THE DISTRIBUTION OF AQUATIC MAMMALS IN THE WATERS OF PENANG ISLAND, MALAYSIA, WITH A FOCUS ON THE ECOLOGY AND CONSERVATION OF THE IRRAWADDY DOLPHIN *Orcaella brevirostris* (Owen in Grey, 1866)

by

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ABSTRAK

Status terkini mengenai mamalia akuatik di Pulau Pinang, Malaysia, tidak didokumentasikan. Ancaman seperti pembangunan pesisir pantai, penangkapan ikan dan aktiviti bot kini semakin meningkat. Tambahan lagi, terdatap bukti tentang aktiviti memerhati lumba-lumba yang tidak dikawal serta beberapa kejadian tangkapan haiwan setasea secara tidak sengaja yang boleh memberi kesan kepada populasi tempatan haiwan ini. Kajian ini bertujuan untuk mendapatkan maklumat mengenai spesies mamalia akuatik, taburan , kekerapan haiwan dilihat, saiz kumpulan, kejadian haiwan terdampar, serta interaksi haiwan ini dengan bot yang memfokuskan terhadap ekologi dan perilaku Lumba-lumba Empesut (*Orcaella brevirostris*) di Pulau Pinang. Program pemantauan berasaskan komuniti mengenai mamalia akuatik telah dijalankan di utara dan barat Pulau Pinang dengan menjalankan soal selidik setiap tiga bulan antara Disember 2012 hingga Disember 2013. Pemantauan menggunakan bot nelayan yang kecil bagi analisa pengecaman foto dan pemantauan tingkah laku Lumba-lumba Empesut telah dilakukan dari Januari hingga November 2013 di barat Pulau Pinang. Lima spesies mamalia akuatik telah disahkan di pulau ini, iaitu Lumba-lumba Putih (*Sousa chinensis*), Lumba-lumba Empesut, Porpois tanpa sirip (*Neophocaena phocaenoides*), Lumba-lumba Hidung Botol (*Tursiops aduncus*), dan Memerang Licin (*Lutrogale perspicillata*). Lumba-lumba Putih dan Empesut adalah spesis yang lebih kerap dilihat di barat laut

dan barat Pulau Pinang. Berdasarkan program pemantauan dan pemerhatian peribadi, kejadian tersangkut dalam jaring telah dikenal pasti sebagai ancaman terhadap semua haiwan, tetapi Lumba-lumba Putih lebih cenderung kepada perlanggaran dengan bot. Penemuan populasi residen Lumba-lumba Empesut di barat Pulau Pinang antara 32 dan 51 individu telah dianggarkan dengan menggunakan analisis tanda-penangkapan semula. Saiz kumpulan purata adalah 5 ± 0.5 (SE), dan kebanyakan kumpulan ditemui berdekatan dengan pantai semasa air pasang sepanjang tempoh kajian ini. Enam belas pasangan ibu dan anak Lumba-lumba Empesut telah diperhatikan. Kebanyakan kemunculan haiwan ini telah direkodkan antara kawasan muara Sungai Pinang dan Sungai Burung iaitu tidak melebihi 3 km dari pantai di perairan cetek (kedalaman < 6m). Berdasarkan analisis statistik , parameter persekitaran seperti suhu permukaan laut, kemasinan, kekeruhan, kedalaman dan pasang surut tidak mempengaruhi kehadiran ikan lumba-lumba. Perilaku yang paling biasa oleh haiwan ini adalah pemakanan, dan haiwan ini berenang dengan menciptakan corak spesifik berbentuk gelung telah diperhatikan beberapa kali semasa aktiviti ini. Oleh sebab itu, beberapa tindakan pemuliharaan telah disyorkan bagi melindungi spesies endemik terancam ini di rantau berkenaan iaitu: kelangsungan program pemantauan, pembentukan satu pelan tindakan untuk mamalia akuatik dan perlaksanaan kawasan perlidungan marin yang diurus secara bersama antara beberapa pihak.

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ABSTRACT

The current status of aquatic mammals in Penang Island, Malaysia, has largely been undocumented. Threats such as coastal development, tourism, fishing, and boating activities are increasing. Additionally, there is evidence of unregulated dolphin watching and incidental catches of cetaceans in fishing gears, which could be affecting the local populations of these animals. This research aimed to obtain information on the species of aquatic mammals, their distribution, frequency of occurrence, group size, strandings, and interactions with boats, with a focus on the ecology and behaviour of the Irrawaddy dolphins (*Orcaella brevirostris*) in Penang. An aquatic mammal community-based monitoring programme was carried out in north and west Penang, by conducting interview surveys every three months, from December 2012 to December 2013. Using an artisanal fishing boat, photo-identification, and behavioural studies of Irrawaddy dolphins were conducted from January to November 2013 in west Penang. Five species of aquatic mammals were confirmed in the island, namely the Indo-Pacific Humpback dolphin (*Sousa chinensis*), the Irrawaddy dolphin, the Finless porpoise (*Neophocaena phocaenoides*), the Indo-Pacific Bottlenose dolphin (*Tursiops aduncus*), and the Smooth-coated otter (*Lutrogale perspicillata*). The Humpback and the Irrawaddy dolphins were sighted more frequently in northwest and west Penang, respectively.

Based on the monitoring programme and personal observations, entanglement in fishing nets was identified as a threat to all the species, but Humpback dolphins are more prone to collisions with boats. Using mark-recapture analysis, the estimated resident population of Irrawaddy dolphins in west Penang was between 32 and 51 individuals. The mean group size was 5 ± 0.5 (SE), and most of the groups were found closer to shore during high tide throughout the period of the study. Sixteen mother-calf associations were observed. Most of the sightings of this species were recorded between Sungai Pinang and Sungai Burung rivers mouth no farther than 3 km from shore in shallow waters (<6 m depth). Based on the statistical analysis, the environmental parameters such as sea surface temperature, salinity, turbidity, depth and tide were not correlated with the presence of the dolphins. Feeding was the most common behaviour, and a specific pattern in which the animals swim creating loops within the same spot was observed several times during this activity. As a result, some conservation actions recommended to protect these threatened species endemic to the region are: the continuation of the monitoring programme, the creation of an action plan for aquatic mammals, and the implementation of co-managed marine protected areas.

CHAPTER 1
IMPORTANCE OF STUDYING AQUATIC MAMMALS IN PENANG ISLAND

1.1 Introduction

Worldwide knowledge on marine mammals is still insufficient (Kaschner et al., 2012). The International Union for the Conservation of Nature (IUCN) has listed 38% of the species as Data Deficient, many of them found in highly human-disturbed areas such as Southeast Asia, which place them in an exceptionally high risk (Chou, 1994; Schipper et al., 2008; Sekiguchi and Aksornkoae, 2008; Polidoro et al., 2009)

Marine mammals in Southeast Asia include seven species of Rorquals, Sperm whales (i.e. *Physeter macrocephalus*), 23 species of small cetaceans and one sirenian. Endemic to this region are Irrawaddy dolphins (*Orcaella brevirostris*), Finless porpoises (*Neophocaena phocaenoides*), and Dugongs (*Dugong dugon*). (Beasley and Jefferson, 1997; Rudolph et al., 1997; Jefferson et al., 2008; Rudolph and Smeenk, 2009)

In Malaysia, there are twenty seven species of marine mammals confirmed, including the Dugong (Jaaman, 2004; Ponnampalam, 2012). Of these, four species, the Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), Indo-Pacific humpback dolphin, Irrawaddy dolphin and the Indo-Pacific Finless porpoise are present in Peninsular and East Malaysia (Nadarajah, 2000; Jaaman, 2006; Minton et al., 2011; Ponnampalam, 2012). However, there is very little information on their distributions and population status in this country.

1.2 Aquatic Mammals in Penang

In Penang, records of marine mammal presence started in the 70's when Mörzer, and Pilleri and Gihr, reported sightings of *Orcaella brevirostris* (Stacey and Leatherwood, 1997). In 2000 a stranding of a melon-headed whale, *Peponocephala*

electra was recorded by Nadarajah (2000). Since 2008, but excluding 2009 and 2010, the Penang State Fisheries Office "*Pejabat Perikanan Negeri Pulau Pinang*" has been recording strandings of marine mammals (Mansor Bin Yobe, personal communication, October 23, 2013). So far, these records include 11 individuals of finless porpoise, four bottlenose dolphins, one Irrawaddy dolphin, three unidentified dolphins, and one Indo-Pacific bottlenose dolphin that died in rehabilitation five days after its attempted rescue. (Mansor Bin Yobe, personal communication, October 23, 2013). Photographs show that some of the dolphins identified as bottlenose are actually *Sousa chinensis*, confirming the presence of these four species in the area (Rudolph et al., 1997; Stacey and Leatherwood, 1997; Rajamani et al., 2014). Until now, none of the studies carried out in Malaysia have provided systematic information about Penang Island, where an obvious coastal development and serious signs of overfishing are becoming significant threats (Ghazali, 2011). Other riverine mammals such as otters are known to be found in Penang's coastal areas (Sivasothi and Burhanuddin, 1994), but information on their current distribution or status is incomplete.

Of the four cetacean species found in Penang, this study will concentrate on the Irrawaddy dolphin examining its distribution, population size, movement patterns, social composition and behaviour. In addition, information on the occurrence of Indo-Pacific humpback dolphin, finless porpoise and otters will be included as well.

1.2.1 Threats

Incidental catch is a major threat for cetaceans restricted to the coast (D'agrosa et al., 2000). According to a survey among fishermen (Rajamani et al., 2014), fishing effort around Penang Island has increased, and the presence of marine mammals in fishing grounds is frequent. Moreover, the interviewees stated to have seen entangled animals once or twice during their fishing career.

Coastal development and human activities are affecting populations of aquatic mammals in Southeast Asia (Dudgeon, 2000; Ponnampalam et al., 2013).

Considering that *Sousa chinensis* and *Orcaella brevirostris* are restricted to coastal waters (Jefferson et al., 1993; Culik, 2011) these species are facing the ongoing coastal development in Penang Island which correlates directly with increased tourism, shipping, and subsequently pollution.

Malaysia is a party and also signatory to the United Nations Convention on Biological Diversity (UNCBD), and the Convention on Trade in Endangered Species (CITES). On its National Policy on Biological Diversity, Malaysia has committed to the principles of conservation and sustainable management of all living forms. Malaysia Federal Law protects all marine mammals, prohibiting any person to fish, disturb, harass, catch, kill, take, posses, transport as well as export and trade any aquatic mammal found within the 200 Nautical Miles of the Economic Exclusive Zone (Fisheries Act 1985; Fisheries Regulations 1999 - Control of Endangered Species of Fish; Wildlife Conservation Act 2010)

1.2.2 Social and economic benefits of aquatic mammal conservation

Worldwide, well-managed marine mammal watching in the wild provides important revenues to local communities and contributes to the environmental education of the public (Hoyt, 2001). Penang Island's economy is highly influenced by tourism (Wong, 1998). The presence of hotels and tourist attractions in the north of the island generates work opportunities for people living in the area (Penang State Government, 1998). Opportunistic dolphin watching represents a benefit for the visitors, especially to those interested in wildlife tourism. However, the activity remains unregulated, and operators may be using the wrong approach disturbing the animal's behaviour (Leela Rajamani, personal communication, 2013). Dolphin watching activities have been observed in the northwest of Penang (Teluk Bahang), nevertheless these are not currently monitored, and so the degree of the sustainability is not known.

The initiative for "Cleaner, Greener, Penang'' supported by Penang State Government and other organizations, is seeking to reposition the island into a

sustainable way of life. Conservation and appropriate management (Wong, 1993) of marine mammals enables that whale watching is sustainable (Lusseau et al., 2006) and therefore increasing the local economy in the long term, going along with the initiative.

1.3. Rationale of the Study

Penang Island is undergoing rapid coastal growth, tourism, and fishing activities. Small cetaceans such as *Orcaella brevirostris,* and some species of Otters are threatened by these changes. These species' habits of feeding, mating and nursing, among others, are limited to coastal areas (Jefferson et al., 1993), which expose them to threats such as habitat loss, depletion of food resources, entanglement in fishing gears, and collision with boats. This study aims to provide basic information on the status of aquatic mammals in northwest and west Penang, where certain species appear to have preferred habitats and dolphin watching may start to grow in popularity, including recommendations for proper management of their habitats and activities related to their observation. The study follows the strategy of the National Policy of Biological Diversity to Improve the Scientific Knowledge Base, and other recommendations on research and conservation of aquatic mammals in Malaysia (Sivasothi and Burhanuddin, 1994; Stacey and Leatherwood, 1997; Perrin et al., 2005; Jaaman, 2006).

The IUCN lists *O. brevirostris*, *N. phocaenoides*, and the otter *Lutrogale perspicillata* as vulnerable, *S. chinensis* as near threatened and *T. aduncus* as data deficient (Hussain et al., 2008; Reeves et al., 2008a; Reeves et al., 2008b; Hammond et al., 2012; Wang and Reeves, 2012). Because knowledge of these species is limited, more scientific research is required to have information that can lead to appropriate management and conservation.

1.4. General Aim, Objectives and Hypothesis

This study was designed to obtain baseline information on the scientific and local knowledge of aquatic mammals in northwest and west Penang, using community based information on the frequency of occurrence and distribution of

cetaceans and otters, which complements with scientific data. Focus will be given on the distribution, movement patterns, range, social composition and behaviour, of *Orcaella brevirostris* in west Penang.

1.4.1 Objectives

A) To study the distribution, occurrence, ecology and general daylight behaviour of Irrawaddy dolphins (*Orcaella brevirostris*) in west Penang.

B) To study the distribution and occurrence of other aquatic mammals in the waters of northwest and west Penang.

C) To determine the distribution and frequency of occurrence of aquatic mammals in the waters of northwest and west Penang by establishing a monitoring programme with key informants.

D) To develop recommendations for the management and conservation of aquatic mammals in Penang, in line with the state government sustainable initiatives.

1.4.2. Hypothesis

1.4.2.1

Ho: The frequency of occurrence of cetaceans in northwest and west Penang is different throughout the year.

Ha: The frequency of occurrence of cetaceans in northwest and west Penang is similar throughout the year.

1.4.2.2

Ho: There is no resident population of Irrawaddy dolphins (*Orcaella brevirostris*) in west of Penang Island.

Ha: There is a resident population of Irrawaddy dolphins (*Orcaella brevirostris*) in the northwest of Penang Island.

1.4.2.3

Ho: Patterns of occurrence of *O. brevirostris* are not influenced by physical parameters of sea surface Temperature, Salinity, Turbidity, Depth and Tides.

Ha: Patterns of occurrence of *O. brevirostris* are influenced by physical parameters of Temperature, Salinity, Turbidity, Depth and Tides.

1.5 Thesis Outline

This document includes six chapters. Chapter 1 is a general introduction to the study regarding the importance of studying aquatic mammals in Penang, including the general aim, objectives and hypothesis proposed for this particular research. Chapter 2 reviews the current knowledge of aquatic mammals in Malaysia focusing on Irrawaddy dolphins (*Orcaella brevirostris*) and four other species found in Penang namely Indo-Pacific Humpback dolphin (*Sousa chinensis),* Indo-Pacific Finless porpoise (*Neophocaena phocaenoides*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus)* and the smooth-coated otter (*Lutrogale perspicillata).*

Chapter 3 analyses on the frequency of occurrence of aquatic mammals in northwest and west Penang and its variability throughout the year, based on the results of the local community monitoring programme, and opportunistic observations. Chapter 4 and Chapter 5 show the results from the photo-identification mark-recapture and behavioural observations, carried out on *Orcaella brevirostris* in west Penang. The final chapter, Chapter 6 presents a final discussion, recommendations for conservation and management and the general conclusions for this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In Malaysia, systematic research and published findings about marine mammals are relatively new. Starting in 1996, a marine mammal survey in the Southern Sulu Sea, obtained information on the occurrence of *Orcaella brevirostris* (Irrawaddy dolphin) and *Sousa chinensis* (Indo-Pacific Humpback dolphin) in the country (Dolar et al., 1997). Between 1997 and 2004, the presence of eleven species of cetaceans was corroborated, and *Tursiops truncatus* and *Lagenodelphis hosei* were recorded for the first time. The research also provided first time information about direct and indirect catches of marine mammals in East Malaysia. (Jaaman, 2006). In 1999, research had extended to West Malaysia, identifying Melaka state coastline and Langkawi Archipelago as marine mammal hotspots (Nadarajah, 2000). In 2006, a research highlighted the small size of the population of Dugongs (*Dugong dugon*) in Sabah (Rajamani and Marsh, 2010).

Research in Sarawak started in 2008 reporting the distribution of *Tursiops aduncus* (Indo-Pacific Bottlenose dolphin), *Sousa chinensis, Neophocaena phocaenoides* (Finless porpoise) and *Orcaella brevirostris* (Peter, 2012; Minton et al., 2013). Since 2010, the Langkawi Dolphin Research project has been studying these four species in Langkawi Island (West Malaysia) as well, with *N. phocaenoides* being the most common, and finding high site fidelity of individuals of *S.chinensis*. It also reported the occurrence of *Balenoptera brydei* whale. This project is still in progress estimating abundances and levels of bycatch of these species in the area (Ponnampalam and Jamal Hisne, 2011). All researches have brought out a common concern regarding catches of marine mammals in Malaysia, being unsustainable (Jaaman, 2006), increasing (Nadarajah, 2000; Minton et al., 2013) and closely related with illegal trade in the case of the Dugongs (Rajamani and Marsh, 2010).

Regarding other semi-aquatic mammals, otters are well represented in Southeast Asia (Dudgeon, 2000) and four species are found in Malaysia [i.e. *Lutra*

lutra – Common or Eurasian Otter (Near threatened), *Lutra sumatrana* - Hairy-nosed Otter (Endangered), *Lutrogale perspicillata* - Smooth Otter (Vulnerable) and *Aonyx cinerea* -Oriental Small-clawed Otter (Vulnerable)]. Although general information about the habitat types, group size, range, diet and behaviour is known (Foster-Turley et al., 1990; Sivasothi and Burhanuddin, 1994) it is still very limited. The hairy-nosed, small clawed and smooth otters have been observed in Penang National Park (Sivasothi, 1995).

This chapter will review the contributions of local knowledge as starting point for systematic research on the species in this study. Information regarding the current status of *Orcaella brevirostris* will be reviewed first and at the end, the current knowledge on the distribution and population sizes of *S. chinensis*, *N. phocaenoides*, *T. aduncus*, the otter *Lutrogale perspicillata*, and the common threats these coastal species face will be presented.

2.2 Local knowledge used in aquatic mammal research

Local knowledge has been used as an inexpensive and effective manner to obtain basic and historical information about aquatic mammals (Aragones et al., 1997; Ortega-Argueta et al., 2012; Rajamani et al., 2014), this method has been widely used in Southeast Asia, to obtain information primarily about interactions with fisheries (Dolar et al., 1997; Dolar et al., 2002; Jaaman, 2006; Moore et al., 2010), and to build robust baselines as the one used for *Orcaella brevirostris* in the Mekong river of Laos and Cambodia (Baird et al., 1994). There, people effectively informed about the historical distribution, calving peaks, by-catch and stranding numbers, environmental issues and concerns about the decreasing population of dolphins (Baird and Mounsouphom, 1994; Baird et al., 1994; Beasley and Davidson, 2007). Local information, have also helped determine the cultural and social importance of aquatic mammals, which in most cases have positive results, being favourable for management and conservation (Baird et al., 1994; Jaaman, 2006; Beasley, 2007; Sutaria, 2009; Rajamani and Marsh, 2010).

By using informal and structured interviews, the information provided by the local community has demonstrated to be helpful in establishing patterns of distribution, occurrence and movements, determining perception and concerns of people towards a species (Rudolph et al., 1997; Nadarajah, 2000; Beasley et al., 2002; Kreb et al., 2007; Flores and Da Silva, 2009). Establishing community-based monitoring programs, allowed to determine the current status of endangered species, such as the Dugongs in Sabah (Rajamani and Marsh, 2010) and the Irrawaddy dolphins in the Mekong river (Beasley, 2007), which provided strong support to implement a similar methodology during this research. In fact, the design of this systematic research was based on the information that the fishermen and tourist operators provided through interview surveys, about the status, threats and conservation issues in Penang (Rajamani et al., 2014).

2.3 The Irrawaddy dolphin *Orcaella brevirostris* (Owen in Gray, 1866)

2.3.1 Description

Orcaella brevirostris (Owen in Gray, 1866) is a delphinid (i.e. Family: Delphinidae) with a rounded head, blunt rostrum, and a "U" shaped blowhole. After the middle back there is a small dorsal fin which ends in a rounded tip (Jefferson et al., 2008; Smith, 2009; Culik and Wurtz, 2011). Pectoral fins are large, i.e. 7.3% of the total length (Jefferson et al., 2008), resembling paddles with a convex leading edge, and strong motion (Culik and Wurtz, 2011). The coloration is grey, changing to lighter tones ventrally. Body length of adults ranges from 173 cm to 275 cm (average = 210 cm), and body weight ranges from 115 to 130 kg. Newborns are approximately 1 m long with an average weight between 10 and 12 kg. (Jefferson et al., 1993; Jefferson et al., 2008; Smith, 2009; Culik and Wurtz, 2011).

Beasley et al. (2005) found that Irrawaddy dolphins from Australia were bigger than the Asian specimens, with shorter dorsal fins, narrower pectoral fins, and a dorsal cape distinguished by a darker colour, among other morphological differences.

Subsequently, a genetic distinction between individuals from Asia and Australia led to the recognition of a different species classified as *Orcaella heinsohni*.

The lifespan of *Orcaella brevirostris* is unknown. Beasley (2007) used as a reference, a value of maximum 30 years old estimated for *O. heinsohni* (Marsh et al., 1989). Being a tropical species, it is assumed that births happen year around (Jefferson et al., 2008) with peaks occurring between April and June, before the monsoon season (Smith, 2009). Gestation in captivity lasts 14 months with 2 years of weaning (Stacey and Leatherwood, 1997).

Irrawaddy dolphins feed on fish, cephalopods and some crustaceans (Culik and Wurtz, 2011) with evidence of catfish, carps, squid, cuttlefish and octopus found in the stomachs and from direct observations in aerial surveys (Stacey and Leatherwood, 1997; Jefferson et al., 2008; Ponnampalam et al., 2013). Spitting water is a behaviour found to be related with feeding (Stacey and Leatherwood, 1997; Jefferson et al., 2008; Culik and Wurtz, 2011).

2.3.2 Distribution and Habitat

Orcaella brevirostris is discontinuously distributed in coastal, estuarine, shallow brackish areas and fresh turbid waters, from the east of the Bay of Bengal to the Ili Ilo strait at the Malampaya Sound Palawan, Philippines (Figure 2.1). (Dolar et al., 2002; Baird and Beasley, 2005; Jefferson et al., 2008; Reeves et al., 2008; Dolar, 2010; Culik and Wurtz, 2011). Physical parameters such as surface temperature, salinity and turbidity have shown no significant correlation with the presence or behaviour of the species in its areas of distribution (Kamaruzzan et al., 2011; Peter, 2012). However, the depth is critical in the distribution of the species. In freshwater it can be found in areas 45.95 m deep (Beasley, 2007) whereas in coastal and estuarine systems it is restricted to waters no more than 26.70 m deep (Kamaruzzan et al., 2011) with the highest concentrations in areas less than 10 m deep (Dolar et al., 2002; Smith et al., 2004; Jaaman, 2006; Dolar, 2010; De La Paz, 2012; Peter, 2012).

The International Union for the Conservation of Nature (IUCN) lists this species as Vulnerable. However, the populations from Lower Mekong river (Laos, Cambodia and Vietnam), Mahakam river (Indonesia), Ayeyarwady river (Myanmar) Songkhla lake (Thailand), and the Malampaya Sound Palawan (Philippines), are Critically Endangered (CR) (Figure 2.1) (Reeves et al., 2008). This status is based upon the small size of the populations (Table 2.1) and the severe threats they are facing, such as entanglement in fishing gears, habitat destruction, pollution and fragmentation of the habitat.

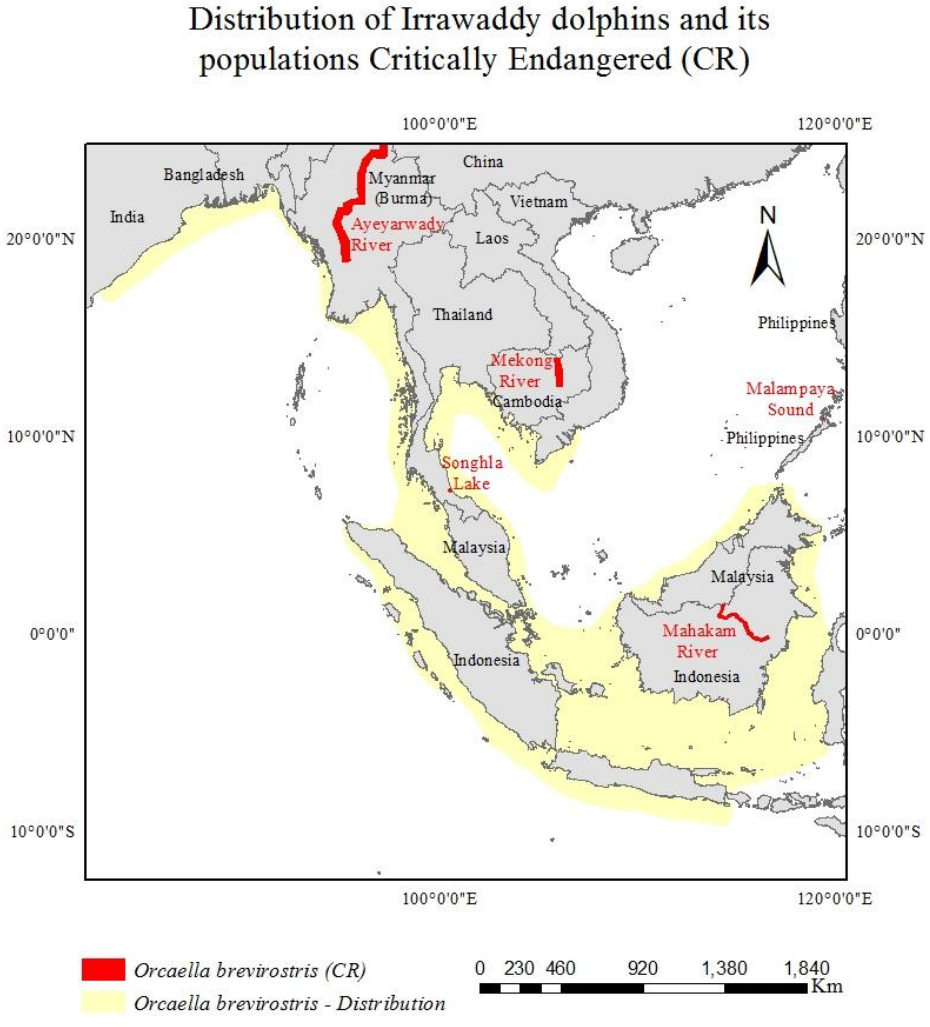

Figure 2.1 Distribution of the Irrawaddy dolphins *Orcaella brevirostris* and populations listed by the IUCN (in red) as Critically Endangered – CR (Source: Digital Distribution Maps of The IUCN Red List of Threatened Species™).

2.3.3 Behaviour

O. brevirostris is an elusive species (Sutaria and Marsh, 2011) and its surfaces are quick and unpredictable, most of the time showing only the melon (Stacey and Leatherwood, 1997; Minton et al., 2013). There are records of these animals rolling, splashing, limb slapping, waving and herding (Stacey and Hvenegaard, 2002; De La Paz, 2012; Ponnampalam et al., 2013). Dive duration in the wild can last 115.3 seconds (Stacey and Hvenegaard, 2002) and can extend longer in the presence of disturbances such as boat noise (Stacey and Leatherwood, 1997; Kreb and Rahadi, 2004). However, the animals have been observed following fishing trawlers and seem to tolerate small low speed boats (Kreb and Rahadi, 2004; Nor Hashim and Jaaman, 2011).

2.3.4 Social structure and interactions with other species

Group sizes are small, no more than 18 individuals in freshwater (Beasley, 2007) and up to 13 in coastal populations (Dolar et al., 2002). However, it is common to find solitary individuals, and small groups from three to four (Kreb, 2008; Sutaria, 2009). Social associations differ between populations. For example, the Mahakam river population is highly structured with a strong association among individuals (Beasley, 2007), whereas the Chilika lake population has a weak association among individuals and a variable structure (Sutaria, 2009).

A unique non-aggressive sympatry has been observed between *S. chinensis* and *O. brevirostris* in Cowie Bay, Malaysia, including interactions between adults of Humpback dolphins and calves of Irrawaddy dolphins, due to a small size of the Humpback dolphin's population and an instinctive need of females to watch over calves (Kamaruzzan and Jaaman, 2013).

2.3.5 Movement Patterns

It has been discovered that movement patterns of freshwater populations of *O. brevirostris* are strongly related with depth, resulting in an uneven distribution within

areas. It was also observed that there is an apparent preference for feeding in the morning, and high site fidelity (Stacey and Leatherwood, 1997; Stacey and Hvenegaard, 2002; Beasley, 2007; Sutaria, 2009; Jaaman, 2006). Coastal groups movement appears to be influenced by the tide and lunar phase (Dolar et al., 2002; Jaaman, 2006; De La Paz, 2012; Peter, 2012).

2.3.6 Populations Size

Populations size have been estimated using direct observations, line transects or mark-recapture methods (Table 2.1). Although line transects have been used (Smith et al., 2004; Minton et al., 2013), biases regarding the unknown distribution, the low detection of the animals, and the complexity of their habitat, as well as financial constrains, (Beasley et al., 2002; Sutaria, 2009) have led to the use of more suitable techniques in other areas.

Abundance estimates using mark-recapture based on photo identification methods (Kreb, 2008; Sutaria and Marsh, 2011; Beasley et al., 2013; Minton et al., 2013; Shu Woan et al., 2013), have shown that regardless of their cryptic nature, individuals of these populations hold distinctive marks in their dorsal fins (e.g. scars, notches) and are accessible using small and mostly low-cost fishing boats. It is worth to mention that this method has been proven to be feasible for *O. heinsohni* in the northern coast of Australia (Parra and Corkeron, 2001).

Population size seems to vary according to area, without evident differences between coastal and freshwater ecosystems. The biggest population of *Orcaella brevirostris* is found in Sundarban's mangrove forest, Bangladesh (Smith et al., 2006), in an area that includes 175,600 ha of a complex swamped location surrounded by three wildlife reserves. The Songkhla Lake, which is restricted to the upper area of the lake, may be the smallest population (Beasley et al., 2002). Its number could not be determined due to low sighting rate, and because of this, it has been listed as *Critically Endangered* by the IUCN (Reeves et al., 2008).

Table 2.1 Methods and results regarding population sizes of *Orcaella brevirostris* along its range of distribution.

	Population Size	Method	Reference
Freshwater populations			
Mekong River (Laos and Cambodia)	93 individuals in 2007	Mark-recapture	(Beasley et al., 2013)
Mahakam River (Indonesia)	67 to 70 individuals in 2005	Mark-recapture	(Kreb et al., 2007)
Ayeyarwady River (Myanmar)	59 to 72 individuals in 2004	Direct Counts	(Smith and Mya, 2007)
Songkhla lake (Thailand)	Undetermined (Too few sightings and high rates of mortality)	Line transects	(Beasley et al., 2002)
Chilika Lagoon (India)	107 to 109 individuals	Mark-recapture	(Sutaria and Marsh, 2011)
Coastal populations			
Malampaya Sound Palawan (Philippines)	77 individuals	Line-transects	(Smith et al., 2004)
Bay of Bengal (Bangladesh)	5383 individuals	Line-transects	(Smith et al., 2008)
Balikpapan Bay (Indonesia)	140 individuals 67 individuals	Line transects Mark-recapture	(Kreb, 2008)
Cowie Bay (Malaysia)	31 individuals	Mark-recapture	(Shu Woan et al., 2013)
Kuching Bay (Malaysia)	149 individuals 233 individuals	Line transects Mark-recapture	(Minton et al., 2013)

2.3.7 Conservation of Irrawaddy dolphins

A lack of information and the potential vulnerability of Irrawaddy dolphin's populations were highlighted in 2005 (Perrin et al., 2005). Subsequently, the Wildlife Conservation Society joined efforts with all researchers involved, and "The Action Plan for the Conservation of Freshwater Populations of Irrawaddy Dolphins" was created (Smith et al., 2007), supported by a full document on the status of all freshwater populations. Projects aiming to increase awareness among local communities and other stakeholders, as well as offering alternatives to improve the livelihood of inhabitants have been implemented in Mahakam and Mekong Rivers. The local NGO Yayasan Konservasi RASI (Conservation Foundation for the Protection of Rare Aquatic Species of Indonesia) monitors the population in the Mahakam river, and increases awareness while working in introducing alternative fishing techniques (Kreb, 2005). In Cambodia, the Ministry of Agriculture, Forestry and Fisheries adopted the "Mekong Dolphin Conservation Management Plan" as a national policy in 2005, while an Integrated Conservation Development Project (ICDP) called Dolphins for Development was successfully implemented (Beasley, 2007). WWF Cambodia continued monitoring this population between 2007 and 2010 yielding data which has increased the need for urgent management decisions (Beasley et al., 2013). In 2012, the Kratie Declaration on the Conservation of the Mekong River Irrawaddy dolphins was signed committing national authorities to the conservation of the dolphins.

Regarding coastal populations, a marine protected area has been established in the Malampaya Sound where the *Critically Endangered* population of Irrawaddy dolphins of the Philippines is found (Smith et al., 2004; Dolar, 2010). In Balikpapan Bay (Indonesia), RASI Foundation efforts include increasing awareness and involving local community, teaching them how to save dolphins entangled and still alive, and how to take samples if the animals are dead (Kreb, 2008). In Malaysia, the NGO MareCet is also working in increasing awareness in Langkawi Island, involving tour guides and involving the local community in a Cetacean Sighting Network (Ponnampalam and Jamal Hisne, 2011).

2.4. Other coastal cetaceans in Southeast Asia

Other small cetaceans typically found in Southeast Asia, such as, *Sousa chinensis* , *Neophocaena phocaenoides* and *Tursiops aduncus* share the characteristic of being distributed in areas near shore (Karczmarski et al., 2000a; Wang and Yang, 2009; Wang and Reeves, 2012). The IUCN lists them as "*Near threatened"*, "*Vulnerable"* and "*Data Deficient"*, respectively. Nonetheless, *S. chinensis* population from Taiwan Strait is *Critically Endangered*, due to a lack of conservation attempts in a highly industrialized area that is threatening their habitat (Reeves et al., 2008a).

2.4.1 Distribution and Habitat

These species are heterogeneously distributed along their range and are restricted to warm tropical waters (Jefferson et al., 2008; Culik and Wurtz, 2011). They share preferences in terms of habitat, overlapping in some of their areas of distribution, especially in Southeast Asian waters (Reeves et al., 2008; Hammond et al., 2012; Wang and Reeves, 2012). *S. chinensis* and *T. aduncus* overlap in most of their range, however, the distribution presented by the IUCN (Figure 2.2) corresponds to that one before the Australian humpback dolphin was confirmed to be a different species (Mendez et al., 2013).

The Indo-Pacific Humpback dolphins are found in waters next to rocky shores, sandy beaches and estuaries, with depths not greater than 25 m (Karczmarski et al., 2000a; Parra et al., 2004; Parra, 2006; Jefferson et al., 2012). The Indo-Pacific Finless porpoise can be found in mangrove and estuarine areas with soft bottoms and, in some cases, shows a preference for clear waters (e.g. Hong Kong) that are less than 50 m deep. However, it has also been seen in waters of the continental shelf 200 m deep (Jefferson and Hung, 2004; Wang and Reeves, 2012). The Indo-Pacific bottlenose dolphin can be found in estuarine waters, in areas with rocks or coral reefs, sandy bottoms and seagrass beds, and waters 200 m deep but always within the continental shelf (Wang and Yang, 2009; Kiszka et al., 2012).

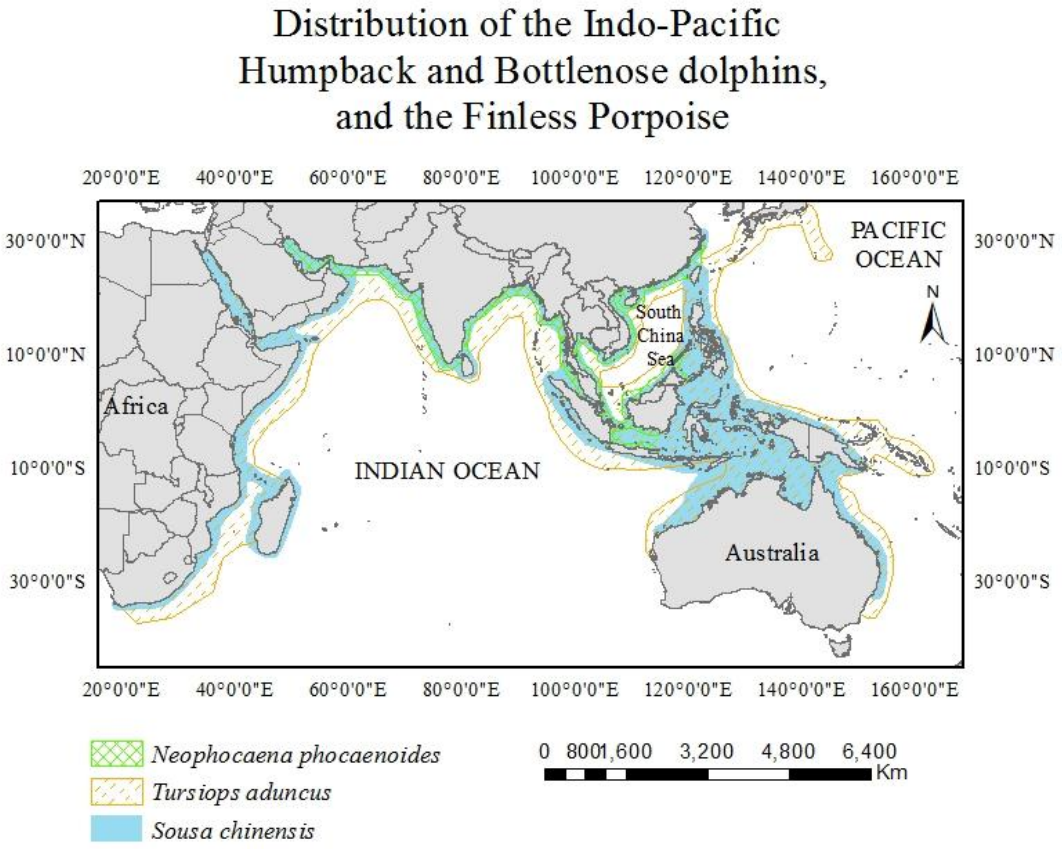

Figure 2.2. Distribution of *Sousa chinensis* (Humpback Dolphin), *Neophocaena phocaenoides* (Finless porpoise) and *Tursiops aduncus* (Bottlenose dolphin), and overlapping areas (Source: Digital Distribution Maps of The IUCN Red List of Threatened Species™).

2.4.2 Populations Size

Knowledge on population size is still limited for these three species (Table 2.2). Among all studies *T. aduncus* holds the biggest population, located in South Africa (Reisinger and Karczmarski, 2010), however, it was not possible to find information about population sizes of this species in Southeast Asia. The Pearl River estuary (China) holds the biggest population of *S. chinensis* (Chen et al., 2010) whereas the smallest one has been reported in Zanzibar (Stensland et al., 2006). There are several records of *Neophocaena phocaenoides* along its range of distribution (Jefferson and Hung, 2004; Culik and Wurtz, 2011), but the abundance for specific populations only have been estimated in Hong Kong and Sarawak (Jefferson et al., 2002; Minton et al., 2013).

Table 2.2. *Sousa chinensis*, *Neophocaena phocaenoides* and *Tursiops aduncus* populations size at locations where research has been conducted.

Location	Population size estimate	Reference
Sousa chinensis		
Pearl River Estuary (China)	2517 to 2555 individuals	(Chen et al., 2010)
Algoa Bay (South Africa)	466 individuals	(Karczmarski et al., 1999)
Leizhou Bay (China)	237 individuals	(Zhou et al., 2007)
Great Sandy Strait (Australia)	150 individuals	(Cagnazzi et al., 2011)
Cleveland Bay (Australia)	Less than 100 individuals	(Parra et al., 2006)
Taiwan Straits	<80 individuals	(Wang et al., 2012)
Xiamen (China)	67 to 93 individuals	(Chen et al., 2008)
Zanzibar (Tanzania)	58 to 65 individuals	(Stensland et al., 2006)
Neophocaena phocaenoides		
Hong Kong (China)	217 individuals	(Jefferson et al., 2002)
Sarawak (Malaysia)	135 individuals	(Minton et al., 2013)
Tursiops aduncus		
Algoa Bay (South Africa)	28482 individuals	(Reisinger and Karczmarski, 2010)
Bay of Bengal (Bangladesh)	2239 individuals	(Mansur et al., 2012)
Zanzibar (Tanzania)	136 to 179 individuals	(Stensland et al., 2006)
Amakusa-Shimoshima Island (Japan)	218 individuals	(Shirakihara et al., 2002)
Bunbury (Australia)	63 to 139 individuals	(Smith et al., 2013)
Clearance River (Australia)	71 individuals	(Fury and Harrison, 2008)
Richmond river estuary (Australia)	34 individuals	(Fury and Harrison, 2008)
Jervis Bay (Australia)	108 individuals	(Möller et al., 2002)
Port Stephens	160 individuals	(Möller et al., 2002)

2.5 The Smooth-Coated Otter *Lutrogale perspicillata* (Geoffroy St.-Hilaire, 1826)

The smooth-coated otter (*Lutrogale perspicillata*) is a mustelid (i.e. Family: Mustelidae) found all over Southeast Asia, and from the south of China to Pakistan. The IUCN lists it as vulnerable, mainly due to loss of habitat (Hwang and Larivière, 2005; Hussain et al., 2008). The species can be found in rocky shores, mangrove areas, sandy banks, rice fields, and the surroundings of rivers, canals, lakes and fish ponds (Foster-Turley, 1992; Hussain and Choudhury, 1997; Ali et al., 2010).

Population estimates were not found, but observations show that in general, the species is decreasing in its range of distribution, mainly due to habitat loss and fragmentation, and pollution (Sivasothi and Burhanuddin, 1994; Hussain et al., 2008; Ali et al., 2010; Acharya and Lamsal, 2011).

2.6 Threats for coastal aquatic mammals in Southeast Asia

Globally, fishing, tourism, shipping, coastal development and pollution are some of the human activities threatening small cetaceans with restricted coastal habitats (Reeves et al., 2003; Parra, 2006; Wang et al., 2007; Dawson et al., 2008; Jefferson et al., 2008).

There are only two species of small cetaceans listed by the IUCN as *Critically Endangered*. *Phocoena sinus*, a porpoise restricted to the north of the Gulf of California (Mexico), and the subspecies *Cephalorhynchus hectori maui*, a dolphin restricted to the west coast of the North Island (New Zealand) (D'agrosa et al., 2000; Currey et al., 2012). Their main threat is entanglement in fishing nets (Rojas-Bracho et al., 2008; Reeves et al., 2013a). In Southeast Asia small cetaceans and Dugongs are facing similar circumstances (Parsons and Wang, 1998; Perrin et al., 2005; Jaaman, 2006; Jaaman et al., 2009; Rajamani and Marsh, 2010; Minton et al., 2013). Gillnets, have been identified as one of the gears that causes higher rates of incidental catches worldwide and in Malaysia (Stensland et al., 2006; Jaaman, 2006; Reeves et al., 2013b).

Boat traffic is another threat. Indo-pacific humpback dolphins from Hong-Kong show scars caused by propellers, and some strandings have been documented to be caused by boat collisions (Parra and Ross, 2009). Similar observations have been reported for freshwater Irrawaddy dolphins (Smith et al., 2007). Kreb (2008) has observed a habitat shift in Balikpapan bay, Indonesia, where Irrawaddy dolphins have practically disappeared from the lower Bay and increased their concentration in the upper Bay, due to the disturbance caused by marine traffic. Additionally, dolphin watching can become a threat if is not managed properly, resulting in harassment of the animals and conflicts among the operators (Beasley et al., 2009).

A clear example of the impacts of coastal development on marine mammals restricted to coastal areas in Asia is seen in Hong Kong, where an increasing human population and construction of infrastructure to sustain it, is threatening the local populations of *S. chinensis* and *N. phocaenoides* and their habitat (Jefferson et al., 2009). It is known that the waters in this area are highly polluted and high concentrations of contaminants such as DDT (Tangtrongpiros, 2006), and other fluorochemicals have been found in the liver of these species, with the potential of causing inmuno-supression, deformities and reproductive dysfunctions (Reijnders et al., 2009). There is concern that new diseases are affecting the populations of *Orcaella brevirostris*, due to the environmental pollution (Van Bressen et al., 2014).

CHAPTER 3
OCCURRENCE OF AQUATIC MAMMALS IN NORTHWEST PENANG ISLAND, BASED ON LOCAL COMMUNITY INFORMATION AND OPPORTUNISTIC SIGHTINGS

3.1 Introduction

Economic activities of the coastal communities inhabiting northwest and west Penang Island are traditionally related with the use of coastal areas, either for fishing, aquaculture or tourism (Penang State Government, 1998; Ismail et al., 2002). Information on the occurrence of aquatic mammals in the waters surrounding the island has not been documented. However, the close relationship of these communities with the sea has made their traditional knowledge an important source of information regarding small cetaceans, and their patterns of occurrence, areas of distribution, and interactions with human activities such as fishing and tourism (Rajamani et al., 2014).

Local knowledge has been previously used in other locations to investigate the presence of aquatic mammals, determine potential threats such as bycatch, and to obtain socio-economical profiles, all of which are critical for marine conservation planning (Dolar et al., 2002; Jaaman, 2006; Beasley, 2007; Rajamani and Marsh, 2010). Interview surveys have been a primary method to gather general information about cetaceans, and community-based monitoring programmes have shown continuous information throughout the year on the occurrence of the animal which reflects a better understanding of the abundance in a particular area (Rajamani and Marsh, 2010).

The local communities, especially fishermen and tourist operators, have been cooperating with the Department of Fisheries, Penang, Malaysia, providing information on strandings of cetaceans in the island since 2008 (except for 2009 and 2010). The species reported include Indo-Pacific Humpback dolphins (*Sousa chinensis*), Irrawaddy dolphins (*Orcaella brevirostris*), Indo-Pacific Finless porpoises (*Neophocaena phocaenoides*), and Indo-Pacific Bottlenose dolphin

(*Tursiops aduncus*). (Mansor Bin Yobe, personal communication, October 2013). Previous research on the presence of otters such as the smooth-coated (*Lutrogale perspicillata*) have been carried out in Penang National Park (Sivasothi and Burhanuddin, 1994), but information on the occurrence and distribution of the smooth-coated otters and other aquatic mammals in the area has not been published.

After identifying the potential of the local knowledge of Penang Island local communities, a cost-effective monitoring programme was implemented between December 2012 and December 2013. In this chapter I present the results of the programme, which aimed to obtain community-based information regarding the aquatic mammals' occurrence, distribution, behaviour, deaths and interactions with boats in northwest and west Penang. Subsequently, I used the information gathered throughout the year to evaluate patterns of seasonality in the occurrence of aquatic mammals every three months. I also compared the local knowledge with opportunistic personal observations to validate the information.

3.2 Methods

3.2.1 Study Area

Penang Island (Figure 3.1) is located in west Malaysia (5°8'' N to 5°35' N and 100°08' E to 100°32' E) and covers an area of 293 km^2 (Ismail et al., 2002). The northwest and western parts of the island are rural areas where fishing is one of the main activities, although tourism is growing, especially in the north (Ismail et al., 2002). Results from previous research involving local knowledge of marine mammals (Rajamani et al., 2014), identified the fishing villages of Teluk Bahang, Sungai Pinang and Sungai Burung as important sources of information, and potential hotspots for the animals.

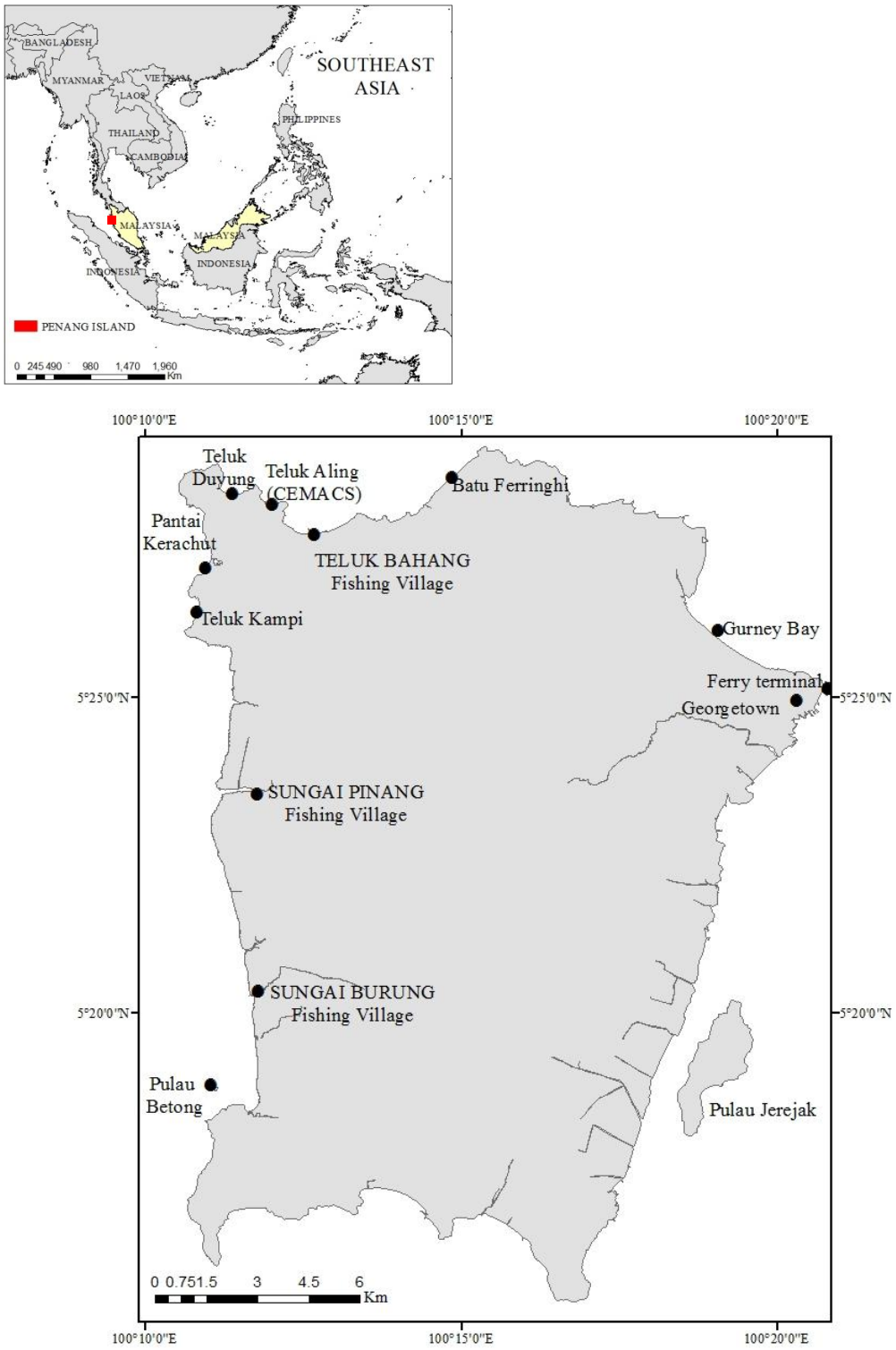

Figure 3.1. Map of study sites in Penang Island (red square), showing the fishing villages of Teluk Bahang, Sungai Pinang and Sungai Burung where interview surveys were carried out and other points of reference with potential to be aquatic mammals' hotspots in the island.

3.2.2 Interview Surveys

Between December 2012 and December 2013, structured interview surveys (Appendix A) were conducted in northwest [Teluk Bahang, Teluk Aling (CEMACS), and Teluk Duyung (Monkey beach)] and west Penang (Sungai Pinang and Sungai Burung). In December 2012 a pilot survey was carried out to determine the feasibility of conducting a monitoring programme in the designated areas. This survey allowed a first approach with the community, also learning about their schedules and availability to be interviewed, and to identify key informants.

In order to evaluate changes in the patterns of occurrence of aquatic mammals throughout the year I conducted the interviews every three months over a four main periods namely January to March, April to June, July to September, and October to December. Starting in March 2014, I visited the main jetty of each of the three fishing villages and interviewed fishermen, tourist operators and other members of the local community known to use the sea. I interviewed the same informants every time, whenever they were available. Each period (Table 3.1) included the reports from the main survey as well as from opportunistic interviews carried out throughout other months of that same period.

Table 3.1. Four periods of the monitoring programme

Period	Months (2013)
1	January – March
2	April – June
3	July - September
4	October - December

During the interview I collected information on the species of aquatic mammals sighted, and its status (i.e. stranded, floating, swimming), date, time, location, behaviour, the activity of the interviewee, and the presence of boats. To obtain information on the proximity of the animals during the encounter, the interviewees were asked to estimate the distance from their position to the animals. Due to logistics constraints between April and June of 2013 the number of interviews