment (PEIA) for the Proposed Integrated Tourism Development on Lots 1404, 1424, Lot 1117, Part of Lot 638 and 3 Parcels of Melaka State Land at Mukim Kuala Linggi, Alor Gajah District, Melaka. Report submitted to Department of Environment.

MIER. (2000). *Sectoral Development plan for the Malaysian fisheries industry*. Malaysian Institute of Economic Research (MIER). Report to the Economic Planning Unit, Malaysia (Unpublished).

Mike, A., and Cowx, I. G. (1996). A preliminary appraisal of the contribution of recreational fishing to the fisheries sector in north-west Trinidad. *Fisheries Management and Ecology, 3*(3), 216-228 https://doi.org/10.1111/j.1365-2400.1996.tb00149.x

Ministry of Agriculture and Agrobased Industry (2016). National Agrofood Policy 2011 – 2020. Ministry of Agriculture and Agrobased Industry, Malaysia

Ministry of Agriculture and Agrobased Industry (2015a). Fisheries Development Authority of Malaysia Act. https://www.lkim.govbmy/en/act/. Downloaded in August, 2015. Ministry of Agriculture and Agro-based Industries, 2015.

Ministry of Agriculture and Agrobased Industry, (2015b).- Fishermen's Association Act. https://www.lkim.gov.my/en/act/. Downloaded in August, 2015. Ministry of Agriculture and Agro-based Industries, 2015.

New Zealand Marine Research Foundation, (2016). Recreational Fishing in in New Zealand. New-Zealand-Fishing-Economic-Report.pdf. Down loaded in June 2020.

Mohammad Zaidi, Z., and Azmi, M. A. (1991). Potentials and benefits of recreational fisheries development in Malaysia. In: Singh, T. (ed.). *Angling and Recreational Fisheries - Another Avenue in Fisheries Development* (pp. 32–42). Occasional Publication No.4. Malaysian Fisheries Society, Serdang, Malaysia

NZstudy of the Straits of Malacca and Singapore. *Journal of International Studies, 8,* 47-75. ISSN 2289-666X. http://e-journal.uum.edu.my/index.php/jis/article/view/7926

Muta Harah, Z., and Japar Sidik, B. (2013). Occurrence and distribution of seagrasses in waters of Perhentian Island Archipelago, Malaysia. *Journal of Fisheries and Aquatic Science, 8*, 441 - 451. doi: 10.3923/jfas.2013.441.451.

Myers, R. A., and Worm, B. (2003). Rapid worldwide depletion of predatory fish communities. *Nature, 423,* 280–283. doi: 10.1038/nature01610.

Nagelkelken, I. (2009). Evaluation of nursery function of mangroves and seagrass beds for tropical decapods and reef fishes: patterns and underlying mechanisms. In: Nagelkerken (ed.). *Ecological Connectivity among Tropical Coastal Ecosystems* (pp. 357-399). Springer, Dordrecht. https://doi.org/10.1007/978-90-481-2406-0_10

National Hydrological Research Institute (NAHRIM). (2008). Port Dickson Integrated Shoreline Management Plan for Port Dickson, Negeri Sembilan. (unpublished) 500pp.

Nguyen, A., Le, B. V. Q., and Richter, O. (2020). The role of mangroves in the retention of heavy metal (chromium): a simulation study in the Thi Vai river catchment, Vietnam. *International Journal of Environmental Research and Public Health, 17* (2823), 1-20. doi: 10.3390/ijerph17165823.

NOAA (2015). National Saltwater Recreational Fisheries Policy. Retrieved November, 25, 2020, from https://www.fisheries.noaa.gov/national/recreational-fishing/national-saltwater-recreational-fisheries-policy

Noorul Shaiful, F., Rahman, A., Nur Hanis, B., Syed Faizal Shah, S. J. S., Mohd Hafizi, S. and Mohammad Khairuddin, O. (2020). The sustainability of nautical sports tourism in Terengganu using a cost benefit analysis. *Journal of Sustainability Science and Management, 15* (1), 148-161. *eISSN: 2672-7226*

Nur Anis Fadilah, S., Singh, H. R., and Nur Hilwani, I. (2015). The gastropod community of the Lukut mangroves, Negeri Sembilan. Proceedings of *ISER 10th International Conference*, Kuala Lumpur, Malaysia, 8th November 2015, ISBN: 978-93-85832-34-5.

O&L Jurutera Perunding (1997). Environmental Impact Assessment for Resort Development Project in Linggi, Port Dickson. Report Submitted to Department of Environment.

Ong, L. T. J., Storey, D., and Minnery, J. (2011). Beyond the beach: Balancing environmental and socio-cultural sustainability in Boracay, the Philippines. *Tourism Geographies, 13* (14), 549 – 569. doi: 10.1080/1416688.2011.590517.

Parkkila, K., Arlinghaus, R., Artell, J., Gentner, B., Haider, W., Aas, Ø., Barton, D., Roth, E., and Sipponen, M. (2010). Methodologies for assessing socio-economic benefits of European inland recreational fisheries. *EIFAC Occasional Paper No. 46.* Ankara, FAO. 112p. ISBN 978-92-5-106636-2.

Pawson, M. G., Glennb, H., and Paddaa, G. (2008). The definition of marine recreational fishing in Europe. *Marine Policy, 32*, 339–350. doi: 10.1016/j.marpol.2007.07.001

People for the Ethical Treatment of Animals (PETA). (n.d.). *Why Sport Hunting is Cruel and Unnecessary*. PETA. Retrieved November 17, 2020, from https://www.peta.org/issues/wildlife/wildlife-factsheets/sport-hunting-cruel-unnecessary/

People for the Ethical Treatment of Animals, UK (PETAUK). (n.d.). *Angling: Recreational Cruelty*. Retrieved November 17, 2020, from https://www.peta.org.uk/issues/animals-not-use-entertainment/angling/

Persatuan Alam Sekitar Selangor. (2014). Sg. Sepang community development study planning report. Report Submitted to United Nations Development Programme (UNDP) (Unpublished).

Phang, S. M. (1995). Distribution and abundance of marine algae on the coral reef flats at Cape Rachado, Port Dickson, Peninsular Malaysia. *Malaysian Journal of Science, 16A*, 23–32.

Phang, S. M. (2000). *Seagrasses of Malaysia*. Universiti Malaya, Botanical Monographs No. 2. Institute of Biological Sciences, Universiti Malaya, Kuala Lumpur. ISBN: 983-2085-09-8.

Phang, S. M. (2006). Seaweed Resources in Malaysia: Current Status and Future Prospects. A*quatic Ecosystem Health and Management, 9*(2), 185 - 202. doi: 10.1080/14634980600710576.

Phang, S. M., and Wee, Y. C. (1991). Benthic marine algae. In: Kiew, R. (ed.) *The State of Nature Conservation in Malaysia* (pp. 51–61). Malayan Nature Society, Kuala Lumpur, Malaysia

Phang, S. M., Yeong, H. Y., and Lim, P. L. (2019). The seaweeds resources of Malaysia. *Botanica Marina, 62* (3), 265-273. doi: 10.1515/bot-2018-0067.

Pitcher, T. J., and Hollingworth, C. E. (2002). Fishing for fun: where's the catch?. Recreational fisheries: ecological, economic and social evaluation. *Fish and Aquatic Resources Series, 8,* 1-16. https://doi.org/10.1002/9780470995402.ch1

PLANMalaysia @ Negeri Sembilan. (2018). Negeri Sembilan Structure Plan 2020 - 2045. Department of Town and Country Planning Negeri Sembilan, Seremban. https://jpbd.ns.gov.my/perkhidmatan/rancangan-pemajuan/rancangan-struktur-negeri.

Praveena, S. M., and Aris, A. Z. (2013). A baseline study of tropical coastal water quality in Port Dickson, Strait of Malacca, Malaysia. *Marine Pollution Bulletin, 67*(1-2), 196–199. doi:10.1016/j.marpolbul.2012.11.037.

Praveena, S. M., Siraj S. S., and Aris, A. Z. (2012) Coral reefs studies and threats in Malaysia: a mini review. *Reviews in Environmental Science and Biology, 11*(1),27–39. doi:10.1007/s11157-011-9261-8.

R Core Team (2020). *R: A language and environment for statistical computing.* R Foundation for Statistical Computing, Vienna, Austria. http://www.r-project.org/index.html.

Raguragavan, J., Hailu, A., and Burton, M. (2010). *Economic valuation of recreational fishing in Western Australia*. Working Paper 1001, School of Agricultural and Resource Economics, University of Western Australia, Crawley, Australia. https://doi.org/10.1111/1467-8489.12009.

Reef, R., Feller, I. C., and Lovelock, C. E. (2010). Nutrition in mangroves. *Tree Physiology, 30,* 1148– 1160. doi:10.1093/treephys/tpq048.

Reeves, S., Peller, J., Goldman, J., and Kitto, S. (2013). Ethnography in qualitative educational research: AMEE Guide No. 80. Web Paper AMEE Guide. *Medical Teacher, 35*(8), e1365-e1379 doi: 10.3109/0142159X.2013.804977

Reid, M., and Schneiker, K. (2008). Strength and conditioning in tennis: current research and practice. *Journal of Science and Medicine in Sport, 11*(3), 248 - 256. doi: 10.1016/j.jsams.2007.05.002

Roberts, K. J., Horst, J. W., Roussel, J. E., and Shephard, J. A. (1996). *Understanding fisheries management. A manual for understanding the federal fisheries management process, including analysis of the 1996 Sustainable Fisheries Act*. Appendix 2: Definition. NOAA.

Rocklin, D., Levrel, H., Drogou, M., Herfaut, J., and Veron, G. (2014). Combining telephone surveys and fishing catches self-report: The French sea bass recreational fishery assessment. *PLoS ONE, 9*(1), e87271. doi: 10.1371/journal.pone.0087271

Roshidi, O., and Wan Masyitah, W. D. (2018). Identification and characterization of pteroplinthite mangrove forests. *Journal of Architecture, Planning and Construction Management,* 8(1), 55-63. https://journals.iium.edu.my/kaed/index.php/japcm/article/view/257

Royce, W. F. (1984). Introduction to the Practice of Fishery Science. *Journal of Marine Biological Association of the United Kingdom, 65 (4),* 1076. doi: https://doi.org/10.1017/S0025315400019615

Sadovy, Y. (2005). The threat of fishing to highly fecund fishes. *Journal of Fish Biology, 59* (sA), 90 – 108. doi: 10.1111/j.1095-8649.2001.tb01381.x

Sadovy, Y., and Domeier, M. (2005). Are aggregation-fisheries sustainable? Reef fish fisheries as a case study. *Coral reef, 24* (2), 254-262. doi: 10.1007/s00338-005-0474-6.

Safuan, C. D. M., Ali, A., Zainol, Z., Ali, A., Akhir, M. F. M., Muslim, A. M., and Bachok, Z. (2018). A baseline assessment of coral reef in Malacca Straits, Malaysia. *Ocean Science Journal, 53*(2), 275–283. doi:10.1007/s12601-018-0021-3.

Seafood New Zealand (n.d.). Key Facts: Seafood New Zealand. Retrieved November 20, 2020, from https://www.seafoodnewzealand.org.nz/industry/key-facts/.

Sen, A., Darnell, A., Crowe, A., Bateman, I., Munday, P., and Foden, J. (2011). *Economic Assessment of the Recreational Value of Ecosystems in Great Britain.* UK National Ecosystem Assessment Economic Analysis Report. The Centre for Social and Economic Research on the Global Environment (CSERGE), University of East Anglia. 38p. http://uknea.unep-wcmc.org/LinkClick.aspx?fileticket=zzHJEl1HCM0%3D&tabid=82

Sharifah, M. S. S. (1984). The relationship between the offshore topography and the Port Dickson- Cape Rachado coast. *Akademia, 25,* 69-85. https://ejournal.ukm.my/akademika/article/view/3795/2177

Sheridan, P., and Hays, C. (2003). Are mangroves nursery habitat for transient fishes and decapods?. *Wetlands, 23*(2), 449–458. doi:10.1672/19-20.

Short, F. T. (1987). Effects of sediment nutrients on seagrass: literature review and mesocosm experiment. *Aquatic Botany, 27*, 41 - 57. https://doi.org/10.1016/0304-3770(87)90085-4.

Shvili, J. (2020, October 16). The Most Popular Sports in the World. WorldAtlas. Retrieved November 17, 2020, from https://www.worldatlas.com/articles/what-are-the-most-popular-sports-in-the-world.html

Singh, H. R. (2013). The mangrove gastropods of Pulau Besar, Pulau Merambong and Tanjung Tuan. Jabatan Taman Laut, Azizan, A. A., Shahima, A. H. and Md. Nizam, I. (eds.). *Marine Biodiversity Expedition Report 2012. Central and Southern Straits of Malacca - Sembilan Islands, Tanjung Tuan and Merambong Shoal. Department of Marine Park Malaysia. Volume 2* (pp. 15-30). ISBN: 978-967- 12320-3-3.

Srisunont, C., Jaiyen, T., Tenrung, M., Likitchaikul, M., and Srisunont, T. (2017). Nutrient accumulation by litterfall in mangrove forest at Klong Khone, Thailand. *Thammasat International Journal of Science and Technology, 22,* 9-18. doi: 10.14456/tijsat.2017.2.

Steffens, W., and Winkel, M. (2002). Evaluating recreational fishing in Germany. In: Pitcher, T. J., and Hollingworth, C. E. (eds). *Recreational Fisheries: Ecological, Economic and Social Evaluation* (pp. 130 - 136). Blackwell Science, Oxford, UK. doi: 10.1002/9780470995402.ch10

Tan, C. E., Chong, B. I., Sier, H. K., and Moulton, T. P. (1973). A report on paddy fields fish production in Krian, Perak. *Report of Ministry of Agricultural and Fisheries Malaysia, 128*, 1-57.

Tarmiji, M., Usman, Y., Norizawati, M. A., and Aimi Shamimi, M. (2012). Population and Spatial distribution of urbanisation in Peninsular Malaysia 1957 – 2000. *Malaysia Journal of Society and Space, 8*(2), 20 – 29. http://journalarticle.ukm.my/3605/1/3.geografia-peb%25202012-themed%2520issue-Tarmiji%2520Masron%2520et%2520al-usm-english-1-22.2.pdf

Templeton, R. G. (1984). *Freshwater fisheries management.* Severn-Trent Water Authority. Farnham, Surrey, England, Fishing News Books Ltd. ISBN 10: 0852381301

Thalathiah, H. S. (1997). Country report: Malaysia. In Fishery and Aquaculture Statistics in Asia: Proceedings of the FAO/SEAFDEC Regional Workshop on Fishery Statistics, Bangkok, Thailand, 19-21st August 1997. Vol. II. *Fishery and Aquaculture Statistical Systems and Programs* (pp. 75-94). Bangkok, Thailand: Secretariat, Southeast Asian Fisheries Development Center. http://repository.seafdec.org/bitstream/handle/20.500.12066/5406/SaidinTBH1997.pdf?sequence=1&isAllowed=y

Thunberg, E. M., and Milon, J. W. (2002). Projecting recreational fishing participation. In: Pitcher, T. J. and Hollingworth, C .E. (eds). *Recreational Fisheries: Ecological, Economic and Social Evaluation* (pp. 63 - 73). Blackwell Science, Oxford, UK. doi: 10.1002/9780470995402.ch5.

Tisdell, C. A. (2003). Recreational Fishing: Its expansion, its economic values and aquaculture's role in sustaining it. Working Paper No. 93, Economic, Ecology and the Environment. *researchgate.net/publication/37629667_Recreational_Fishing_Its_Expansion_Its_Economic_Value_and_Aquaculture's_Role_in_Sustaining_It.*

Toivonen, A. L. (2002). A survey of the economic value of Nordic recreational fisheries. In: Pitcher, T. J., and Hollingworth, C. E. (eds). *Recreational Fisheries: Ecological, Economic and Social Evaluation* (pp. 137 - 143). Blackwell Science, Oxford, UK. doi: 10.1046/j.1365-2400.2003.00376.x

Toledo, V. (1992). La racionalisas ecologica de la produccion campesina. In: Sevilla Guzman, E. and Gonzalez de Molina M. (eds). *Ecologia, campesinado e historia* (pp 197-218). Las Ediciones de La Piqueta, Madrid.

Tourism Malaysia (2019). *Annual Report 2018*. Tourism Malaysia, Ministry of Tourism, Arts and Culture Malaysia. 130p.

UPEN Negeri Sembilan (2006) Negeri Sembilan Tourism Master Plan. Negeri Sembilan State Planning Unit, Seremban (unpublished) 322p.

Walker, D. I., and McComb, A. J. (1990). Salinity Response of the seagrass *Amphibolis antarctica* (Labill.) sonder ex aschers: an experimental validation of field results. *Aquatic Botany, 36*, 359 - 366. https://doi.org/10.1016/0304-3770(90)90052-M

Wan Faridah Akmal, W. J., Nor Rasidah, H., and Selina Zaiton, I. (2010). Distribution and abundance of *Pteroptyx* fireflies in Rembau-Linggi estuary, Peninsular Malaysia. *Environment Asia, 3* (Social Issues), 56-60. doi: 10.14456/ea.2010.40

Weisgerger, M. (2017, May 28). *Hunting Big Game: Why People Kill Animals for Fun.* Scientific American. Retrieved February 15, 2019 from https://www.scientificamerican.com/article/hunting-big-game-why-people-kill-animals-for-fun/

Whitehead, J. C. (2005). *Contingent valuation and random utility model estimates of the recreational value of king mackerel*. Working Papers 05-08, Department of Economics, Appalachian State University. https://econ.appstate.edu/RePEc/pdf/wp0508.pdf

Williamson, S. (2000). The economic value of New Zealand marine recreational fishing ant its use as a policy tool. Paper presented at *IIFET 2000 Conference*. Corvallis, Oregon, July, 10-15, 2000. https://ir.library.oregonstate.edu/downloads/fx719n336

Willingham, A. J. (2018, March 7). *Cecil the Lion 'Suffered Incredible Cruelty' for 10 Hours Before He Died, A New Book Claims*. CNN. Retrieved February 15, 2019 from https://edition.cnn.com/2018/03/07/africa/cecil-lion-death-book-excerpt-trnd/index.html

Wong, C. L., and Phang, S. M. (2004). Diversity and distribution of Malaysian *Sargassum* species. *Proceedings of the Asia Pacific Conference on Marine Science & Technology.* Kuala Lumpur, Malaysia.

Worldometer (n.d.). *Current World Population.* Retrieved November 17, 2020, from https://www.worldometers.info/world-population/.

Yan, S. W., Ahmad Fauzan, M. N., Nurul Nabila, F., and Zulaikha, S. (2016). Transboundary air pollution in Malaysia: Impact and perspective on haze. *Nova Journal of Engineering and Applied Sciences, 5 (*1), 1-11.

Zhang, Z. W., Xu, X. R., Sun, Y. X., Yu, S., Chen, Y. S., and Peng, J. X. (2014). Heavy metal and organic contaminants in mangrove ecosystems of China: A review. *Environmental Science and Pollution Research, 21,* 11938–11950. doi: 10.1007/s11356-014-3100-8.

Appendix 1: Phase 1 Questionnaire – Angler Profile

Establishment of Recreational Fisher Hotspots in Port Dickson

Data Collection Template

Profile

1. Location Code:
2. Date:
3. Status:

Week Status	Workday Status		
	Normal	Public Holiday	School Holiday
Weekday			
Weekend			

4. Time of Collection:
5. Time Window:
   a. Forenoon (Before 12pm)…….
   b. Afternoon (12pm – 5pm)……
   c. Evening (5pm – 7pm)……..……
   d. Night (7pm – 6am) ……..……..

Legend for Angler Profile

Race: M = Malay
C = Chinese
I = Indian
O = Others

Origin: P = PD District
S = Seremban
K = Klang Valley
O = Others

Angler Profile

Age (years)				Race	Gender	Occupation	Origin	Income Level (RM'000/month)			
<20	20-40	41 – 60	>60					<1	1 - 2	2.1 - 5	> 5

Appendix 2: Phase 1 Questionnaire – Locational Profile

Establishment of Angling Hotspots in Port Dickson

Data Collection Template

Location Profile

1. Name of Location:
2. Code:
3. GPS Coordinates:
    - Latitude
    - Longitude
4. Nature of Location
    - Ox-Bow lake……
    - River……
    - Estuary……..
    - Seafront…….
5. Recreational Fisheries Infrastructure:
    - Fishing Jetty…….
    - Angling Jetty……
    - Shorefront……
    - Wave breaker……..
    - Revetment…..……..
    - Angling *kelong*…….
    - Marina……
    - Other……
6. Nature of activity at the point:
    - Static Casting:
    - Boat based fishing:
7. General Description of the site:
    - From PD Town:
        - Orientation: ……
        - Distance: ……
    - To closest township: ……
        - Orientation: ……
        - Distance: ……
    - Supporting Infrastructure:
        - Road access: ……

- Electricity: ……
- Piped water: ……

- Surrounding commercial activity:
  - Restaurants
  - Commercial establishments
  - Others ……
- Other Comments

……

……

……

Appendix 3: Phase 1 Questionnaire – Establishment of Angling Businesses in Port Dickson

Data Collection Template

1. Name of Location:
2. Code:
3. GPS Coordinates:
    - Latitude
    - Longitude
4. Nature of Location
    - Shophouse……..
    - Permanent Stall……..
    - Temporary stall……..
5. Nature of business
    - Bait…….
    - Fishing tackle sale…….
    - Fishing Tackle rental……
    - Others……
6. General Description of the site:

    ……

    ……

    ……

Appendix 4: Coral and Associated Flora (Seaweed) and Fauna (Reef Fish and Invertebrates) Assessment Methodology

The coral reef assessments was undertaken using SCUBA. A quadrat-based method (Bohsack and Bannerot, 1986) was used to assess the sessile benthic community, flora (seaweed) and fauna (reef fish and invertebrates) of the coral reefs and establish the diversity, density and health status of reefs. The survey method was the based on a modified Line Intercept Transect (LIT), which involved the arrangement of quadrats in parallel rows (English et al., 1994).

The general procedure employed at each site are as follows:

- The positions of the centre line of the survey was established, after which a team of divers laid a central transect line of 50m using a measuring tape and delineated into 5 m x 10 m survey quadrates.
- After delineating the quadrates, the divers left the survey area for 10 minutes or more to allow normal fish activity to resume.
- When the divers returned, they recorded coral species and other fauna (reef fish and invertebrates) within each quadrate along the transect.
- The coral species other flora (seaweed) and fauna (reef fish and invertebrates) are identified up to genera/species level where possible in the field or after the dive were completed using field guidebooks. The references that provide the background material for the identification of species are Kelley (2009), Veron (2000), Janes and Lee (2007), Fabricius and Alderslade (2001), Allen and Steen (1999), Delbeek and Sprung (1994), Chou (1988) and Searle (1980). Coral species that could not be identified *in-situ*, photographs and videos are taken for further identification and documentation.
- The data collected include latitude and longitude using GPS of the quadrate centre points, coral speciation (including reef fish), their distribution within each quadrate, percentage coverage and health of coral reef based on live/dead coral ratios which is the normal metric for reef health assessment.

References

1. Allen, G. R., and Steen, R. (1999). In*do-Pacific Coral Reef Field Guid*e. Tropical Reef Research, Singapore. 378p.
2. Bohsack, J. A., and Bannerot, S. P. (1986). A Stationary visual census technique for quantitatively assessing community structure of coral reef fishes. J*uly NOAA Technical Report NMFS, 41,* 1-15.
3. Chou, L .M. (1988). *A Guide to the Coral Reef Life of Singapore*. Singapore Science Centre. 128p.
4. Delbeek, J. C., and Sprung, J. (1994). *The Reef Aquarium- A Comprehensive Guide to the Identification and Care of Tropical Marine Invertebrates.* Ricordea Publishing Coconut Grove, Florida. Vol 1. 544p.
5. English S., Wilkinson, C. and Baker, V. (1994). *Survey Manual for Tropical Marine Resources.* ASEAN-Australian Marine Science Project. Australian Institute of Marine Science, Townsville.
6. Fabricius, K., and Alderslade, P. (2001). *Soft Coral and Sea Fans – A Comprehensive Guide to the Tropical Shallow Water Genera of the Central-West Pacific, the Indian Ocean and the Red Sea*. Australian Institute of Marine Science, Townsville MC, Queensland, Australia, 264p.
7. Janes M. P., and Lee, M. W. (2007). O*ctocoral Taxonomy Laboratory Manual. Results of the International Workshop on the Taxonomy of Octocorals.* University of Kerala, India.
8. Kelley, R. (2009). *The Australian Coral Reef Society Coral Finder 2.0.* Indo-Pacific.
9. Searle. A. G. (1980). A*n Illustrated Key to Malayan Hard Cora*ls. The Malayan Nature Society. 70p.
10. Veron, J. (2000). *Corals of the World*. Australian Institute of Marine Science, Queensland, Australia.

Appendix 5: Seagrass Assessment Methodology

The sampling was based on the method by McKenzie et al. (2007) with minor modifications and involved the following:

- Surveys were initiated at the edge of an exposed seagrass/seaweed meadow and the first point was marked with a pole. Latitude and longitude of the GPS reading was recorded on the data sheet.
- The transect tape was laid until it reached the other end of the meadow in a straight line and the end point was also marked with a pole.
- At the starting point, a quadrate (1.0m X 1.0m) was placed at the right hand side of the transect line.
- The major characteristic within the quadrate i.e. sediment type, species of seagrass/seaweed/algae, percent of seagrass/seaweed/algae cover were recorded in the data sheet. The seagrass/seaweed species were identified using field guidebooks such as by El Shaffai (2011), McKenzie and Campbell (2002), Phang (2000) and Lanyon (1986).
- After completing one point (1st quadrate), the second point was placed at the next 2 m and this procedure repeated until the end of transect.
- Photographs of the representative seagrass and algae species was recorded.

References

1. El Shaffai, A. (2011). *Field Guide to Seagrasses of the Red Sea*. First Edition. Gland, Switzerland. 56p.
2. Lanyon, J. (1986). *Guide to the Identification of Seagrasses in the Great Barrier Reef Region*. Great Barrier Reef Marine Park Authority Special Publication Series. 54p.
3. McKenzie, L. J., Campbell, S. J., Vidler, K. E., and Mellors, J. E. (2007). *Seagrass-Watch: Manual for Mapping and Monitoring Seagrass Resources*. Seagrass-Watch HQ, Cairns. 114p.
4. Phang, S. M. (2006). Seaweed Resources in Malaysia: Current Status and Future Prospects. A*quatic Ecosystem Health and Management, 9*(2), 185 - 202.

Appendix 6: Phase 2 Questionnaire – Catch Landing Profile of Boat Fishers

Data Collection Template

1. Location Code:
2. Date:
3. Time:
4. Tidal level:
    - 4.1 High tide
        - 4.1.1 Time: …….
        - 4.1.2 Level: ……
    - 4.2 Low Tide
        - 4.2.1 Time: …….
        - 4.2.2 Level: ……
    - 4.3 Tidal Status:
        - 4.3.1 Neap low ……
        - 4.3.2 Neap high ……..
        - 4.3.3 Spring high …….
        - 4.3.4 Spring Low ……..
5. API Reading: ……
6. Weather: ……..
7. Status:

Week Status	Workday Status		
	Normal	Public Holiday	School Holiday
Weekday			
Weekend			

8. Time of Collection:
    - 8.1 Time Window:
        - 8.1.1 Forenoon (Before 12pm)……
        - 8.1.2 Afternoon (12pm – 5pm)……
        - 8.1.3 Evening (5pm – 7pm)……..……
        - 8.1.4 Night (7pm – 6am): ……..……..

9. Personal Details

Age (years)				Race	Gender	Occupation	Origin	Income Level (RM'000/month)			
<20	20-40	41 - 60	>60					<1	1 - 2	2.1 - 5	> 5

Legend for Angler Profile

Race: *M = Malay*
C = Chinese
I = Indian
O = Others

Origin: *P = PD District*
S = Seremban
K = Klang Valley
O = Others

10. Conditions

10.1 Weather. What is the ideal weather for fishing?

Weather	**Acceptability**
Warm and Clear	
Rainy	
Cloudy but dry	
Hazy	

10.2 Timing

Timing	**Boat Based Fishing**	
	Day	*Night*
Weekends		
Normal		
School holidays		
Other holidays		
Weekdays		
Normal		
School holidays		
Other holidays		

10.3 How many hours do you spend fishing during each trip:

	Up to 2 hours	Up to 4 hours	Up to 6 hours	Up to 12 hours	Up to 24 hours	More than 24 hours
Boat based fishers						

11. Catch

11.1 What is the main species that you obtain during your most recent fishing trip?

Date	Type	Species	Number	Total Weight

12. Expenditure

12.1 How many fishing trips do you do in a year?

12.1.1 Boat based fishing ……

12.1.2 Shore based fishing ……

12.2 What is your capital expenditure for recreational fisheries:

12.2.1 Number of rods that you possess ……

12.2.2 Total cost of rods ……

12.2.3 Number of lures that you possess ……

12.2.4 Total cost of lures ……

12.2.5 Other equipment cost.……

12.3 What is your operational expenditure in doing each trips:

12.3.1 Transport (fuel/toll/public transport): ……

12.3.2 Bait ……

12.3.3 Accommodation ……

12.3.4 Boat hire ……

12.3.5 Others ……

13. Other Comments

Motivation ……..

Disposal of Catch …….

Others …….

Appendix 7: Phase 2 Questionnaire – Recreational Boat Operators

Data Collection Template

Date:

Project:

Site Code:

Questionnaire no.:

1. Name of boat operator: ……..
2. Fish Landing Point: ……..
3. Number of workers: …….
4. Operation time:

	Weekdays	Weekends/Public Holidays
a) Rental rate:		
RM/hour		
RM/day		
RM/anglers		
b) Baits:		
Not provided		
Provided (+RM…		

5. No. of boat
   a. Non-powered boat …….. unit
   b. Inboard …….. unit
   c. Outboard …….. unit
6. No of angler/boat
   a. Non-powered boat …….. anglers/boat
   b. Inboard …….. anglers/boat
   c. Outboard …….. anglers/boat
7. No. of fishing gear/angler ……
8. Angling location…….
9. Type of bait and rate (RM)
   …….
10. Common fish caught
    …….
    …….
    …….

Open question:

Have you noticed any changes in the catches over the last x years? (species, abundance etc)

Open question:

Where do you commonly take clients? Maybe you could provide a map of area??

Has the location changed over time? (why?)

Has the type of client changed over time? (from what to what?) and has this affected earnings?

11. Average catch

a. kg/boat ……..

b. kg/angler ……..

12. Average number of anglers (week@month@year)

	Weekdays	Weekends/Public Holidays
Gender:		
Male	…… angler	…… angler
Female	…… angler	…… angler
Age:		
<12 years old	…… angler	…… angler
<18 years old	…… angler	…… angler
<40 years old	…… angler	…… angler
>40 years old	…… angler	…… angler
Race:		
Malay	…… angler	…… angler
Chinese	…… angler	…… angler
Indian	…… angler	…… angler
Others	…… angler	…… angler
Origin:		
Local		
Outside area		

Appendix 8: Recreational Fisheries Model Employed by Gopinath et al., 2013

Recreational fishing effort was computed by Gopinath et al. (2013) based on the following assumptions.

- That recreational fishers fish both during the night as well as during the day.
- Recreational fishing is undertaken during weekends, public and school holidays.
- The fishing effort is based on a person-day, each person controlling one (1) to four (4) rods.
- A person-day is 8 person-hours
- Shore-based fishing time is broken up into time segments as follows:
    - 2 pm – 7 pm (5 hours)
    - 7 pm – 12 am (5 hours)
- The boat-based fishing trip is
    - 7am -7pm (12 hours) for those renting outboards
    - 7am-7am (24 hours) for renting inboards

Thus, fishing effort for shore based fishing is calculated as follows:

F = (5N $\sum(p\ x)\ z$)/8

Where

- F = fishing effort in terms of visitor days
- N = number of weekends, public and school holidays
- p = number of survey respondents
- q = frequency of fishing
- z = average number fishing during weekends

Fishing effort for boat based fishing is calculated as follows:

F = (5N $\sum[(p\ x)\ zn] + [(px)zm$)/8

- F = fishing effort in terms of visitor days
- N = number of weekends, public and school holidays
- p = number of survey respondents
- q = frequency of fishing
- z = average number fishing during weekends, public and school holidays
- n = numbers renting outboards
- m = numbers renting inboards

Reference

1. Gopinath, N., Puvanesuri, S. S., and Norhayati, S. (2013). Marine recreational fisheries development in policy and planning: a case study for Port Dickson District, Negeri Sembilan. *Paper Presented at the PD2013 International Conference on Sustainable Development of Tropical Coastal Zones*, 5th – 6th September 2013, Port Dickson.

Appendix 9: Profile of Two Submerged Habitats in PDD Waters

The two sites were chosen based on anecdotal information by recreational fishers and their presence in the North and South of PDD shoreline. As pointed out earlier, their presence was indicated by recreational fishers and the objective was to verify their perceptions.

The two sites were as follows:

a. A small (about 600 m^2), previously understudied, seagrass meadow at Kg. Gelam, about 1.5km north of Port Dickson town. Its presence had been flagged by an angler who frequented the area. The meadow also supported some seaweeds. The site was close to a power station (Tuanku Jaafar Power Station or TJPS) and single point mooring (SPM) and jetty infrastructure commonly referred to as Shell jetty. (The refinery has now been taken over by a Chinese company, Heng Yuan). The habitat supports a small artisanal fishery (Kg. Gelam landing point) but discussions with a number of recreational fishers indicate that the recreational activity was dissuaded by shipping traffic in deference to sites further south of the PDD.

b. More relevant was the preponderance of boat-based fishing activity in the south of the Tanjung Tuan headland. While this could be accounted for partly by the lack of shipping activity in the area, the data we collected and have elaborated in the subsequent chapters also relate to a habitat related issue. Though there was data on coral reefs off the Tanjung Tuan headland, it did not explain the extent to which recreational fishers gravitated to the area and the kind of species they chose to target. Towards engendering a better understanding of this pattern, the presence and mapping of a coral reef, previously unrecorded, along Teluk Pelanduk, immediately south of the Tanjung Tuan headland was investigated. It is referred to as the Pelanduk Reef in this report.

The outcome of our surveys appears below. The surveys were undertaken were based on the methodologies described in Appendix 4. Anecdotal information from recreational fishers suggest there are other reefs that also co-exist in deeper waters which we were not in and I was not in a position to investigate.

a. Kg. Gelam Seagrass Meadow

The assessment of the meadow indicated a seagrass/coral reef/seaweed. The location of the study site and transect locations are provided in **Figure A9-1.**

Seagrasses

The survey recorded a total of three (3) species of seagrass, namely *Halodule pinifolia, Halophila ovalis* and *Enhalus acoroides* (**Figure A9-2**). The intertidal zone was mostly dominated by *Halodule pinifolia*, while *Halophila ovalis* was spotted at the edges of the seagrass boundary. Only small patches of *Enhalus acoroides* were observed (**Figure A9-2**).

Seaweeds

A total of 12 species of seaweeds recorded (**Figure A9-3**), that belonged to three (3) divisions. Chlorophyta represented by *Bryopsis* sp., *Caulerpa lentillifera, Caulerpa taxifolia, Caulerpa prolifera, Halimeda discoidea* and *Udotea petiolata*, while Phaeophyta consisted of *Padina gymnospora* and *Sargassum polycystum*. Rhodophyta comprised of *Acanthophora* sp., *Gracilaria changii, Gracilaria Salicornia* and *Spyridia filamentosa*. Based on visual observation, *Halimeda discoidea* was found to be the most abundant species at the study area. *Halimeda* is commonly found in many tropical reef regions and this species has been reported at water depths of up to 130 m (Hillis, 2001; Blair and Norris, 1988) and can tolerate temperatures above 30°C (Abel and Drew, 1985). This species is a biological indicator of reef health (Vroom *et. al*., 2003). According to Phang (2006), *Halimeda* is calcified algae that contribute towards reef building. However, increase in macroalgal cover (or increases of *Halimeda* population), possibly due to absence of herbivorous fishes or sea urchin and increase in nutrients, can lead to declining reef health (Vroom et al., 2003; Miller et al., 1999; Lapointe, 1997; Hughes et al., 1987; Hay et al., 1983).

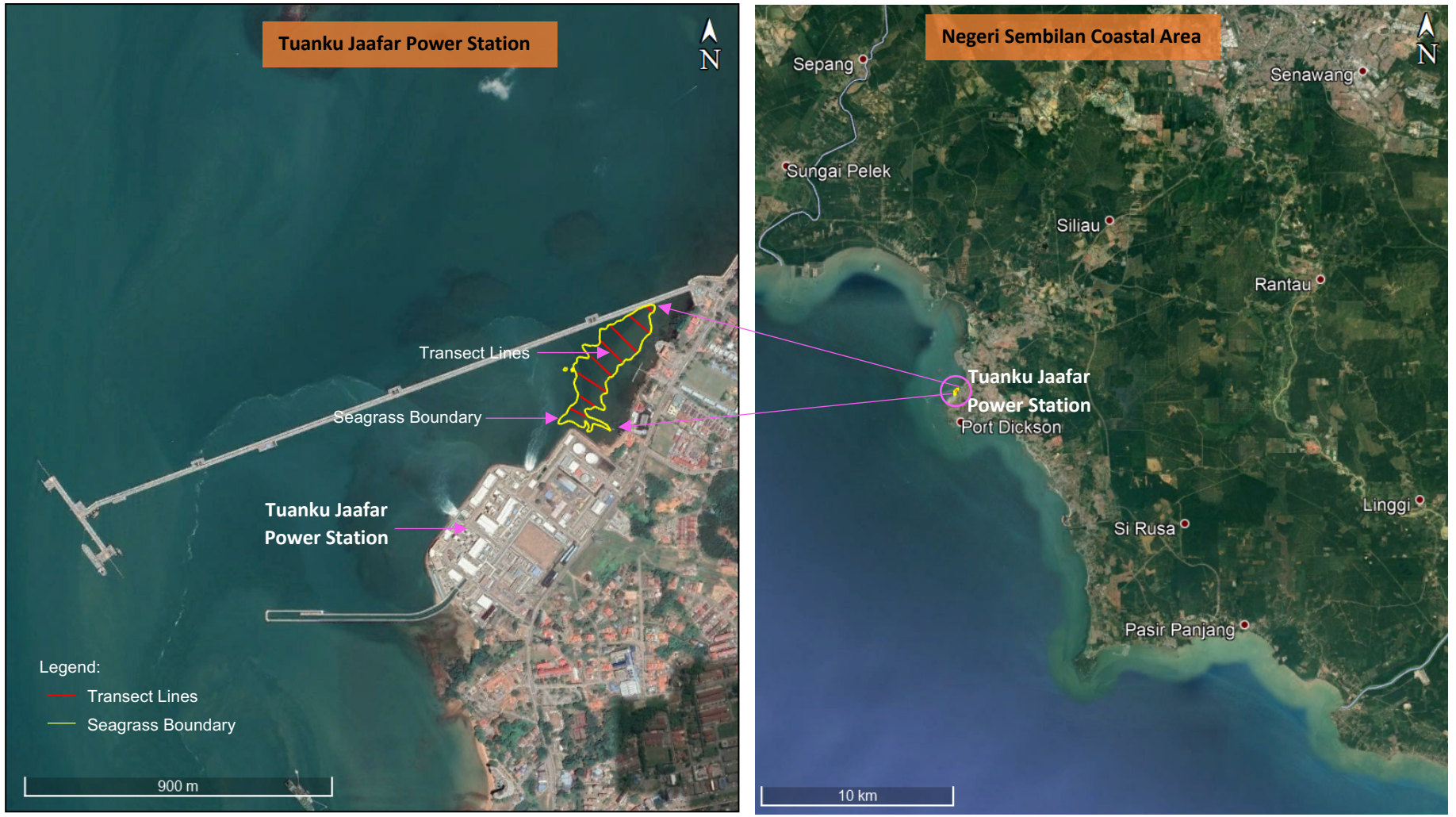

Figure A9-1: Map and Transect Locations of the Gelam Seagrass

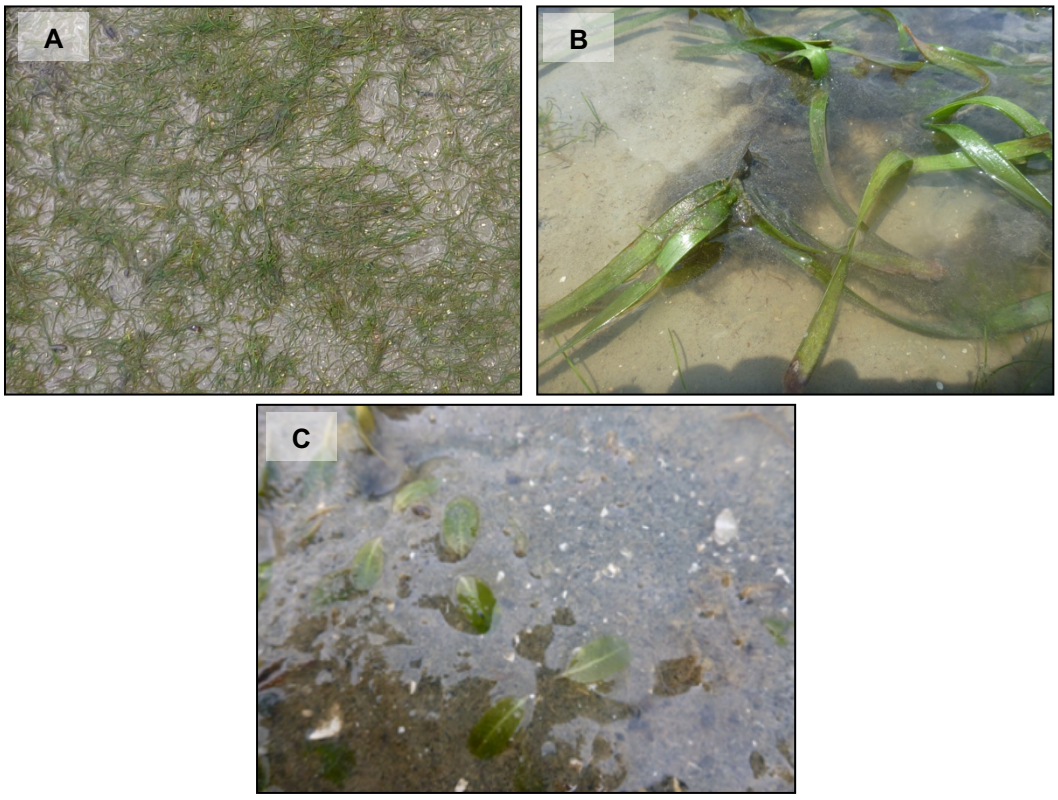

Figure A9-2: Seagrasses Found at Kg. Gelam Seagrass Meadow: A: *Halodule pinifolia*, B: *Enhalus acoroides,* C: *Halophila ovalis*

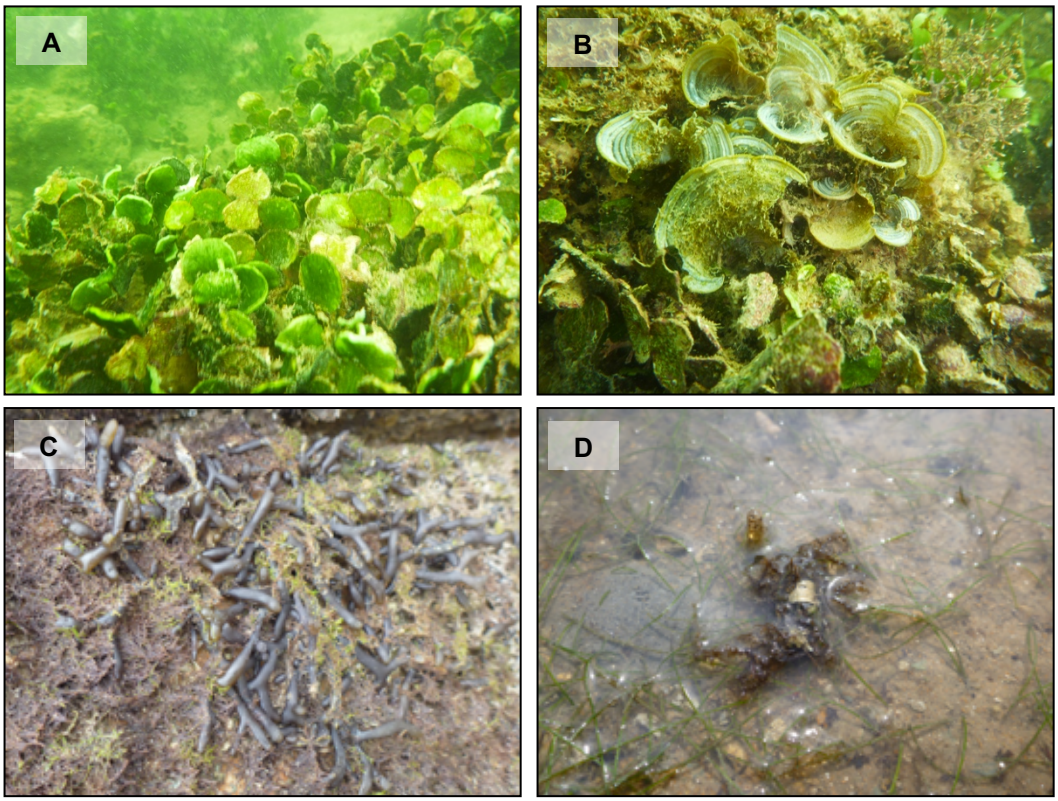

Figure A9-3: Seaweeds Species Found at the Study Area. A: *Halimeda discoidea,* B: *Padina* sp., C: *Gracilaria salicornia*, D*: Acanthophora* sp.

Invertebrates

In addition, a total of 31 invertebrate taxa were recorded, with 20 taxa belonging to Mollusca, nine (9) taxa were from Arthropoda (Crustacea), one taxa each were from Cnidaria and Annelida. Among the common invertebrate species found were *Clithon oualaniensis* and *Cerithium* spp. (**Table A9.1**). *Clithon oualaniensis* is found in brackish water on sandy shores covered by a thin film of mud, muddy substrates or on mangroves, seagrass, rocks, coral and shells in Thailand, Malaysia, Australia and Singapore (Tan and Clements, 2008; Sriaroon et al., 2005; Tan and Kastoro, 2004; Dye and Lasiak, 1987). They were found in large numbers with shell colours usually yellow, olive or greenish (Tan and Clements, 2008). This species have a wide range of patterns on their shell. The patterns can be in the form of triangles or tongues, axial (transverse), zigziag or spiral lines and patterns (Gruneberg, 1982). They mainly feed on detritus and algae (Takada, 2000; Leo and Peter, 1988).

The *Cerithium* species inhabit shallow intertidal waters particularly in clean coral or weedy sand, while some species live under rocks on a hard substrate covered by sand (Rattanarpa et al., 2006; Walter, 1972). This species, are also commonly found in intertidal and rocky shore area. They usually have thick shells and a thick operculum made of a horn-like material. This group of snails preys mainly on barnacles, oysters and other molluscs (Tan and Sigurdsson, 1990). From this result, the presence of invertebrate fauna at the study area indicated that the seagrass meadows provide a sufficient supply of detritus and grazing matter.

Table A9-1: List of Invertebrate Species Recorded

Phylum	Class	Family	Scientific Name
Mollusca	Gastropoda	Nassariidae	*Nassarius* spp.
	Gastropoda	Nassariidae	*Nassarius jacksonianus*
	Gastropoda	Nassariidae	*Nassarius pullus*
	Gastropoda	Nassariidae	*Nassarius livescens*
	Gastropoda	Neritidae	*Clithon oualaniensis*
	Gastropoda	Neritidae	*Nerita histrio*
	Gastropoda	Neritidae	*Nerita chameleon*
	Gastropoda	Naticidae	*Natica* spp.
	Gastropoda	Cerithiidae	*Cerithium* spp.
	Gastropoda	Potamididae	*Pirenella cingulate*
	Gastropoda	Conidae	*Conus* spp.
	Gastropoda	Melongenidae	*Volegalea cochlidium*
	Gastropoda	Muricidae	*Thais* spp.
	Gastropoda	Muricidae	*Indothais rufotincta*
	Gastropoda	Potamididae	*Telescopium* sp.
	Gastropoda	Haminoeidae	*Haminoea* spp.
	Gastropoda	Strombidae	*Laevistrombus turturella*
	Bivalvia	Placunidae	*Placuna* sp.
	Bivalvia	Veneridae	*Circe* spp.
	Bivalvia	Veneridae	*Gafrarium tumidum*
Arthropoda (Crustacea)	Malacostraca	Diogenidae	*Clibanarius* spp.
	Malacostraca	Portunidae	*Portunus pelagicus*
	Malacostraca	Portunidae	*Charybdis* sp.
	Malacostraca	Portunidae	*Thalamita* sp.
	Malacostraca	Portunidae	*Thalamita crenata*
	Malacostraca	Ocypodinae	*Ocypode* spp.
	Malacostraca	Ocypodidae	*Uca* (*Gelasimus*) spp.
	Malacostraca	Varunidae	*Varuna* sp.
	Malacostraca	Alpheidae	*Alpheus* sp.
Cnidaria	Anthozoa	Cerianthidae	*Cerianthus* sp.
Annelida	Polychaeta	-	Unidentified

Note: + : present, - : absent

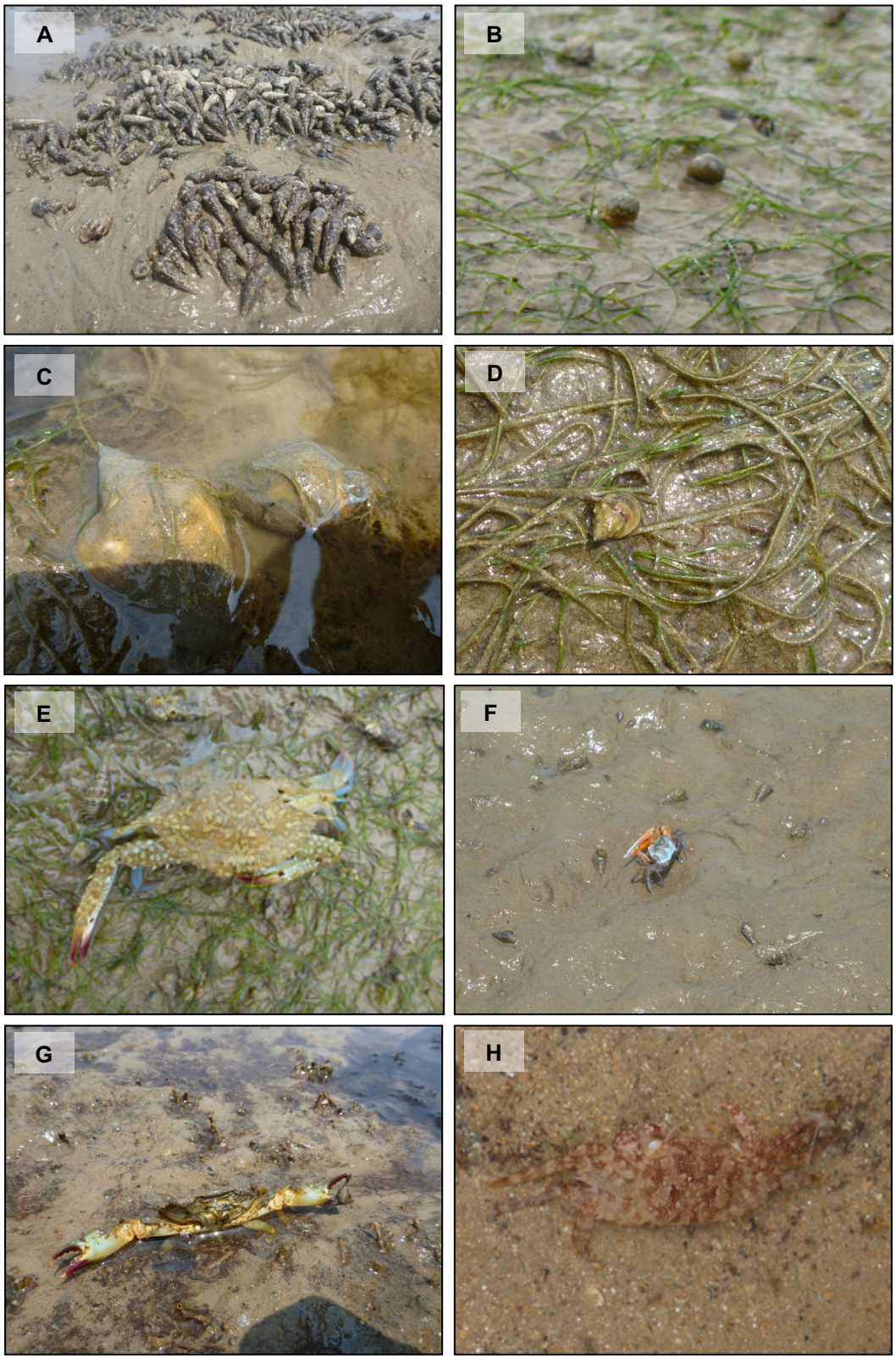

Figure A9-4: Invertebrates Found at the Study Area. A: *Pirenella cingulata*, B: *Clithon oualaniensis,* C: *Laevistrombus turturella,* D: *Nassarius jacksonianus,* E: *Portunus pelagicus,* F: *Uca* sp., G: *Thalamita crenata,* H: *Charybdis* sp.

b. Pelandok Reef

Corals have been found at off Tg. Tuan (Gopinath et al., 2000) but little else. In this study, we examined reports of corals off Teluk Pelanduk and Pulau Perjudi. There is no historical data on the reefs in these areas. The sampling I undertook was divided into three (3) areas i.e. Area 1 (Tanjung Tuan), Area 2 (Tg. Gemuk to Teluk Pelanduk) and Area 3 (Pulau Perjudi). Area 1 and 2 consisted of three (3) transects while Area 3 consisted of 2 transects.

The coral reefs in the area were found distributed within 3 major zones as indicated in **Figure A9-5.** The sampling stations in the study area were divided into three (3) areas i.e. Area 1 (Tanjung Tuan), Area 2 (Tg. Gemuk to Teluk Pelanduk) and Area 3 (Pulau Perjudi). Area 1 consisted of three (3) stations i.e. S1, S2 and S3, while Area 2 comprised of S4, S5 and S6 and the remaining (S7 and S8) were in Area 3.

Corals

A total of 20 species of hard coral, 11 species of gorgonians (sea whips and sea fan) and seven (7) species of soft coral were recorded in the study area. Most of the hard coral was found at Area 1. Gorgonians extensively inhabited the study area and were commonly found at all sampling stations with the highest number of Gorgonians species detected in Area 3. Soft corals were only found at Area 1.

Various studies have showed that, substantial coral reefs to be present particularly at areas around Tanjung Tuan (Area 1) and off Pulau Perjudi (Area 3), though the reefs are not as spectacular as those in the islands off the East Coast of Peninsular Malaysia (Gopinath et al., 2000), they still represent a very substantial resource (Liew and Hoare, 1979; Goh and Sasekumar, 1980; Gopinath et al., 2000; Hydec-Via Natura, 2004; Lee, 2005). In addition, there have been no studies has that been undertaken in the area between Tg. Gemuk to Teluk Pelanduk (Area 2).

The dive studies identified the coral species *in-situ*. These identifications are provided in **Table A9-2**, while their images appear in **Figure A9-6.** Where necessary, samples were brought to the surface for closer examination (**Figure A9-7** to **A9-8**). These were examined, photographed and returned with 5 minutes to their original locations. The removal an d examination of these samples was with the permission of the Port Dickson District Fisheries Head at that time, who pointed out that the regulation under the Fisheries Act, 1985 (Amended 1991) did not prohibit their removal for research purposes but only banned their harvesting for the marine aquarium trade.

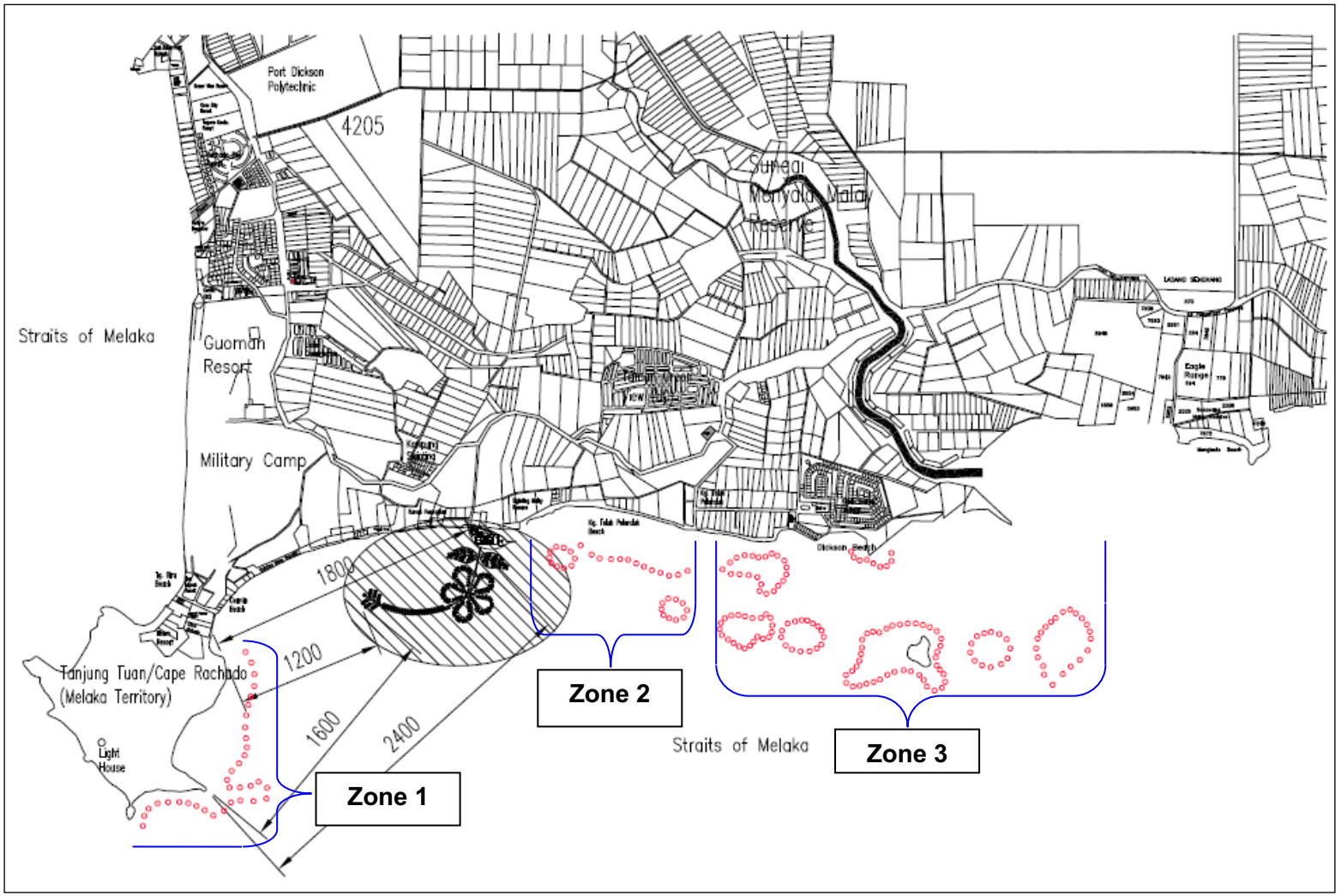

Figure A9-5: Survey Zones Within in Teluk Pelanduk Area

Table A9-2: List of Hard Corals, Gorgonian and Soft Coral Recorded in Teluk Pelanduk

Common Name	Family	Taxa	Dive Sites						
			Zone 1 (Tg. Tuan)	Zone 1 (Tg. Tuan)		Zone 2 (Tg. Gemok to T. Pelandok)		Zone 3 (P. Perjudi)	
			S1	S2	S3	S4	S5	S6	S7
Hard Coral									
Candy Cane Coral	Faviidae	*Caulastrea*	-	-	+	-	-	-	-
Brain Coral	Faviidae	*Favia*	-	+	+	+	+	-	-
Brain Coral	Faviidae	*Favites*	-	+	+	-	+	-	+
Brain Coral	Faviidae	*Goniastrea*	-	+	+	-	-	-	-
Brain Coral	Faviidae	*Platygyra*	-	+	+	-	-	-	-
Star Coral	Faviidae	*Montastrea*	-	+	-	-	+	-	-
Anemone Coral	Poritidae	*Goniopora*	-	+	+	+	+	+	+
Boulder Shape Coral	Poritidae	*Porites*	-	+	+	-	-	-	+
Leaf Coral	Agariciidae	*Pavona*	-	+	+	-	-	-	-
Elephant Skin Coral	Agariciidae	*Pachyseris*	-	+	-	-	-	-	-
Lettuce Coral	Agariciidae	*Leptoseris*	-	+	-	-	-	-	-
Brain Coral	Mussidae	*Symphyllia*	-	+	-	-	-	-	-
Brain Coral	Mussidae	*Lobophyllia*	-	+	-	-	-	-	-
Cup Coral	Dendrophylliidae	*Turbinaria*	-	+	+	+	+	+	+
Octopus Coral	Oculinidae	*Galaxea*	-	+	+	-	-	-	-
Lettuce Coral	Pectiniidae	*Pectinia*	-	+	-	-	-	-	-
Lettuce Coral	Pectiniidae	*Merulina*	-	+	-	-	-	-	-
Plate Coral	Pectiniidae	*Mycedium*	-	+	-	-	-	-	-
Moon Coral	Diploastreidae	*Diploastrea heliopora*	-	+	-	-	-	-	-
Frogspawn Coral	Euphyllidae	*Euphyllia*?	-	-	+	-	-	-	-
Gorgonian									
Sea Fan	Ellisellidae	*Ctenocella pectinate*	-	+	+	+	+	+	+
Sea Fan	Ellisellidae	*Dichotella gemmacea*	-	+	+	+	+	+	+
Sea Fan	Ellisellidae	*Verrucella* sp.	-	+	+	+	+	+	+
Sea Whip	Ellisellidae	*Junceella fragilis*	-	+	+	+	+	+	+

Common Name	Family	Taxa	Dive Sites						
			Zone 1 (Tg. Tuan)	Zone 1 (Tg. Tuan)		Zone 2 (Tg. Gemok to T. Pelandok)		Zone 3 (P. Perjudi)	
			S1	S2	S3	S4	S5	S6	S7
Sea Whip	Ellisellidae	*Junceella* sp.	-	+	+	+	+	+	+
Sea Fan	Plexauridae	*Echinogorgia* sp.	-	+	+	+	+	+	+
Sea Fan	Plexauridae	*Echinogorgia* sp1.	-	+	-	-	-	+	+
Sea Fan	Plexauridae	*Menella* sp.	-	+	-	-	+	+	+
Sea Fan	Melithaeidae	*Melithaea* sp.	-	+	+	+	+	+	+
Sea Fan	Melithaeidae	*Acabaria* sp.	+	-	-	-	-	-	-
Sea Fan	Subergorgiidae	*Subergorgia suberosa*	-	+	+	+	+	+	+
Soft Coral									
White Cauliflower Coral	Nephtheidae	*Dendronephthya* sp.	+	+	-	-	-	-	+
Orange Cauliflower Coral	Nephtheidae	*Dendronephthya* sp1.	+	+	-	-	-	-	-
Red Cauliflower Coral	Nephtheidae	*Dendronephthya* sp2.	-	+	-	-	-	-	-
Finger Leather Coral	Alyconiidae	*Sinularia* sp.	-	+	-	-	-	-	-
Soft Coral	Alyconiidae	*Lobophytum compactum*	-	-	+	-	-	-	-
Tube Anemone	Cerianthidae	*Pachycerianthus*	-	+	+	-	-	-	-
Mushroom Anemone	Discosomatidae	*Discosoma*	-	+	+	-	-	-	-

Note: '+' = present, '-' = absent

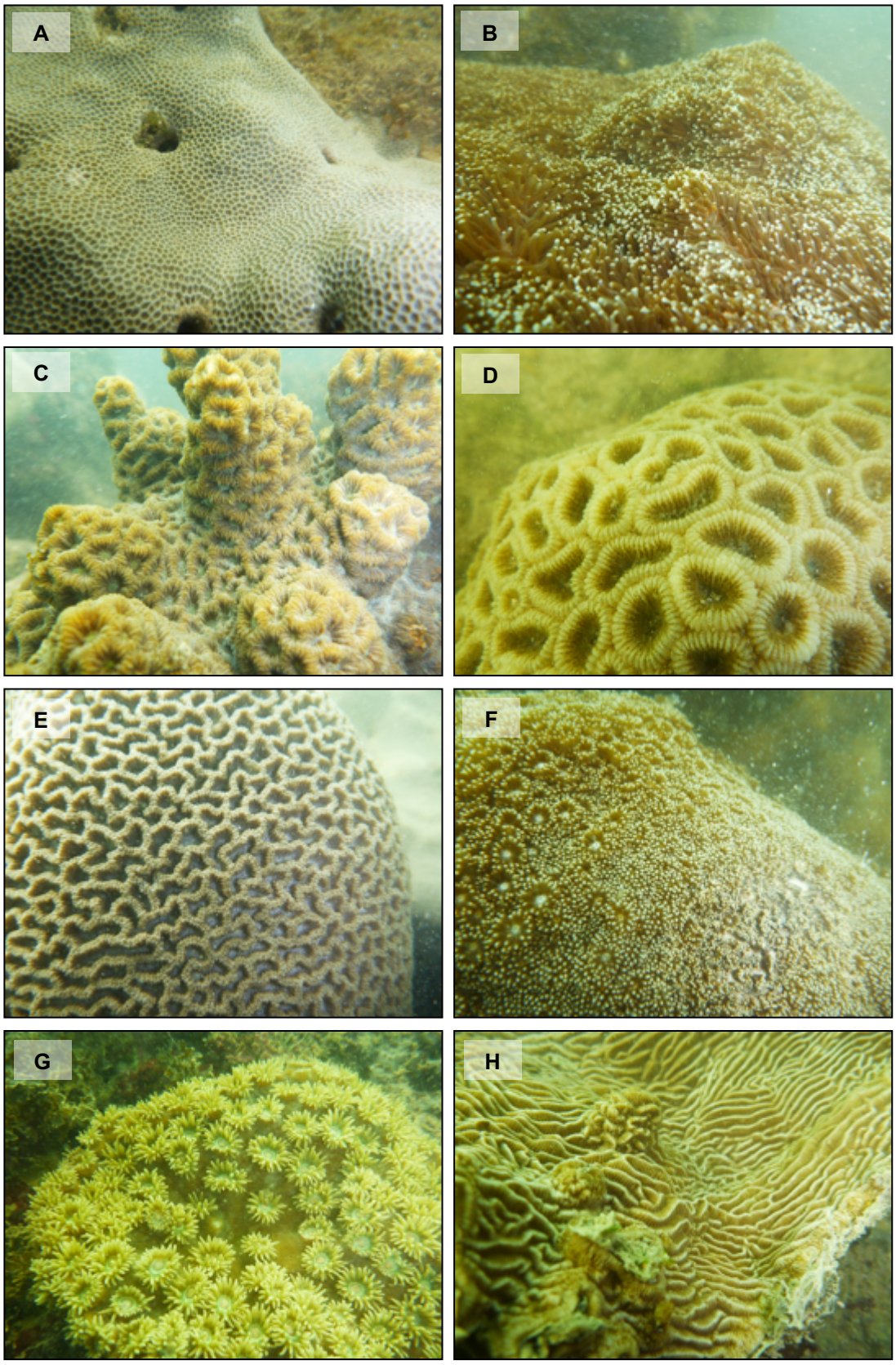

Figure A9-6: Some Corals Found at Study Site. A: *Porites* sp., B: *Galaxea* sp., C: *Favites* sp., D: *Favia* sp., E: *Platygyra* sp., F: *Goniopora* sp., *G. Turbinaria* sp., *H: Pachyseris* sp.

Figure A9-7: Hard Coral (*Porites* sp.) Regeneration, Perjudi Reefs

Figure A9-8: Regenerating Hard Coral and Sponge

Associated Marine Fauna

Coral reefs support a diverse range of fauna, both vertebrate as well as invertebrate. This is because apart from playing a major role in protecting shorelines from storms and waves, they also act as refuges, feeding and nursery grounds for the fish fauna. The diversity of marine life is directly proportional to the complexity of the coral ecosystem i.e. the more complex and diverse the reefs, the more species the ecosystem supports (Luckhurst and Luckhurst, 1978). In addition, Bell et al. (1985) reported a positive correlation between coral cover and coral fish diversity in some fish communities.

Reef Fish

A total of 15 fish species belonging to nine (9) families and were recorded during the survey, of which the wrasses, the rabbitfish and sweetlips were sought after by recreational fishers. The highest species diversity recorded at Area 1 (Tanjung Tuan), followed by Area 3 (Pulau Perjudi) and Area 2 (Tg. Gemuk to Teluk Pelanduk). No previous reef fish studies have undertaken in the study area to enable comparisons to be carried out. However, all of the species recorded are commonly found inhabit in coral reefs throughout the country. A detailed listing of fish species recorded at the study area is provided in **Table A9-3,** while images of some of the species observed appear in **Figure A9-9.**

Table A9-3: List of Fish Recorded in the Study Area

Common Name	Family	Species	Dive Sites						
			Area 1 (Tg. Tuan)			Area 2 (Tg. Gemok to T. pelandok)		Area 3 (Pulau Perjudi)	
			S1	S2	S3	S4	S5	S6	S7
Yellowtail Demoiselle	Pomacentridae	*Neopomacentrus azysron*	-	+	+	+	-	-	-
Damselfish	Pomacentridae	*Neopomacentrus* sp.	-	-	-	+	-	+	+
Chromis	Pomacentridae	*Chromis* sp.	-	+	+	+	-	+	+
Emperor Angelfish	Pomacanthidae	*Pomacanthus imperator*	-	+	-	-	-	-	-
Six-Banded Angelfish	Pomacanthidae	*Pomacanthus sextriatus*	-	-	+	-	-	-	-
Beaked Coralfish	Chaetodontidae	*Chelmon rostratus*	-	-	+	-	-	-	-
Butterflyfish	Chaetodontidae	*Chaetodon* sp.	-	+	-	-	-	-	-
Longfin Bannerfish	Chaetodontidae	*Heniochus acuminatus*	-	+	+	-	-	-	-
Wrasse	Labridae	*Halichoeres* sp.	-	+	-	-	-	-	-
Sunset wrasse	Labridae	*Thalassoma* sp.	-	+	-	-	-	-	-
Parrotfish	Scaridae	*Scarus* sp.	-	+	-	-	-	-	-
Decorated goby	Gobiidae	*Istigobius decoratus*	-	-	-	-	-	-	+
White Spotted Rabbitfish	Siganidae	*Siganus canaliculatus*	-	+	-	-	-	-	-
Sweetlips	Haemulidae	*Plectorhinchus* sp.	-	+	-	-	-	-	-
Monocle Bream	Nemipteridae	*Scolopsis vosmeri*	-	+	-	-	-	-	-

Note: '+' = present, '-' = absent

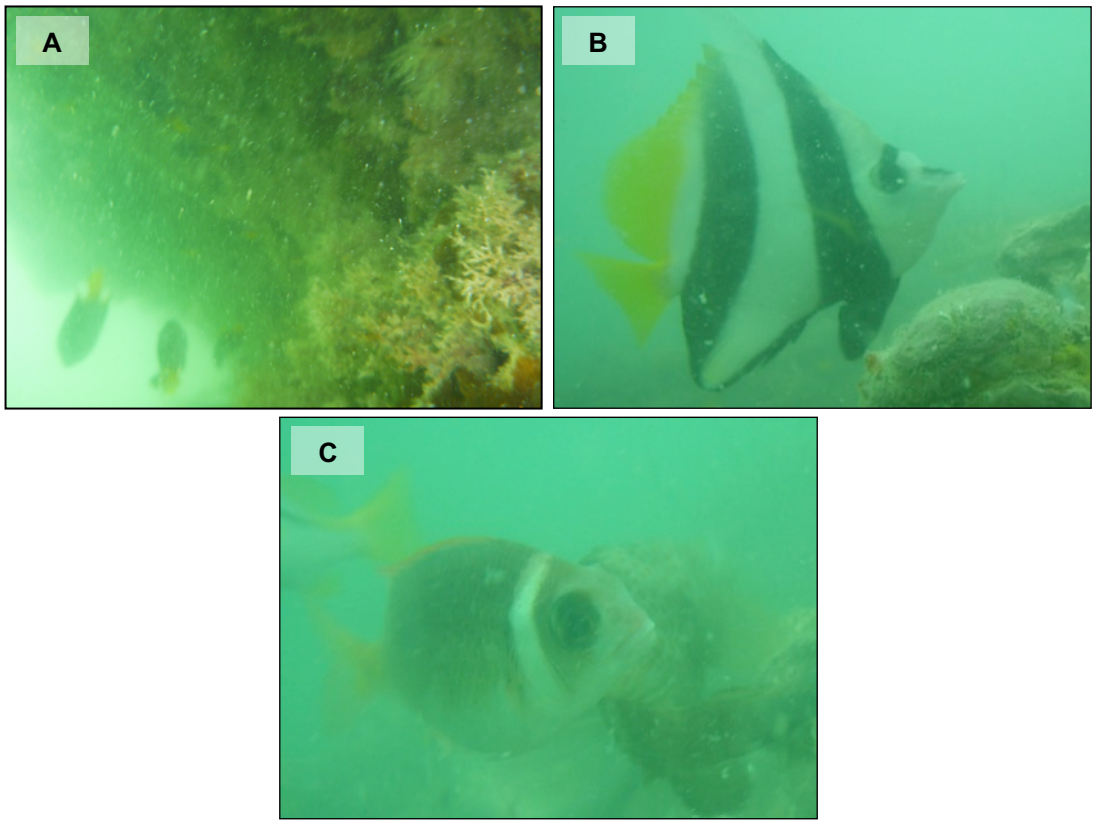

Figure A9-8: Fish Spotted in the Study Area: A Yellowtail Demoiselle (*Neopomacentrus azysron*), B: Longfin Bannerfish (*Heniochus acuminatus*), C: Monocle Bream (*Scolopsis vosmeri*)

Invertebrates

In our survey, nine (9) groups of invertebrates were recorded and represented by more than 31 taxa (**Table A9-4**). Most of the taxa recorded in the study area were found in Zone 1, followed by Zone 3 and Zone 2. At Zone 1 (Tanjung Tuan), there were more than 28 taxa from seven (7) groups were recorded. This zone were mostly dominated by sponges such as Barrel Sponge (*Xestospongia testudinaria),* Thorny Stem Sponge (*Gelliodes fibulata),* Green Rope Sponge (*Haliclona cymaeformis*), Lumpy Pink Sponge (*Haliclona cf. baeri*), Vase Sponge (*Callyspongia*), Straw Sponge (*Leucosolenia*), Spiky Sponge (*Dysidea*), Volcano Sponge (*Spheciospongia*) and several unidentified sponges with various colours. Sample images are in **Figure A9-9.**

Table A9-3: List of Invertebrates Recorded in the Study Area

Common Name	Family	Taxa	Zone 1 (Tg. Tuan)			Zone 2 (Tg. Gemuk to T. Pelanduk)		Zone 3 (P. Perjudi)	
			S1	S2	S3	S4	S5	S6	S7
Sponge									
Barrel Sponge	Petrosiidae	*Xestospongia testudinaria*	-	+	+	-	-	-	-
Blue Jorunna Sponge	Petrosiidae	*Neopetrosia* sp.	-	+	-	-	-	+	-
Brown Sponge	Petrosiidae	*Neopetrosia exigua*	-	+	-	-	-	-	-
Orange Spiky Sponge	Darwinellidae	*Dendrilla* sp.	-	+	+	-	-	-	-
Thorny Stem Sponge	Niphatidae	*Gelliodes fibulata*	-	+	-	-	-	-	+
Green Rope Sponge	Chalinidae	*Haliclona cymaeformis*	-	+	+	-	-	-	-
Lumpy Pink Sponges	Chalinidae	*Haliclona cf. baeri*	-	+	-	-	-	-	-
Vase Sponge	Callyspongiidae	*Callyspongia* sp.	-	+	+	+	-	+	+
Straw Sponge	Leucosoleniidae	*Leucosolenia* sp.	-	+	-	-	-	-	+
Spiky Sponge	Dysideidae	*Dysidea* sp.	-	+	-	-	-	-	-
Volcano Sponge	Clionaidae	*Spheciospongia* sp.	-	+	-	-	-	-	-
Sponge	-	Unidentified Sponge	-	+	+	-	-	+	+
Crinoid									
Feather Star	Colobometridae	*Cenometra* sp.	-	+	+	+	+	+	+
Feather Star	Colobometridae	*Oligometra* sp.	-	+	+	+	+	+	+
Feather Star	Himerometridae	*Himerometra* sp.	-	+	+	-	-	+	+
Feather Star	Mariametridae	*Lamprometra* sp.	-	+	-	-	+	+	+
Bryozoan									
Lace Coral	Phidoloporidae	*Triphyllozoon inornatum*	-	+	-	-	-	+	+
Lace Coral	Phidoloporidae	*Triphyllozoon* sp.	-	+	+	+	+	+	+
Fan Bryozoan	Phidoloporidae	*Reteporellina* sp.	-	+	+	-	-	+	+
Rag Sponge	Phidoloporidae	*Sertella* sp.	-	-	-	-	-	+	+
Hydroid									

Common Name	Family	Taxa	Zone 1 (Tg. Tuan)			Zone 2 (Tg. Gemuk to T. Pelanduk)		Zone 3 (P. Perjudi)	
			S1	S2	S3	S4	S5	S6	S7
Stinging Hydroid	Plumulariidae	*Macrorhynchia philippina*	-	+	-	-	-	-	-
Mollusca									
Zig Zag Oyster	Ostreidae	*Lopha* sp.	-	+	+	-	-	-	-
Oyster	Ostreidae	*Crassostrea* sp.	-	+	+	-	-	+	+
Allied Cowrie	Ovulidae	*Hiatavolva* sp.	-	+	-	-	-	+	+
Green Mussel	Mytilidae	*Perna viridis*	-	+	+	-	-	-	-
Wing Oyster	Pteridae	*Pteria* sp.	-	+	-	+	+	+	+
Pen Shell	Pinnidae	*Pinna* sp.	-	+	+	-	-	-	+
Echinodermata									
Thorny Sea Cucumber	Cucumariidae	*Colochirus quadrangularis*	-	-	-	-	-	+	+
Arthropoda									
Barnacle	Balanidae	*Balanus* sp.	-	+	+	-	-	-	-
Sea Pen									
Sea pen	Pennatulidae	*Pteroeides* sp.	-	+	+	+	-	+	+
Cnidaria									
Sea Anemone	Cerianthidae	*Cerianthus* sp.	-	-	-	-	-	+	-

Note: '+' = present, '-' = absent

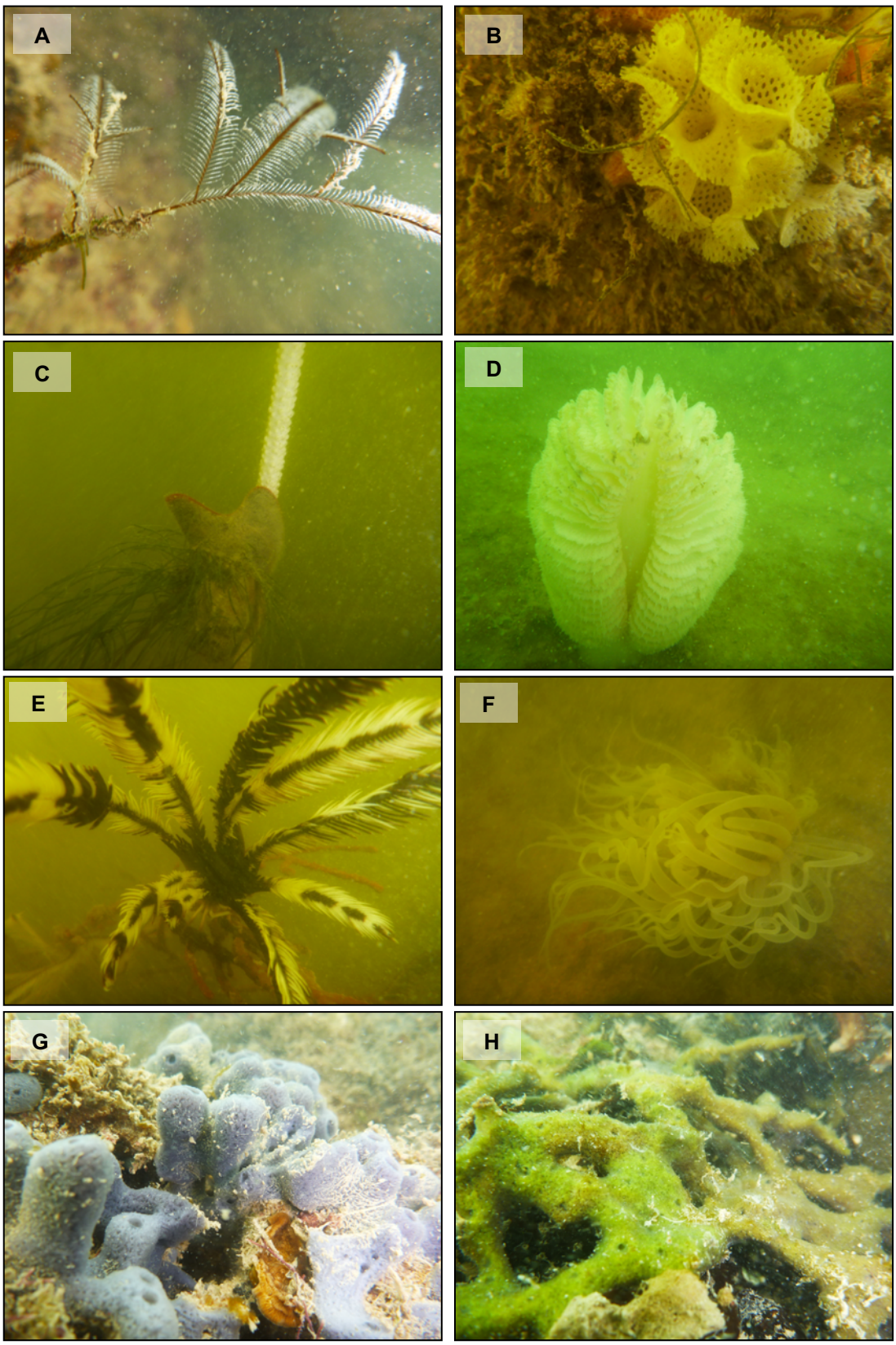

Figure A9-9: Invertebrates Found at the Study Area. A: *Macrorhynchia philippina*, B: *Triphyllozoon* sp., C: *Pinna* sp., D: *Pteroeides* sp., E: *Cenometra* sp., F: *Cerianthus* sp, G: *Neopetrosia* sp., H: *Haliclona cymaeformis*

Figure A9-10: Invertebrates Found at the Study Area (*Euryale* sp.)

Figure A9-11: Invertebrates Found at the Study Area (*Goniodiscaster scaber*)

Seagrass

In respect to the study area, two (2) species of seagrass were observed in patches at Teluk Pelanduk and Pantai Dickson. These were the Tropical eelgrass (*Enhalus acoroides*) and Dugong grass (*Thalassia hemprichii*) (**Figure A9-12**). The seagrasses were clearly associated with the presence of coral reefs. Several past studies also have been reported other species of seagrass found at these areas (Japar, 1994; Japar et al., 1995; Phang, 2000; Japar et al., 2001) (**Table A9-6**).

Table A9-6: Distribution of Seagrass Beds at Pantai Dickson (Teluk Pelanduk)

ubstrate Type	Species	References			
		Japar, 1994	Japar et al., 1995	Phang, 2000	Japar et al., 2001
Sand, coral rubble	*Enhalus acoroides*	-	-	-	+
	Halodule uninervis	-	-	+	-
Compact sand, sandy rocky	*Halodule pinifolia*	-	+	-	+
	Thalassia sp.	+	-	-	-

Note: '+' = present, '-' = absent

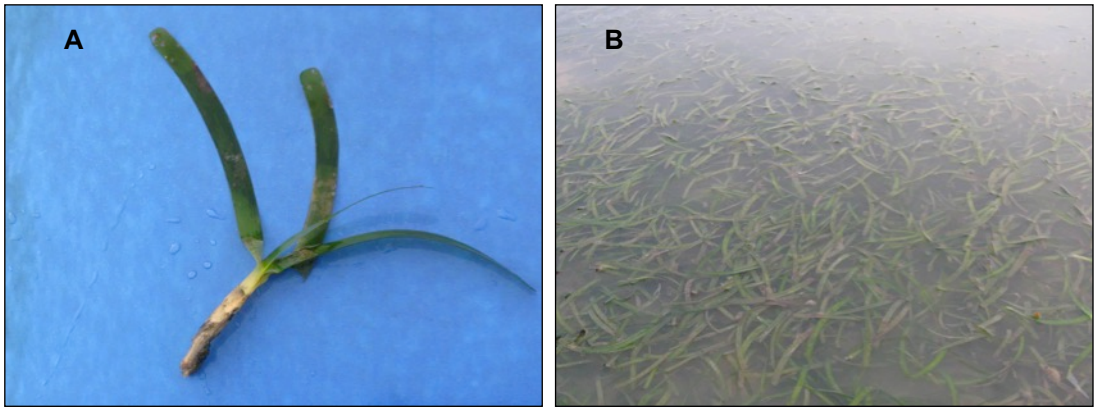

Figure A9-12: Dugong Grass (*Thalassia hemprichii*) found at Pantai Dickson in Front of Pulau Perjudi

Seaweeds

The seaweed assessment indicated the presence of of a total of 19 species of seaweed to be present in study area (**Table A9-7; Figure A9-13**). There were seven (7) species from Division Rhodophyta and Chlorophyta and five (5) species from Phaeophyta (Plates A11-10 - 12). The highest number of species was recorded at Pantai Dickson with 14 species compared to ten (10) species and six (6) species at Tg. Tuan and Teluk Pelanduk respectively. The major species found were *Padina australis* and *Sargassum* sp.

Mijan Uddin et al. (2007) reported that 26 species of seaweeds found from Tg. Tuan to Pulau Babi (Pulau Impian). From their study, the most common genera found were *Sargassum, Padina, Caulerpa* and *Glacilaria*. Other studies (Japar et al., 2001) undertaken at Pantai Dickson reported the presence of 11 species of seaweed. The most common genera found were *Caulerpa*. The list of species found from both studies is presented in Table A11-6.

According to Chapman (1968) and Smith and Smith (2001), the distribution and composition of seaweeds change with time and place due to the several factors such as light, temperature, nutrients as well as grazing by molluscs. In addition, severe impacts through human activities can also cause changes to their distribution. Infrastructural development at the adjacent areas such as road construction, building hotels and rest houses can contribute to the declining habitat condition for the seaweeds in Port Dickson (Mijan Uddin et al., 2007).

In addition, Diez et al. (2003) reported that the sedimentation could also affect the composition and abundance of seaweeds. Phang (1995) found that an increase in Total Suspended Solids (TSS) from construction activities resulted in decreased biomass production at a coral reef flat. Though it appeared to recover after the end of construction, but, species such as *Avrainvillea*, which was probably more sensitive to sediment loads, did not re-establish.

Table A9-7: List of Seaweed Species Found at the Study Area

Division	Species	Location		
		Tg. Tuan	T. Pelanduk	P. Dickson
Chlorophyta	*Avrainvillea* sp.	-	-	+
	Valonia utricularis	-	-	+
	Enteromorpha sp.	+	-	-
	Bryopsis sp.	+	-	-
	Caulerpa taxifolia	+	-	-
	Caulerpa sp.	+	+	-
	Cladophoropsis membranaceae	+	-	+
Rhodophyta	*Gracilaria Salicornia*	-	-	+
	Gracilaria changii	-	-	+
	Gracilaria sp. 1	-	+	+
	Acanthophora specifera	+	-	+
	Amphiroa sp. 1	-	+	+
	Amphiroa sp. 2	-	+	+
	Laurencia cartilaginea	-	-	+
Phaeophyta	*Padina australis*	+	+	+
	Padina minor	-	-	+
	Dictyota dichotoma	+	-	-
	Dictyota sp.	+	-	-
	Sargassum sp.	+	+	+

Note: '+' = present, '-' = absent

Figure A9-13: Seaweeds Species Found at Study Area. A: *Avrainvillea* sp., B: *Valonia utricularis*, C: *Enteromorpha* sp., D; *Bryopsis* sp., E: *Enteromorpha* sp., F: *Caulerpa taxifolia*

References

1. Abel, K. M., and Drew, E. A. (1985). Response of *Halimeda* metabolism to various environmental parameters. *Proceedings of 5th International Coral Reef Symposium, 5,* 21 – 26.
2. Bell, J. D., Harmelin-Vivien, M. L. R., and Gazlin, R. (1985). Large-scale spatial variation in abundance of butterflyfish (Chaetodontidae) on Polynesian Reef. *Proceeding of the 5th International Coral Reef Congress, Tahiti, 5,* 421 - 426.
3. Blair, S. M., and Norris, J. N. (1988). The deep-water species of *Halimeda* Lamouroux (Halimedaceae, Chlorophyta) from San Salvador Island, Bahamas: Species composition, distribution and depth records. *Coral Reefs, 6,* 227 - 236.
4. Chapman, V. J. (1968). *The Algae.* New York, Macmillan & Company Limited.
5. Diez, I., Santolaria, A., and Gorostiaga, J. M. (2003). The relationship of environmental factors to the structure and distribution of subtidal seaweed vegetation of the Western Basque Coast. *Estuarine, Coastal and Shelf Science, 56,* 1041 - 1054.
6. Dye, A. H., and Lasiak, T. A. (1987). Assimilation efficiencies of fiddler crabs and deposit feeding gastropods from tropical mangrove sediments. *Comparative Biochemical Physiology, 87,* 341- 344.
7. Goh A. H., and Sasekumar, A. (1980). The community structure of the fringing coral reef, Cape Rechado. *Malayan Nature Journal, 34,* 25-37p.
8. Gopinath, N., Yusoff, F. M., and Shariff, M. (2000). Status of the Marine Environment off Port Dickson, Negeri Sembilan, Malaysia. In: Shariff, M., Yusoff, F. M., Gopinath, N., Ibrahim, H. M., and Nik Mustapha, R. A. (eds.). *Towards Sustainable Management of the Straits of Malacca* (pp. 45-59). Malacca Straits Research and Development Centre (MASDEC), Faculty of Science and Environmental Study, Universiti Putra Malaysia.
9. Gruneberg, H. (1982). Pseudo-polymorphism in *Clithon oualaniensis*. *Proceeding of the Royal Society of London, Series B, Biological Sciences, 216* (1203), 147 - 157.
10. Hay, M. E., Colburn, T., and Downing, D. (1983). Spatial and Temporal patterns in herbivory on a Caribbean fringing reef: The effects on plant distribution. *Ecologia (Berlin), 58,* 299 - 308.
11. Hillis, L. W. (2001). The calcareous reef alga *Halimeda* (Chlorophyta, Bryopsidales): A cretaceous genus that diversified in the cenozoic. *Palaeogeography, Palaeoclimatology and Palaeoecology, 166,* 89 - 100.
12. Hughes, T. P., Reed, D. C., and Boyle, M. J. (1987). Herbivory on coral reefs: community structure following mass mortalities of sea urchins. *Experimental Marine Biology and Ecology, 113,* 39 - 59.

13. Hydec Engineering and via Natura (M). (2004). Detailed Environmental Impact Assessment Study of the Proposed Islands Reclamation at Palm Springs Resort Port Dickson, Negeri Sembilan.
14. Japar Sidik, B. (1994). Status of seagrass resources in Malaysia. In: Wilkinson, C.R., Sudara, S. and Chou, L. M. (eds.). *Proceeding of the ASEAN-Australia Symposium on Living Coastal Resources. Vol. 1. Status Reviews* (pp. 283 – 289). Chulalongkorn University, 16 – 20 May 1994, Bangkok, Thailand.
15. Japar Sidik, B., Aziz, A. and Law, A. T. (1995). Inventory for seagrass beds in Malaysia, In: Japar Sidik, B. (ed.) *UNEP: EAS-35: Malaysia Inventory of Watersheds, Coastal Wetlands, Seagrasses and Coral Reefs* (pp. 48-79). Department of Environment, Ministry of Science, Technology and Environment, Kuala Lumpur, Malaysia.
16. Japar Sidik, B., Mutaharah, Z., Kanamoto, Z. and Mohd. Pauzi, A. (2001). Seagrass communities of the Straits of Malacca*. In:* Japar Sidik, B., Aziz, A. Tan, S. G., Daud, S. K., Jambari, H. A., and Sugiyama, S. (eds.). *Aquatic Resources and Environmental Studies of the Straits of Malacca: Current Research and Reviews* (pp. 81-98). Malacca Straits Research and Development Centre (MASDEC). University Putra Serdang, Malaysia.
17. Lapointe, B. E. (1997). Nutrient thresholds for bottom-up control of macroalgal blooms on coral reefs in Jamaica and southeast Florida. *Limnology and Oceanography, 42* (5-4), 119-131. https://doi.org/10.4319/lo.1997.42.5_part_2.1119
18. Lee, Y. L. (2005). *Ecology of scleractinian corals in the waters of Port Dickson and their tolerance to sedimentation*. Master of Science Thesis. Universiti Putra Malaysia, Serdang, Malaysia. 153p.
19. Leo, W. H. T., and Peter, K. L. P. (1988). *A Guide to the Seashore Life*. Singapore Science Centre. 160p.
20. Liew, H. C., and Hoare, H. (1979). The effects of sediment accumulation and water turbidity upon the distribution of scleractinian corals at Cape Rachado, Malacca Straits. In: *Proceeding of the International Conference on Trends in Applied Biology in South East Asia* (pp. 759-799). University Sains Malaysia, Penang, Malaysia.
21. Luckhurst, B. E., and Luckhurst, K. (1978). Analysis of the influence of substrate variables on coral reef fish communities. *Marine Biology, 49*, 317 - 323.
22. Mijan Uddin, S. M, Ahmad, I., and Asmida, I. (2007). Species composition of seaweeds in Port Dickson, Peninsular Malaysia. *Journal of Malaysian Applied Biology*, *36*(2), 69 - 73.

23. Miller, M. W., Hay, M. E., Miller, S. L., Malone, D., Sotka, E. E., and Szmant, A. M. (1999). Effects of nutrients versus herbivores on reef algae: a new method for manipulating nutrients on coral reefs. *Limnology and Oceanography, 44*, 1847 - 1861.
24. Morales-Nin, B. F. Cardona, M. Maynou and A. Maria-Grau (2015) How relevant are recreational fisheries? Motivation and activity of resident and tourist anglers in Majorca.
Fisheries Research; Volume 164, April 2015, Pages 45-49
25. Phang, S. M. (1995). Distribution and abundance of marine algae on the coral reef flats at Cape Rechado, Port Dickson, Peninsular Malaysia. *Malaysian Journal of Science, 16A,* 23-32.
26. Phang, S. M. (2000). *Seagrasses of Malaysia*. Universiti Malaya, Botanical Monographs No. 2. Institute of Biological Sciences, Universiti Malaya, Kuala Lumpur.
27. Phang, S. M. (2006). Seaweed resources in Malaysia: current status and future prospects. *Aquatic Ecosystem Health and Management, 9*(2), 185 - 202.
28. Rattanarpa, K., Limsuwan, C., and Chuchird, N. (2006). Study on larva development of the creeper snail, *Cerithium* sp. Bruguiere. *Fisheries Research Bulletin, 29*, 1-5.
29. Smith, R. L., and Smith, T. M. (2001). *Ecology and Field Biology*. United States, Benjamin Cummings.
30. Sriaroon, P., Lohachit, C., and Harada, M. (2005). Brackish-water molluscs of Surat Thani Province, Southern Thailand. *Southeast Asian Journal of Tropical Medicine and Public Health, 36*(4), 180 - 188.
31. Takada, Y. (2000). *Activity patterns of Clithon oualaniensis (Mollusca: Gastropoda) on intertidal seagrass beds in Hong Kong*. Hong Kong University Press. 225p.
32. Tan, K. S., and Sigurdsson, J. B. (1990). A new species of *Thais* (Gastropoda: Muricidae) from Singapore and Peninsular Malaysia. *Raffles Bulletin of Zoology, 38*(2), 205 – 211.
33. Tan, K. S., and Kastoro, W. W. (2004). A small collection of gastropods and bivalves from the Anambas and Natuna Islands, South China Sea. *The Raffles Bulletin of Zoology, 11* (Supplement), 47 - 54.
34. Tan, S. K., and Clements, R. (2008). Taxonomy and distribution of Neritidae (Mollusca: Gastropoda) in Singapore. *Zoological Studies, 47*(4), 481 - 494.
35. Vroom, P. S., Smith, C. M., Coyer, J. A., Walters, L. J., Hunter, C. L., Beach, K. S., and Smith, J. E. (2003). Field biology of *Halimeda tuna* (Bryopsidales, Chlorophyta) across a depth gradient: comparative growth, survivorship, recruitment, and reproduction. *Hydrobiologia, 501*, 149 - 166.

36. Walter, O. C. (1972). *Marine Shells of the Pacific*. Volume 2. Pacific Publications, Sydney, 411p.

Appendix 10: Boat Based Recreational Fishing Information in Port Dickson

Table A.10-2: Sampling Data (Fishing Effort by Weekday Type – Pengkalan Kempas)

Day Type	No. of days sampled	No. of days in the sampling year			No. of boats hired	No. of angler involved	Fishing Effort (person-days)
		Sept 2016 – Dec 2016	Jan 2017 – Aug 2017	Total			
WD/R	24	57	171	228	59	104	156
WE/R	18	18	59	77	108	206	309
WD/SH	5	27	18	45	24	46	69
WE/SH	6	14	13	27	38	85	127.5
WD/PH	4	3	6	9	23	63	94.5
WE/PH	2	3	6	9	7	12	18
Total	**59**	**122**	**273**	**395**	**259**	**516**	**774**

Notes:

Day Type

- WD/R Weekday Regular
- WE/R Weekend Regular (not including public holidays)
- WD/SH Weekday School Holiday
- WE/SH Weekend School Holiday
- WD/PH Weekday Public Holiday (inclusive weekend spillovers)

Fishing Effort

- CPUE basis 0.5 day: 12 hours or less
- Fishing Effort 1 person day = 1 person/8 hours

Table A10-3: Sampling Data: Socio-Economics – Pengkalan Kempas

Day Type	Ethnic Distribution			Main Age Cohort	Rental Value	Catch Volume (kg/boat)	Catch value (RM)
	Malay	Chinese	Iban				
WD/R	98	0	6	35-50	84	23.5	50
WE/R	198	8	0	35-50	84	25.5	50
WD/SH	46	0	0	35-50	84	9.5	50
WE/SH	81	4	0	35-50	84	10.0	50
WD/PH	58	5	0	35-50	84	9.0	50
WE/PH	12	0	0	35-50	84	3.0	50
Total	**493**	**17**	**6**	**-**	-	**80.5**	**RM4,025**

Note:

Average rental cost standardised atRM84/boat/day
Average fuel cost RM20 - RM40 per boat. Standardised at RM30

Table A.10-4: Estimated Annualised Fishing Effort and Landings – Pengkalan Kempas

Day Type	No. of boat hired	No. of angler involved	Fishing Effort (persons-days)	Rental Value (RM)	Other Expenses (RM)			Catch volume (kg/boat)	Catch value (RM)	Catch Volume per Unit Effort (kg/person-day)	Catch Value Per Unit Effort (RM/person-day)
					Fuel	Bait	Transport				
WD/R	561	988	1482.0	19,152.00	6,840.00	7,980.00	10,830.00	91	4,540.68	0.06	1.22
WE/R	462	881	1321.8	6,468.00	2,310.00	2,695.00	5,817.78	18	909.03	0.01	0.16
WD/SH	216	414	621.0	3,780.00	1,350.00	1,575.00	3,690.00	18	890.63	0.03	0.57
WE/SH	171	383	573.8	2,268.00	810.00	945.00	2,700.00	7	355.26	0.01	0.16
WD/PH	52	142	212.6	756.00	270.00	315.00	652.50	4	176.09	0.02	0.32
WE/PH	32	54	81.0	756.00	270.00	315.00	450.00	4	192.86	0.05	1.02
Total	**1493**	**2861**	**4292.2**	**33180.00**	**11,850.00**	**13,825.00**	**24,140.28**	**141**	**7,064.54**	**0.18**	**3.45**

Note:
Average rental cost standardised atRM84/boat/day
Average fuel cost RM20 - RM40 per boat. Standardised at RM30

Day Type

- WD/R Weekday Regular
- WE/R Weekend Regular (not including public holidays)
- WD/SH Weekday School Holiday
- WE/SH Weekend School Holiday
- WD/PH Weekday Public Holiday (inclusive weekend spillovers)

Table A.10-5: Sampling Data: Fishing Effort by Weekday Type – Tanjung Agas

Day Type	No. of days sampled	No. of days in the sampling year			No. of boats hired	No. of anglers involved	Fishing Effort (person-days)
		Sept 2016 – Dec 2016	Jan 2017 – Aug 2017	Total			
WD/R	22	57	171	228	11	49	138.4
WE/R	17	18	59	77	35	112	378.0
WD/SH	3	27	18	45	3	9	30.4
WE/SH	5	14	13	27	9	21	70.9
WD/PH	3	3	6	9	6	17	57.4
WE/PH	2	3	6	9	6	8	27.0
Total	**52**	**122**	**273**	**395**	**70**	**216**	**702.0**

Notes:

Day Type

- WD/R Weekday Regular
- WE/R Weekend Regular (not including public holidays)
- WD/SH Weekday School Holiday
- WE/SH Weekend School Holiday
- WD/PH Weekday Public Holiday (inclusive weekend spillovers)

Fishing Effort

- CPUE basis 0.5 day: 12 hours or less
- Fishing Effort 1 person day = 1 person/8 hours

Table A.10-6: Sampling Data: Socio-Economics – Tanjung Agas

Day Type	Ethnic Distribution			Main Age Cohort	Rental Value	Catch Volume (kg/boat)	Catch value (RM/boat)
	Malay	Chinese	Iban				
WD/R	49	0	0	40 - >60	1,200	6.8	272.73
WE/R	112	0	0	35 - >60	1,200	9.2	368.00
WD/SH	9	0	0	40 - 60	1,200	10.0	400.00
WE/SH	21	0	0	40 - 55	1,200	8.9	355.56
WD/PH	17	0	0	40 - 55	1,200	8.3	333.33
WE/PH	8	0	0	40 - 55	1,200	10.0	400.00
Total	**216**	**0**	**0**	**-**	-	**53.2**	**2,129.62**

Note:
Rental cost standardised at RM1,200/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-7: Estimated Annualised Fishing Effort and Landings – Tanjung Agas

Day Type	No. of boat hired	No. of angler involved	Fishing Effort (persons-days)	Rental Value (RM)	Other Expenses (RM)			Catch volume (kg/boat)	Catch value (RM)	Catch Volume per Unit Effort (kg/person-day)	Catch Value Per Unit Effort (RM/person-day)
					Fuel	Bait	Transport				
WD/R	114	508	1434.1	273,600.00	0.00	7,980.00	27,360.00	1554.5	62,181.82	1.08	43.36
WE/R	159	507	1712.1	92,400.00	0.00	2,695.00	9,240.00	708.4	28,336.00	0.41	16.55
WD/SH	45	135	455.6	54,000.00	0.00	1,575.00	5,400.00	450.0	18,000.00	0.99	39.51
WE/SH	49	113	382.7	32,400.00	0.00	945.00	3,240.00	240.0	9,600.00	0.63	25.08
WD/PH	18	51	172.1	10,800.00	0.00	315.00	1,080.00	75.0	3,000.00	0.44	17.43
WE/PH	27	36	121.5	10,800.00	0.00	315.00	1,080.00	90.0	3,600.00	0.74	29.63
Total	**411**	**1351**	**4278.2**	**474,000.00**	**0.00**	**13,825.00**	**47,400.00**	**3117.9**	**124,717.82**	**4.29**	**171.56**

Note:
Rental cost standardised at RM1,200/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-8: Sampling Data: Fishing Effort by Weekday Type – Teluk Kemang (12 hours)

Day Type	No. of days sampled	No. of days in the sampling year			No. of boat hired	No. of angler involved	Fishing Effort (person-days)
		Sept 2016 – Dec 2016	Jan 2017 – Aug 2017	Total			
WD/R	12	57	171	228	4	24	36.0
WE/R	6	18	59	77	14	52	78.0
WD/SH	3	27	18	45	7	16	24.0
WE/SH	4	14	13	27	11	42	63.0
WD/PH	2	3	6	9	7	25	37.5
WE/PH	0	3	6	9	0	0	0
Total	**27**	**122**	**273**	**395**	**43**	**159**	**238.5**

Notes:

Day Type

- WD/R Weekday Regular
- WE/R Weekend Regular (not including public holidays)
- WD/SH Weekday School Holiday
- WE/SH Weekend School Holiday
- WD/PH Weekday Public Holiday (inclusive weekend spillovers)

Fishing Effort

- CPUE basis 0.5 day: 12 hours or less
- Fishing Effort 1 person day = 1 person/8 hours

Table A.10-9: Sampling Data: Socio-Economics – Teluk Kemang (12 hours)

Day Type	Ethnic Distribution			Main Age Cohort	Rental Value	Catch Volume (kg/boat)	Catch value (RM/boat)
	Malay	Chinese	Iban				
WD/R	24	0	0	40 - 60	300.00	1.0	50.00
WE/R	44	8	0	40 - 60	214.29	1.1	53.57
WD/SH	16	0	0	30 - 60	257.14	1.0	50.00
WE/SH	36	6	0	40 - 60	218.18	1.9	95.45
WD/PH	25	0	0	40 - 60	171.43	1.3	64.29
WE/PH	0	0	0	0	0.00	0.0	0.00
Total	**145**	**14**	**0**	**-**	-	**6.3**	**313.31**

Note:
Rental cost standardised at RM600/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-10: Estimated Annualised Fishing Effort and Landings – Teluk Kemang (12 hours)

Day Type	No. of boat hired	No. of angler involved	Fishing Effort (persons-days)	Rental Value (RM)	Other Expenses (RM)			Catch volume (kg/boat)	Catch value (RM)	Catch Volume per Unit Effort (kg/person-day)	Catch Value Per Unit Effort (RM/person-day)
					Fuel	Bait	Transport				
WD/R	76	456	684	22,800.00	0.00	2,660.00	7,600.00	228.0	11,400.00	0.33	16.67
WE/R	180	667	1,001	38,500.00	0.00	6,288.33	17,966.67	82.5	4,125.00	0.08	4.12
WD/SH	105	240	360	27,000.00	0.00	3,675.00	10,500.00	45.0	2,250.00	0.13	6.25
WE/SH	74	284	425	16,200.00	0.00	2,598.75	7,425.00	51.5	2,577.27	0.12	6.06
WD/PH	32	113	169	5,400.00	0.00	1,102.50	2,362.50	11.6	578.57	0.07	3.43
WE/PH	0	0	0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
Total	**466**	**1,759**	**2,639**	**109,900.00**	**0.00**	**16,324.58**	**45,854.17**	**418.6**	**20,930.84**	**0.73**	**36.53**

Note:
Rental cost standardised at RM600/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-11: Sampling Data: Fishing Effort by Weekday Type – Teluk Kemang (30 hours)

Day Type	No. of days sampled	No. of days in the sampling year			No. of boat hired	No. of angler involved	Fishing Effort (person-days)
		Sept 2016 – Dec 2016	Jan 2017 – Aug 2017	Total			
WD/R	12	57	171	228	9	36	135.0
WE/R	6	18	59	77	13	52	195.0
WD/SH	3	27	18	45	2	8	30.0
WE/SH	4	14	13	27	14	44	165.0
WD/PH	2	3	6	9	6	24	90.0
WE/PH	0	3	6	9	0	0	0.0
Total	**27**	**122**	**273**	**395**	**44**	**164**	**615**

Notes:

Day Type

- WD/R Weekday Regular
- WE/R Weekend Regular (not including public holidays)
- WD/SH Weekday School Holiday
- WE/SH Weekend School Holiday
- WD/PH Weekday Public Holiday (inclusive weekend spillovers)

Fishing Effort

- CPUE basis 0.5 day: 12 hours or less
- Fishing Effort 1 person day = 1 person/8 hours

Table A.10-12: Sampling Data: Socio-Economics – Teluk Kemang (30 hours)

Day Type	Ethnic Distribution			Main Age Cohort	Rental Value	Catch Volume (kg/boat)	Catch value (RM/boat)
	Malay	Chinese	Iban				
WD/R	19	16	1	40 - 60	400.00	2.7	133.33
WE/R	32	20	0	40 - 60	461.54	2.9	146.15
WD/SH	4	4	0	40 - 60	600.00	3.5	175.00
WE/SH	22	22	0	30 - 60	342.86	3.3	164.29
WD/PH	15	8	1	40 - 60	400.00	2.7	133.33
WE/PH	0	0	0	0	0.00	0.0	0.00
Total	**92**	**70**	**2**	**-**	-	**15.0**	**752.11**

Note:
Rental cost standardised at RM1,200/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-13: Estimated Annualised Fishing Effort and Landings – Teluk Kemang (30 hours)

Day Type	No. of boat hired	No. of angler involved	Fishing Effort (persons-days)	Rental Value (RM)	Other Expenses (RM)			Catch volume (kg/boat)	Catch value (RM)	Catch Volume per Unit Effort (kg/person-day)	Catch Value Per Unit Effort (RM/person-day)
					Fuel	Bait	Transport				
WD/R	171	684	2,565	68,400.00	0.00	5,985.00	17,100.00	608.0	30,400.00	0.24	11.85
WE/R	167	667	2,503	77,000.00	0.00	5,839.17	16,683.33	225.1	11,253.85	0.09	4.50
WD/SH	30	120	450	18,000.00	0.00	1,050.00	3,000.00	157.5	7,875.00	0.35	17.50
WE/SH	95	297	1,114	32,400.00	0.00	3,307.50	9,450.00	88.7	4,435.71	0.08	3.98
WD/PH	27	108	405	10,800.00	0.00	945.00	2,025.00	24.0	1,200.00	0.06	2.96
WE/PH	0	0	0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
Total	**489**	**1,876**	**7,036**	**206,600.00**	0.00	**17,126.67**	**48,258.33**	**1,103.3**	**55,164.56**	**0.82**	**40.79**

Note:
Rental cost standardised at RM1,200/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-14: Sampling Data: Fishing Effort by Weekday Type – Admiral Cove (12 hours)

Day Type	No. of days sampled	No. of days in the sampling year			No. of boat hired	No. of angler involved	Fishing Effort (person-days)
		Sept 2016 – Dec 2016	Jan 2017 – Aug 2017	Total			
WD/R	0	57	171	228	0	0	0.0
WE/R	31	18	59	77	30	159	238.5
WD/SH	0	27	18	45	0	0	0.0
WE/SH	12	14	13	27	14	104	156.0
WD/PH	1	3	6	9	1	4	6.0
WE/PH	3	3	6	9	2	12	18.0
Total	**47**	**122**	**273**	**395**	**47**	**279**	**418.5**

Notes:

Day Type

- WD/R Weekday Regular
- WE/R Weekend Regular (not including public holidays)
- WD/SH Weekday School Holiday
- WE/SH Weekend School Holiday
- WD/PH Weekday Public Holiday (inclusive weekend spillovers)

Fishing Effort

- CPUE basis 0.5 day: 12 hours or less
- Fishing Effort 1 person day = 1 person/8 hours

Table A.10-15: Sampling Data: Socio-Economics – Admiral Cove (12 hours)

Day Type	Ethnic Distribution			Main Age Cohort	Rental Value	Catch Volume (kg/boat)	Catch value (RM/boat)
	Malay	Chinese	Iban				
WD/R	0	0	0	0	0.00	0.0	0.00
WE/R	57	102	0	30 – 60	801.00	7.1	356.67
WD/SH	0	0	0	0	0.00	0.0	0.00
WE/SH	11	93	0	30 – 60	900.00	6.4	317.86
WD/PH	4	0	0	30 – 40	1440.00	1.0	50.00
WE/PH	0	12	0	30 – 60	720.00	5.0	250.00
Total	**72**	**207**	**0**	**-**	**3861.00**	**19.5**	**974.52**

Note:
Rental cost standardised at RM1,350-1,440/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-16: Estimated Annualised Fishing Effort and Landings – Admiral Cove (12 hours)

Day Type	No. of boat hired	No. of angler involved	Fishing Effort (persons-days)	Rental Value (RM)	Other Expenses (RM)			Catch volume (kg/boat)	Catch value (RM)	Catch Volume per Unit Effort (kg/person-day)	Catch Value Per Unit Effort (RM/person-day)
					Fuel	Bait	Transport				
WD/R	0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
WE/R	75	395	592.4	59,687.42	0.00	2,608.06	8,941.94	549.3	27,463.33	0.93	46.36
WD/SH	0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
WE/SH	32	234	351.0	28,350.00	0.00	1,102.50	3,780.00	171.6	8,582.14	0.49	24.45
WD/PH	9	36	54.0	12,960.00	0.00	315.00	1,080.00	9.0	450.00	0.17	8.33
WE/PH	6	36	54.0	4,320.00	0.00	210.00	720.00	45.0	2,250.00	0.83	41.67
Total	**121**	**701**	**1,051.4**	**105,317.42**	**0.00**	**4,235.56**	**14,521.94**	**774.9**	**38,745.48**	**2.42**	**120.81**

Note:
Rental cost standardised at RM1,350-1,440/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-17: Sampling Data: Fishing Effort by Weekday Type – Admiral Cove (30 hours)

Day Type	No. of days sampled	No. of days in the sampling year			No. of boat hired	No. of angler involved	Fishing Effort (person-days)
		Sept 2016 – Dec 2016	Jan 2017 – Aug 2017	Total			
WD/R	0	57	171	228	0	0	0.0
WE/R	31	18	59	77	23	165	618.8
WD/SH	0	27	18	45	0	0	0.0
WE/SH	12	14	13	27	4	21	78.8
WD/PH	1	3	6	9	2	12	45.0
WE/PH	3	3	6	9	5	30	112.5
Total	**47**	**122**	**273**	**395**	**34**	**228**	**855.0**

Notes:

Day Type

- WD/R Weekday Regular
- WE/R Weekend Regular (not including public holidays)
- WD/SH Weekday School Holiday
- WE/SH Weekend School Holiday
- WD/PH Weekday Public Holiday (inclusive weekend spillovers)

Fishing Effort

- CPUE basis 0.5 day: 12 hours or less
- Fishing Effort 1 person day = 1 person/8 hours

Table A.10-18: Sampling Data: Socio-Economics – Admiral Cove (30 hours)

Day Type	Ethnic Distribution			Main Age Cohort	Rental Value	Catch Volume (kg/boat)	Catch value (RM/boat)
	Malay	Chinese	Iban				
WD/R	0	0	0	0	0.00	0.0	0.00
WE/R	32.8	102.8	29.3	30 – 60	1,043.48	21.0	1,052.17
WD/SH	0	0	0	0	0.00	0.0	0.00
WE/SH	0	21	0	30 – 60	1,200.00	16.3	812.50
WD/PH	0	12	0	30 – 40	800.00	20.0	1,000.00
WE/PH	7.5	15	7.5	30 – 60	640.00	12.0	600.00
Total	**40.3**	**150.8**	**36.8**	**-**	-	**69.3**	**3,464.67**

Note:
Rental cost standardised at RM1,600/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-19: Estimated Annualised Fishing Effort and Landings – Admiral Cove (30 hours)

Day Type	No. of boat hired	No. of angler involved	Fishing Effort (persons-days)	Rental Value (RM)	Other Expenses (RM)			Catch volume (kg/boat)	Catch value (RM)	Catch Volume per Unit Effort (kg/person-day)	Catch Value Per Unit Effort (RM/person-day)
					Fuel	Bait	Transport				
WD/R	0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
WE/R	57	410	1,536.9	59,612.90	0.00	1,999.52	6,855.48	1,620.3	81,017.39	1.05	52.71
WD/SH	0	0	0.0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
WE/SH	9	47	177.2	10,800.00	0.00	315.00	1,080.00	438.8	21,937.50	2.48	123.81
WD/PH	18	108	405.0	14,400.00	0.00	630.00	2,160.00	180.0	9,000.00	0.44	22.22
WE/PH	15	90	337.5	9,600.00	0.00	525.00	1,800.00	108.0	5,400.00	0.32	16.00
Total	**99**	**655**	**2,456.6**	**94,412.90**	**0.00**	**3,469.52**	**11,895.48**	**2,347.1**	**117,354.89**	**4.29**	**214.75**

Note:
Rental cost standardised at RM1,600/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-20: Sampling Data: Fishing Effort by Weekday Type – Pulau Burung

Day Type	No. of days sampled	No. of days in the sampling year			No. of boat hired	No. of angler involved	Fishing Effort (person-days)
		Sept 2016 – Dec 2016	Jan 2017 – Aug 2017	Total			
WD/R	12	57	171	228	0	0	0.0
WE/R	6	18	59	77	13	42	63.0
WD/SH	3	27	18	45	0	0	0.0
WE/SH	4	14	13	27	6	18	27.0
WD/PH	2	3	6	9	13	45	67.5
WE/PH	0	3	6	9	0	0	0
Total	**27**	**122**	**273**	**395**	**32**	**105**	**157.5**

Notes:

Day Type

- WD/R Weekday Regular
- WE/R Weekend Regular (not including public holidays)
- WD/SH Weekday School Holiday
- WE/SH Weekend School Holiday
- WD/PH Weekday Public Holiday (inclusive weekend spillovers)

Fishing Effort

- CPUE basis 0.5 day: 12 hours or less
- Fishing Effort 1 person day = 1 person/8 hours

Table A.10-21: Sampling Data: Socio-Economics – Pulau Burung

Day Type	Ethnic Distribution			Main Age Cohort	Rental Value	Catch Volume (kg/boat)	Catch value (RM/boat)
	Malay	Chinese	Iban				
WD/R	0	0	0	0	600	0	0.00
WE/R	42	0	0	40 - 55	600	2.9	93.54
WD/SH	0	0	0	0	600	0.0	0.00
WE/SH	18	0	0	40 - 55	600	5.8	184.00
WD/PH	45	0	0	40 - 55	600	3.1	98.46
WE/PH	0	0	0	0	0	0.0	0.00
Total	**105**	**0**	**0**	**-**	-	**11.8**	**376.00**

Note:
Rental cost standardised at RM600/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-22: Estimated Annualised Fishing Effort and Landings – Pulau Burung

Day Type	No. of boat hired	No. of angler involved	Fishing Effort (persons-days)	Rental Value (RM)	Other Expenses (RM)			Catch volume (kg/boat)	Catch value (RM)	Catch Volume per Unit Effort (kg/person-day)	Catch Value Per Unit Effort (RM/person-day)
					Fuel	Bait	Transport				
WD/R	0	0	0	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.00
WE/R	167	539	809	100,100.00	0.00	5,839.17	16,683.33	225.08	7,202.46	0.28	8.91
WD/SH	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WE/SH	41	122	182	24,300.00	0.00	1,417.50	4,050.00	155.25	4,968.00	0.85	27.26
WD/PH	59	203	304	35,100.00	0.00	2,047.50	4,387.50	27.69	886.15	0.09	2.92
WE/PH	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**266**	**863**	**1,295**	**159,500.00**	**0.00**	**9,304.17**	**25,120.83**	**408.02**	**13,056.62**	**1.22**	**39.09**

Note:
Rental cost standardised at RM600/boat/day
Fuel cost included within rental cost
Average bait cost standardised at RM35/boat

Table A.10-23: Sampling Data: Fishing Effort by Weekday Type – All Locations

Location	No. of days sampled	No. of days in the sampling year			No. of boat hired	No. of angler involved	Fishing Effort (person-days)
		Sept 2016 – Dec 2016	Jan 2017 – Aug 2017	Total			
Pengkalan Kempas	59	122	273	395	259	516	774.0
Tanjung Agas	52				70	216	702.0
Teluk Kemang (12 hours)	27				43	159	238.5
Teluk Kemang (30 hours)					44	164	615.0
Admiral Cove (12 hours)	47				47	279	418.5
Admiral Cove (30 hours)					34	228	855.0
Pulau Burung	27				32	105	157.5
Total		**122**	**273**	**395**	**529**	**1,667**	**3,760.5**

Notes:

Fishing Effort

- CPUE basis 0.5 day: 12 hours or less
- Fishing Effort 1 person day = 1 person/8 hours

Table 5-24: Estimated Annualised Fishing Effort and Landings – All Locations

Location	No. of boat hired	No. of angler involved	Fishing Effort (persons -days)	Rental Value (RM)	Other Expenses (RM)			Catch volume (kg/boat)	Catch value (RM)	Catch Volume per Unit Effort (kg/person-day)	Catch Value Per Unit Effort (RM/person -day)
					Fuel	Bait	Transport				
Pengkalan Kempas	1,493	2,861	4,292.2	33,180.00	11,850.00	13,825.00	24,140.28	141.0	7,064.54	0.18	3.45
Tanjung Agas	411	1,351	4,278.2	474,000.00	0.00	13,825.00	47,400.00	3,117.9	124,717.82	4.29	171.56
Teluk Kemang (12 hours)	466	1,759	2,639.0	109,900.00	0.00	16,324.58	45,854.17	418.6	20,930.84	0.73	36.53
Teluk Kemang (30 hours)	489	1,876	7,036.0	206,600.00	0.00	17,126.67	48,258.33	1,103.3	55,164.56	0.82	40.79
Admiral Cove (12 hours)	121	701	1,051.4	105,317.42	0.00	4,235.56	14,521.94	774.9	38,745.48	2.42	120.81
Admiral Cove (30 hours)	99	655	2,456.6	94,412.90	0.00	3,469.52	11,895.48	2,347.1	117,354.89	4.29	214.75
Pulau Burung	266	863	1,295.0	159,500.00	0.00	9,304.17	25,120.83	408.0	13,056.62	1.22	39.09
Total	**3,345**	**10,066**	**23,048.4**	**1,182,910.3**	**11,850**	**78,110.5**	**217,191.00**	**8,310.82**	**377,034.75**	**13.95**	**626.98**

Table A10-25: Sampling Data: Socio-Economics – All Locations

Location	Ethnic Distribution			Main Age Cohort	Catch Volume (kg/boat)	Catch Value (RM/boat)
	Malay	Chinese	Iban			
Pengkalan Kempas	493	17	0	35 - 50	2.1	105.66
Tanjung Agas	216	0	0	35 - 60	53.2	2129.62
Teluk Kemang (12 hours)	145	14	0	30 - 60	6.3	313.31
Teluk Kemang (30 hours)	92	70	2	30 - 60	15.0	752.11
Admiral Cove (12 hours)	72	207	0	30 - 60	19.5	974.52
Admiral Cove (30 hours)	40	151	36.8	30 - 60	69.3	3464.67
Pulau Burung	105	0	0	40 - 55	11.8	376.00
Total	**1,163**	**459**	**39**	**30 - 60**	**177.2**	**8,115.89**