Population Trend and Spatial Behaviour of Indo-Pacific Humpback Dolphins (*Sousa chinensis*) in Donsak Bay, Surat Thani Province, Thailand

Suwat Jutapruet

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Marine and Coastal Resources Management

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I hereby certify that this work has not been accepted in substance for any degree, and is not being currently submitted in candidature for any degree

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Ph.D. Candidate

ชื่อวิทยานิพนธ์ แนวโน้มประชากรและพฤติกรรมเชิงพื้นที่ของโลมาหลังโหนก (*Sousa chinensis*) ในอ่าวดอนสัก จ.สุราษฎร์ธานี ประเทศไทย

ผู้เขียน นายสุวัฒน์ จุฑาพฤทธิ์

สาขาวิชา การจัดการทรัพยากรทะเลและชายฝั่ง

ปีการศึกษา 2557

บทคัดย่อ

การศึกษาครั้งนี้ดำเนินการตรวจสอบจำนวนประชากร การกระจายตัว ลักษณะแหล่งที่อยู่อาศัย และพฤติกรรมเชิงพื้นที่ของโลมาหลังโหนก รวมไปถึงการสอบถามการพบเห็นและทัศนคติต่อโลมาในพื้นที่ของชุมชนชาวประมงในพื้นที่ในอำเภอขนอม จังหวัดนครศรีธรรมราช และอำเภอดอนสัก จังหวัดสุราษฎร์ธานี การประมาณจำนวนประชากรโลมาหลังโหนกด้วยข้อมูลจากการจำแนกครีบหลังของโลมาด้วย แบบจำลอง POPAN บนซอฟต์แวร์ MARK ซึ่งได้จำนวนประชากรโลมาหลังโหนกแบบไม่แบ่งโครงสร้างอายุอยู่ที่ 162 (95% CI. 152 – 178) และแบบแบ่งโครงสร้างอายุที่ 193 (167–249, 95% CI) โดยแบ่งเป็น ทารก 36 (34 – 44) ตัว วัยรุ่น58 (48 – 77) ตัว วัยระหว่างวัยรุ่นและตัวเต็มวัย 40 (35 – 52) ตัว และ ตัวเต็มวัย 59 (51 – 75) ตัว อย่างไรก็ตาม จากเส้นแนวโน้มของจำนวนประชากรที่ถูกพบยังเพิ่มสูงขึ้นและยังไม่คงที่

จากการวิเคราะห์ลักษณะแหล่งที่อยู่อาศัยด้วย Principal Component Analysis และ Discriminant Analysis ของข้อมูลปัจจัยทางสิ่งแวดล้อมอันได้แก่ ค่าระยะห่างจากฝั่ง ค่า pH ความโปร่งแสง อุณหภูมิผิวน้ำทะเล ความลึก ความเข้มแสงแดด ร้อยละของการปกคลุ่มของเมฆ การขึ้นลงของน้ำ ฝน ความแรงของลม ระดับความแรงของคลื่นผิวน้ำทะเล ชี้ให้เห็นว่า โลมาตัวเต็มวัยมีแนวโน้มที่จะพบในที่ลึกและใสกว่าโลมาในกลุ่มอายุอื่นๆ นอกจากนั้นระยะห่างจากชายฝั่ง ความลึกและความขุ่นใส เป็นปัจจัยทางกายภาพของแหล่งที่อยู่อาศัยทางทะเลของโลมาหลังโหนกในพื้นที่ศึกษาอย่างมีนัยสำคัญ สถานที่พบ ลักษณะแหล่งที่อยู่อาศัย ฤดูกาล ความใกล้ไกลจากพื้นที่ชายฝั่งเทียบกับเกาะนอกชายฝั่ง สามารถจัดกลุ่มของข้อมูลได้อย่างชัดเจน สามารถแสดงคุณลักษณะเฉพาะลักษณะทางกายภาพของแหล่งที่อยู่อาศัยของโลมาหลังโหนกได้ แต่ไม่สามารถจำแนกคุณลักษณะเฉพาะของปัจจัยทางกายภาพต่อการแสดงพฤติกรรมต่างๆของโลมาหลังโหนกได้ การแสดงพฤติกรรมในพื้นที่ได้แก่ การหาอาหาร การเลี้ยงลูก การเล่นและการเข้าสังคมของโลมาในพื้นที่สำรวจสามารถพบเห็นได้บ่อยครั้งในบริเวณ รอบเกาะเชือก ท่าเรือสมเสริม ท่าเรือ

ราชา ในอำเภอดอนสัก จังหวัดสุราษฎร์ธานี และอ่าวเตล็ด อำเภอขนอม จังหวัดนครศรีธรรมราช ยกเว้นพฤติกรรมการเดินทาง ซึ่งจะห่างจากบริเวณดังกล่าวประมาณ 1 กิโลเมตร

ข้อมูลจากการสัมภาษณ์ชาวประมงแสดงให้เห็นความเป็นไปได้ของพื้นที่ในการพบเห็นโลมาที่กว้างกว่า และสามารถตรวจสอบเวลาที่สามารถพบเห็นได้ทั้งในขณะที่ทำการประมง และในขณะที่พานักท่องเที่ยวชมโลมา เป็นข้อมูลที่ใช้สนับสนุนการทวนสอบจากการสำรวจและสามารถนำไปใช้ประโยชน์ในเชิงการบริหารจัดการพื้นที่เชิงอนุรักษ์ได้เป็นอย่างดี

งานวิจัยชิ้นนี้เป็นแหล่งข้อมูลพื้นฐานที่สำคัญบางประการในการทำความเข้าใจเกี่ยวกับจำนวนประชากร แหล่งที่อยู่อาศัย พฤติกรรมบางประการของโลมาหลังโหนก รวมไปถึงบริบททางสังคมอื่นๆ ที่เกี่ยวข้องในพื้นที่ เช่น ภัยคุกคาม การท่องเที่ยวชมโลมา การทำการประมงชายฝั่งขนาดเล็ก การคมนาคมขนส่งทางทะเล อันสามารถสะท้อนภาพรวมในการหาแนวทางในการอนุรักษ์โลมาหลังโหนกในพื้นที่ศึกษาได้ การค้นพบข้อมูลที่สำคัญในครั้งนี้ จะช่วยสนับสนุนการตัดสินใจให้กับผู้มีส่วนเกี่ยวข้อง อันเป็นประโยชน์ในการวางแผนการอนุรักษ์โลมาหลังโหนกในพื้นที่ศึกษาอย่างยั่งยืนและมีบูรณาการต่อไปในอนาคต

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Author	Mr.Suwat Jutapruet
Major Program	Marine and Coastal Resources Management
Academic Year	2014

ABSTRACT

The aim of this study was to determine the population size, distribution, habitat characteristics and spatial behaviour of Indo-Pacific humpback dolphins (*Sousa chinensis*), including the experiences and attitudes of the fishing community in the area of Khanom, Nakhon Si Thammarat, and Donsak District, Surat Thani Province. Estimation of the population size was based on photo–ID recorded by using the POPAN model on MARK software. The population size of the humpback dolphins off Donsak shore was estimated without age category parameter to 162 (95% CI. 152 - 178) and with age category parameter to 193 (167-249, 95% CI), which are 36(34 - 44) unspotted calves (UC), 58 (48 - 77) spotted juveniles (SJ), 40 (35 - 52) spotted adults (SA), and 59 (51 - 75) unspotted adults (UA). The trend line of the cumulative newly identified individuals was found to increase and was not constant. It is possible that some of the dolphins present in the area have not yet been identified for the purposes of this study.

Analysis of the physical characteristics (distance off the shore, pH level, water transparency, sea surface temperature, water depth, sun light, % cloud cover, tide, rain, wind power, Beaufort sea state) of habitats with Principal Component Analysis and Discriminant Analysis indicated that UA dolphins tend to be found in deeper and clearer water than dolphins in other age categories. In addition, the distance off the shore, water depth and water transparency are significant parameters for the dolphin habitat in the study area. Location, habitat characteristics, season, in/off shore areas can group data clearly but there is no difference in physical parameters due to Indo-Pacific humpback dolphin behaviours. The surrounding areas of Chuek Island, Som Serm and Raja Ferries, Donsak District, Surat Thani Province and Ta Led Bay, Khanom District, Nakhon Si

Thammarat Province were frequently found to contain dolphins with hunting, nursing, playing and socializing behaviours. However, travelling behaviours were found further into the sea around 1 km.

Data from interviews with fishermen indicated the possibility of widening the space of the survey area. The fishing and dolphin watching tour period data were interviewed on any dolphin encounter. The interview data was used to support the verification of the survey and could be utilized in the management of future conservation areas as well.

This research is a source of important fundamental information for understanding the population size, habitats and aspects of Indo-Pacific humpback dolphin behaviors, as well as other social contexts. Information contained in this research is relevant in areas such as threats, dolphin-watching tourism, fisheries, small-scale fishing and transportation. It will aid in constructive reflection on ways to protect the Indo-Pacific humpback dolphins in the study area. The discovery of this important information will contribute to the decisions of stakeholders in marine planning and policy-making. It will be useful for sustainable Indo-Pacific humpback dolphin conservation planning in the future.

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Suwat Jutapruet

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LIST OF ABBREVIATIONS AND SYMBOLS

m = Meter

km = Kilometer

nm = Nautical mile

°C = Degree celcious

DS = Distance off the shore

WD = Water depth

SC = Secchi disc (Water transparency)

WT = Water temperature

TD = Tidal

CC = Cloud cover

WP = Wind power

SL = Sunlight

RN = Rain

BF = Beaufort sea state

GIS = Geographic Information System

GPS = Global Positioning System

UC = Unspotted calves

SJ = Spotted juveniles

SA = Spotted adults

UA = Unspotted adults

MCRC = Marine and Coastal Resources Research Center

DMCR = Department of Marine and Coastal Resources

IUCN =International Union for Conservation of Nature

CHAPTER 1

Introduction

1.1 Background and Rational

Investigations of the distribution, abundance and habitat characteristics of cetacean populations provides baselines for assessing population status (IUCN 2001), extent of occurrences (Hung and Jefferson 2004; Rayment *et al*., 2009; Frère *et al*., 2010) and distribution tendency (Parra 2006; Panigada *et al*., 2008; Anadón *et al*., 2009; Smith *et al*., 2009; Embling *et al*., 2010). These are essential for sound conservation management (IUCN, 2001; Whitehead *et al*., 2004; Compton *et al*., 2008; Huntington 2009; Jefferson *et al*., 2009; Dolman and Simmonds 2010; Wade *et al*., 2010)

Without basic data about these attributes, necessary conservation actions may not be properly identified, developed, or implemented, resulting in insufficient mitigation of threats to populations and habitats (Thompson *et al*., 2000; Williams *et al*., 2006; Compton *et al*., 2008; Jefferson *et al*., 2009; Thompson *et al*., 2010; Huang *et al*., 2012). These data are sparse in developing countries, including those in Southeast Asia, where rapid economic development in recent decades and large human populations along the coast have a high potential to affect the environment (Makinnon *et al*., 2012).

The Indo–Pacific humpback dolphin (*Sousa chinensis* Osbeck, 1765) is widely distributed in the coastal waters of the western Indian Ocean to the western Pacific Ocean (Stensland *et al*., 2006; Zhou *et al*., 2007; Chen *et al*., 2008; Reeves *et al*., 2008; Chen *et al*., 2011). Though the species is widely distributed, population abundance estimates are limited across most of its distribution (Jefferson and Karczmarski, 2001; Reeves *et al*., 2008). In Southeast Asia, including Thailand, investigation and information on the distribution and abundance of humpback dolphins has been sparse. This area is considered an important habitat of humpback dolphins (Reeves *et al*., 2008).

The Department of Marine and Coastal Resources (DMCR), Thailand observes the cetacean from both sides of southern Thailand with techniques including fishermen interviews, photo-identification, boat-based observation, stranded cetacean data, acoustic surveying and aerial observation. At least 27 different species have been reported between the Andaman seaside and the Gulf of Thailand. The cetacean populations found in these regions showed both migratory and non-migratory behaviours.

Indo-Pacific humpback dolphins were found frequently in the middle part of the Gulf of Thailand, between Donsak District, Surat Thani Province and Khanom District, Nakhon Si Thammarat Province. The habitats of the Indo-Pacific humpback dolphin in Thailand include rocky shores, estuaries, sandy beaches, mangroves, sea-grass beds, and mudflats that alternate with fabricated structures, ferry piers, factories, residential communities, resorts and hotels along the shoreline. Indo-Pacific humpback dolphins were found in this area frequently (Jaroensutasinee *et al*. 2010). Human interaction with dolphins, including fishing gear, ferries and dolphin-watching tours, creates potential water pollution and habitat degradation. Dolphins support local tourism activities and are familiar with fishermen communities within the study area. It is important to study these species for baseline information on the benefits of marine policies, planning, management, and future conservation.

This study aims to analyze the population size and habitat characteristics of Indo-Pacific humpback dolphins. Boat-based photo-identification surveys, measurements, environmental observations and interviews with local fishermen will assist in providing more accurate estimates. The Indo-Pacific humpback dolphin data set will be calculated with a population estimation model and statistical analysis. The relationship between habitat use and physical parameters will explain baseline information for the humpback dolphin. The interviewing of fishermen, along with other observational methods, will provide more accurate data for the purpose of accessing dolphin habitats.

1.2 Objectives

1.2.1 To study the population size of Indo-Pacific humpback dolphins in the study area

1.2.2 To study the habitat characteristics of individual Indo-Pacific humpback dolphin age classes

1.2.3 To study the behaviours and distribution of Indo-Pacific humpback dolphins

1.2.4 To study the attitudes of fishermen due to dolphin presence in the study area and compare them with dolphin encounter data from the survey

1.2.5 To enhance the management plan and define the marine protected area for dolphin conservation in the study area

1.3 Review of Literature

Twenty seven species of whales and dolphins are found in Thailand, 19 species in the Andaman Sea and 17 species in the Gulf of Thailand (Chantrapornsyl *et al*., 1996; Department of Marine and Coastal Resources, 2004). The differences between whales and dolphin include body length and teeth shape. The common species along the coast of both sides of southern Thailand are the Irrawaddy dolphin (*Orcaella Brevirostris* Gray, 1866), Indo-Pacific humpback dolphin (*Sousa Chinensis*), Finless porpoise (*Neophocaena* phocaenoides G. Cuvier, 1829) and Bottlenose dolphin (*Tursiops truncatus*) (DMCR, 2004).

Several studies of endangered dolphins and whales in Thailand have been carried out by aerial observation and boat based observation for species list, population size, distribution and general biology. Furthermore, the dolphin carcasses necropsy (Sirimontaporn and Sritakol, 1995; Chantrapornsyl *et al*., 1996; Thongsukdee *et al*., 2005; 2008), DNA and genetic analysis (Limsantisin *et al*., 2008) were investigated in Thailand.

1.3.1 Indo-Pacific Humpback Dolphin biology

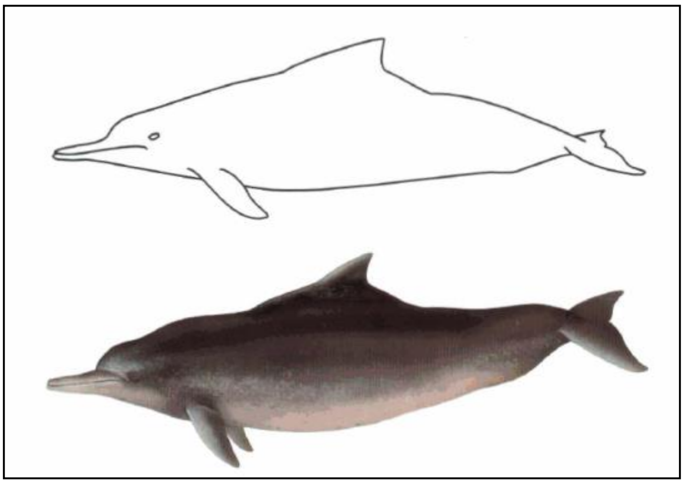


Figure 1 Indo-Pacific humpback dolphin (*Sousa chinensis* Osbeck, 1765)

Size:	3.2 m body length in male, 2.8 m in female, 1 m in newborn.
Figure:	Round head and long rostrum, dorsal base length one third of overall body length (Figure 1)
Colour:	Dark gray skin colour in calves and juveniles, which changes to white or pink upon maturity
Teeth:	58 -76 teeth on upper and lower jaw
Dorsal fin:	Short and small dorsal fin based on a larger dorsal hump
Behaviours:	10-30 individuals schooling and swimming slowly near the shore
Diving and Breathing:	cannot dive for long periods, with surface breathing every 40-60 seconds
Habitat:	< 2 km near the shores of estuaries, mangroves and coastlines in tropical climate zones, distributed in the South China Sea, Indonesia, Australia, Indian Ocean and southern Africa (figure 2).
Food:	Coastal fish and coral reef fish
Reproductivity:	Breeding all year round and birthing in the summer season
Threaten status:	Caught for food in the Indian Ocean, by-catch from shark protected nets in Australia, habitat degradation will affect the population size.

1.3.2 Photo-identification of Indo-Pacific Humpback Dolphins

Photo-identification studies enhance the description of cetacean life history that can be conducted from the shore and boat with cameras and 50-300 mm zoom lenses (Würsig and Jefferson 1990). The photographically identified examples of Indo-Pacific humpback dolphin studies were abundance and distribution (Chen et al 2008), distribution and group dynamics (Chen et al 2011), long-term photo-identification for status reviewing (Jefferson and Hung 2004), behaviours (Karczmarski et al 1997), habitat use and preferences (Karczmarski 2000), life history (Jefferson et al 2012) etc. The major distinctive features of small cetaceans were used to identify individuals (Würsig and Jefferson 1990). Indo-Pacific humpback dolphins were identified by the scars on their flanks, backs and dorsal fins (Saayman and Tayler 1973, Saayman and Tayler 1979). Other distinctive features were marks, pigment patterns, and speckling characteristics, which can be used to enhance identification of individual humpback dolphins (Chen et al 2011). Furthermore, age class categorization of Indo-Pacific humpback dolphins were grouped by the distinctive characteristic on the humpback dolphin's dorsal fin (Wenshi et al 2006).

1.3.3 Indo-Pacific Humpback Dolphin, Age Classes and Skin Colour Patterns (Jefferson *et al.,* 2012)

The pigmentation development of Indo-Pacific humpback dolphin skin appears to be different in each age class with an average age of 40-45 years. The colour pattern changes from unspotted dark gray on calves to spotted white on adults. The changing of colour and pigmentation loss were used to categorize the age class of Indo-Pacific humpback dolphins. A calf's skin colour is dark gray and unspotted with a lighter belly. A newborn's body length averages 1 meter and pair swims with an adult at all times. A juvenile's skin colour is lighter than a newborn, with white spots spread on their skin and an average body length of 2 meters. This age class can swim solitary but they appear to swim in groups during social activities. The sub-adults or younger adults have a partial white on light gray coloured skin with white spots, while the older Indo-Pacific humpback dolphin or adult dolphin has gray spots on grounded white skin. However, skin colour patterns are in many forms (Table 1, Figure 2) and any age class categorization depended on the study area (Jefferson, 2000; Wenshi *et al*., 2007; Jefferson *et al*., 2012).

Table 1 An example of age class and skin colour pigmentation categorization (Figure 4) (Wenshi *et al*., 2007)

Age Class	Characteristics
Unspotted calve (UC)	Very young dolphins with smooth gray skin colour, body length less than 150 cm, observed to be paired with adults
Spotted juvenile (SJ)	Individuals with white spots on gray skin colour and some nicks on the dorsal fin, body length longer than 150 cm
Spotted adult (SA)	Dolphins with less than 50% white colour on gray skin colour, starting white from the tip of the dorsal fin
Unspotted adult (UA)	Dolphins with more than 50% almost white or pink body skin colour with small gray spots.

Figure 2 The four age classes of the Indo-Pacific humpback dolphin, discriminated by body colour pattern and approximate body length: Unspotted Calves (UC), Spotted Juveniles (SJ), Spotted Adults (SA) and Unspotted Adults (UA)

1.3.4 Indo-Pacific Humpback Dolphin Population Size

Abundance and population size of Indo-Pacific humpback dolphins were studied in areas such as Richards Bay, South Africa (Durham, 1994; Atkins and Atkins, 2002), Moreton Bay, Australia (Parra *et al.*, 2004), Xiamen, China (Chen *et al.*, 2008), Leizhou Bay, China (Zhou *et al.*, 2007), Khanom, Thailand, (Jaroensutasinee *et al.*, 2010), etc. Almost all of the studies reported small populations per study area, except the Pearl River Estuary (PRE) and adjacent area in China (Jefferson, 2000), which offered the largest population size. Table 2 shows the global ranking of Indo-Pacific humpback dolphin populations.

Table 2 Known size and population estimates for Indo-Pacific humpback dolphins (Huang, and Karczmarski, 2014 and Jaroensutasinee *et al*., 2010)

	Populations	Areas	N	Source
1.	Pearl River Estuary (PRE)	China	2552	Chen *et al*. (2010)
2.	Hong Kong + adjacent area	China	1028	Jefferson (2000)
3.	Goa Bay	India	842	Sutaria and Jefferson (2004)
4.	Algoa Bay	South Africa	466	Karczmarski *et al*. (1999); Karczmarski (2000)
5.	Leizhou Bay	China	237	Zhou *et al*. (2007)
6.	Gulf of Kachch	India	174	Sutaria and Jefferson (2004)
7.	Richards Bay	South Africa	166	Durham (1994)
			170	Atkins and Atkins (2002)
8.	Moreton Bay	Australia	163	Parra *et al*. (2004)
9.	Great Sandy Strait	Australia	150	Cagnazzi *et al*. (2011)
10.	Moreton Bay	Australia	119	Corkeron *et al*. (1997)
11.	Dafengjiang River	China	114	Chen *et al*. (2009)
12.	Maputo Bay	Mozambique	105	Guissamulo and Cockcroft (2004)
13.	Eastern Taiwan Strait	Taiwan	99	Wang *et al*. (2007);
			85	Yu *et al*. (2010)
14.	Xiamen	China	86	Chen *et al*. (2008)
15.	Xiamen	China	76	Chen *et al*. (2009)
16.	Zanzibar (south coast)	East Africa	63	Stensland *et al*. (2006)
17.	Cleveland Bay	Australia	54	Parra *et al*. (2006)
18.	Khanom	Thailand	49	Jaroensutasinee *et al*. (2010)
19.	Hepu	China	39	Chen *et al*. (2009)

The declining dolphin population was studied with population trend analysis in PRE, China (Huang *et al.*, 2012). Stranded cetaceans were recorded into a life-table using data estimated by demographic analysis of Indo-Pacific humpback dolphin (*Sousa chinensis*) populations. The PRE Indo-Pacific humpback dolphin is the largest population facing a major risk of decline due to industrial development. The IUCN criteria suggested endangerment in A3. A declining population indicated an individually based Leslie-Matrix model. Except for PRE, China is the biggest country in Asia with a fragmented sub-population along its shores. Industrial initiatives are growing throughout the country, which are decreasing the population of the Indo-Pacific humpback dolphin. One of the factors helping to increase the population of the species is the Chinese government's conservation plans and policies.

1.3.5 Habitat Characteristics of Indo-Pacific Humpback Dolphins

Though specific habitat preferences may vary among populations, corresponding to varying coastal environments (Jefferson and Karczmarski, 2001; Parra and Jedensjö, 2009; Ross *et al*., 2010), humpback dolphins are typically found in shallow and coastal waters up to general depths of 20 m (Karczmarski *et al*., 2000; Jefferson and Karczmarski, 2001; Jaroensutasinee *et al*., 2010). There are no obvious preferences for clear and turbid water (Karczmarski *et al*., 2000). Indo-Pacific humpback dolphin habitats were rocky reefs, coves, sandy shores, and man-made reefs near the coast (Karczmarski *et al*., 2000; Chen *et al*., 2011).

1.3.6 Behaviours, Habitat Utilization and Distribution of Indo-Pacific Humpback Dolphins

1.3.6.1. Indo-Pacific Humpback Dolphin Behaviours

The behavioural study for the humpback dolphin was conducted in many patterns, such as physical body movements with behaviours, interaction with motivators, foraging behaviour and interaction to boat types. Humpback dolphin behaviour was observed by surface behaviour monitoring. Normally, the behaviour was monitored during every time period. However, fatigue of observers sometimes occurred after 60 minutes. Thus, 30-60 minutes were spent on observation to reduce the errors and bias of behaviour monitoring. (Cancho and Lusseau, 2006). The categorization of Indo-Pacific humpback dolphin behaviours (Karczmarski *et al*., 1997; 2000) were observed on the sea surface.

Foraging/feeding: Enthusiastic swimming on the surface, often changing direction to swim fast, herding fish and catching fish with their mouth

Travelling: Groups of dolphins swimming in the same direction, surface breathing synchronized and continuous

Resting: No activities, slow movement, very slow surface breathing, swimming speed less than 2 nm/hr.

Playing: Many activities, including flipping their flippers over the sea surface, leaping, fast movement and frequently changing direction

Courtship and mating: Upside down and circulatory swimming in many positions (Figure 3)

Allomaternal alliances/nursing: Adult and calf dolphins always swimming paired

Boat Avoidance: The humpback dolphins swim in the opposite direction when a ship follows them from behind (Karczmarski *et al*., 1997) (Figure 4)

Interactions with other species: Grouping with bottlenose dolphins and swimming in the same group with Irrawaddy dolphins in Thailand, Figure 5 (Adulayanukosol, unpublished data)

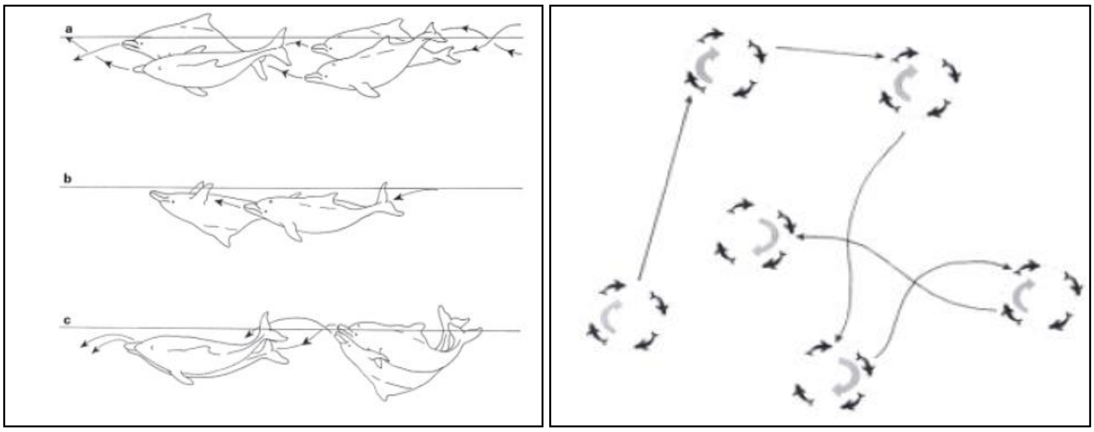


Figure 3 The courtship and mating behaviour of Indo-Pacific humpback dolphins (Karczmarski *et al*., 1997)

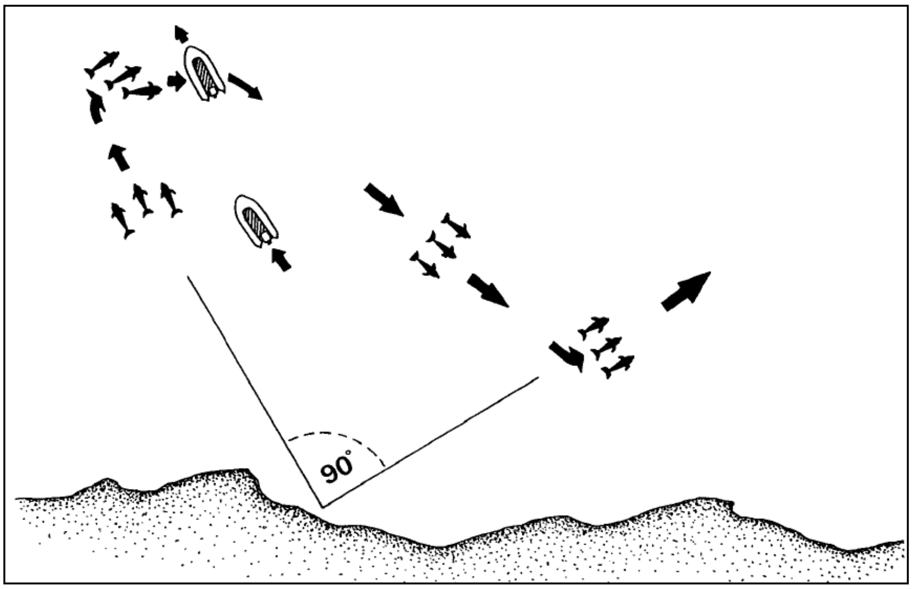


Figure 4 The avoidance behaviour of Indo-Pacific humpback dolphins (Karczmarski *et al*., 1997)

Figure 5 Interaction between Indo-Pacific humpback dolphins and Irrawaddy dolphins in the Gulf of Thailand (MCRC, Upper Gulf of Thailand, unpublished data)

1.3.6.2. Indo-Pacific Humpback Dolphin (*Sousa chinensis*) Habitat Utilization and Distribution

Habitat utilization of the Indo-Pacific humpback dolphin was studied along with the Australian snubfin dolphin (Parra, 2006). The shared resources from the two species were analyzed with 50% kernel range as core area and 95% kernel range as 95% representative range.

Two dolphin species can live in the same area with different factors such as behaviour and environmental conditions of variable strength and magnitude (Parra, 2006).

The location and range of the Indo-Pacific humpback dolphins studied defines the effective marine protected area for conservation (Chen *et al*., 2011). Line transects and locations of the dolphins were used to analyze dolphin distribution by minimum convex polygon (MCP), density or area estimation (Chen *et al.,* 2006; Wang *et al.,* 2007). Home range and distribution of the Indo-Pacific humpback dolphin studied can create the core habitat area for effective conservation.

Because the Indo-Pacific humpback dolphins are spread along the Southeast Asian shore (including Northern Australia), the dolphin populations in Southeast Asia separated during the last glacial age with multiple north–south migrations across the Sahul Shelf area of northern Australia. There are different mitochondrial DNA evolutions in these species (Lin *et al.,* 2010)

There are three species of Indo-Pacific humpback dolphin throughout the world. Firstly, *Sousa plumbea* is distributed along the coast between eastern South Africa to eastern India and Sri Lanka. *Sousa chinensis* is distributed along the coast of South-east Asian countries and a new, un-named species exists in northern Australia (Perrin, 2014) (Figure 6).

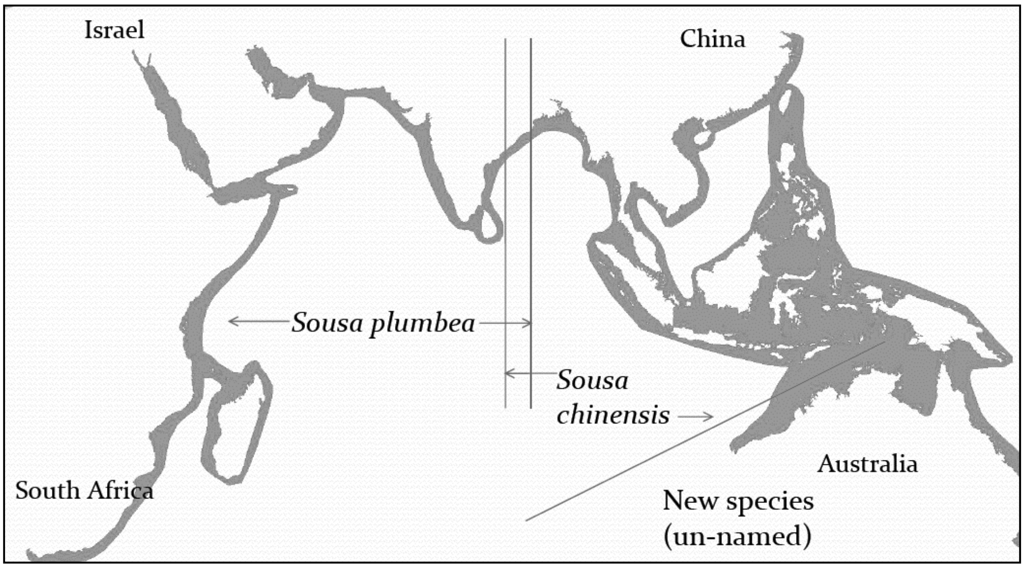


Figure 6 Indo-Pacific humpback dolphin distributions (Perrin, 2014)

1.3.7 The Relationship Between Fishermen and Dolphins

Many studies have reported that some dolphin species interact with humans. One example is the cooperative fishing between fishermen and Irrawaddy dolphins in the Ayeyarwady River (Figure 7) (Smith *et al*., 2009). The bottlenose dolphin herding fish into fishing nets in Santa Catarina and Barra de Imbe/Tramandai, southern Brazil (Pryor *et al*., 1990; Peterson *et al*., 2008; Zappes *et al*., 2011) and dolphin tourism in Florida, USA are other examples (Samuels and Bejder, 2004). Furthermore, Indo-Pacific humpback dolphins interact with fisheries and respond to dolphin watching boats in Khanom District, Nakhon Si Thammarat Province, Thailand (Figure 8, 9).

Figure 7 Cooperative fishing between Irrawaddy dolphins and fishermen in the Ayeyarwady River, Myanmar (Smith *et al*., 2009)

Figure 8 Dolphin watching tour in Khanom District, Nakhon Si Thammarat Province

Figure 9 Interaction between fishermen and Indo-Pacific humpback dolphins

Previous studies presented a very small humpback dolphin population (49 dolphins with no 95% CI) in Khanom Sea, Nakhon Si Thammarat Province (Jaroensutasinee *et al.*, 2010). The waters off Donsak comprise small islands, rocky cliffs, sandy beaches, rocky shores and mangroves, along with anthropogenic coastal development including human communities, ferry-piers, resorts/hotels and factories in the north of overlapped adjacent Khanom District, Nakhon Si

Thamarat Province. The Marine and Coastal Resources Research Centre found a humpback dolphin habitat along the shore and offshore islands in Donsak District, Surat Thani Province (Personal connection). The south of the adjacent area is Khanom District, Nakhon Si Thammarat Province, where there is the wild dolphin watching tour in Ta Rai Island and Taled Bay.

Dolphin watching tourism, originally developed in Khanom District, has been extended to the waters off Donsak since 2007, in Kwaeng Pao Bay and Laem Prathub Village, Khanom District, Nakhon Si Thammarat and Nang Gum Bay, Donsak District, Surat Thani Province. The dolphin tourism became more popular in 2011 until the present time (April 2014). Three species were found in the dolphin watching program, including the Indo-Pacific humpback dolphin (*Sousa chinensis*), Irrawaddy dolphin (*Orcaella brevirostris*) and Finless porpoises (*Neophocaena phocaenoides*). Dolphin watching tourism in the 3 fishing villages is not the primary source of revenue. Dolphin watching tours are a supplemental source of income when they are free from fishing, para-latex harvesting, palm and coffee harvesting etc. The fishermen use their own long-tailed boats, with 15-19 horsepower onboard engines, for dolphin watching activities. Table 3 shows the prices for three fishing villages that have dolphin-watching tours.

Table 3 The dolphin watching business in Nakhon Si Thammarat Province and Surat Thani Province (March 19-22, 2014)

Village Name	Location	Average Boat No.		Price	Major Income
		Weekday	Weekend	(baht)	
Kwaeng Pao	Kwaeng Pao Village, Khanom District, Nakhon Si Thammarat	0-5	10-15	1,200	Farming, Fishing
Laem Pra-Thub	Laem Prathub Village, Laem Prathub, Nakhon Si Thammarat	0-5	20-30	1,000	Farming,
Nang Gum	Nang Gum Bay, Donsak District, Surat Thani	0-5	0-10	800-1000	Fishing, Business Owner

Ng and Leung studied the effect of vessel traffic on Indo-Pacific humpback dolphin behaviour in 2003. Indo-Pacific humpback dolphin habitats adjust with the anthropogenic, but fast-moving vessels often cause disturbances in behaviours and social life. The impact of tourism activities on humpback dolphin behaviours (Stenland *et al.,* 2006) and the vessel traffic affects the behavioural response of the Indo-Pacific humpback dolphin. Conservation policies should be created to decrease the effects of vessel traffic and dolphin watching tourism (Ng and Leung, 2003; Stenland *et al.,* 2006).

The attitudes of the fishermen are one of the important tools for a dolphin conservation plan in the study area. The fishermen's routines relate to the dolphin habitat in the study area directly, such as fishing, dolphin watching tourism and travelling. The fishermen's personal experiences can explain information about dolphin locations, some behaviours and encounter periods. Positive attitudes by fishermen support dolphin conservation management plans and policies in the future. In contrast, conflict of interest prevention can decrease understanding of negative attitudes.

1.3.8 Indo-Pacific Humpback Dolphin Conservation and Management Plan

Conservation International, China invited marine mammal scientists and related governors from South-eastern Asian countries to join an international workshop about Planning for *Sousa Chinensis* Corridors and Protected Areas in the Southeast Asian Sea Eco-region, on January 21-23, 2014 in Xiamen, China. The workshop summarized Indo-Pacific humpback dolphin research gaps in Southeast Asia. The workshop discussed the need for each country to find opportunities to fill in the gaps in Table 4. Gap analysis can help to criticise the marine protected area for Indo-Pacific humpback dolphins in the entire Southeast Asia region.

Table 4 Overview of Indo-Pacific Humpback Dolphin Status in Southeast Asian Region, including China, Hong Kong, Taiwan, Thailand and Malaysia (Planning for *Sousa chinensis* Corridors and Protected Areas in the Southeast Asian Sea Eco-region, January 21-23, 2014, Xiamen, China)

Country	Distribution and Abundance	Critical Life & History	Associates Habitat Types	Associate Ecology Process	Threats	Management	Associate Ecology Process
China	Yangze, Xiamen, Kingmen, Laizhou, Beibu Gulf	All	All	Feed	Habitat degradation pollution	MPA Fishery	Feed
Hong Kong	Completed	Further Analysis	More data + analysis	Feed	Habitat degradation Habitat loss Pollutions Shipping	MPA Fishery restrictions	Feed
Taiwan	Southern Boundary	More data + analysis	More data + analysis	Feed	Noise Fishery Habitat degradation	Noise Regulation MPA (Ongoing)	Feed
Thailand	Fragmented	All	All	All	Pollution	Fishery regulation acts (Marine National Park, Not specific for Sousa)	All
Eastern	(Ongoing)	-	-		Fishery		
Upper	-	-	Done		Transportation		
Middle (Study site)	(Done)	-	-				
Lower	-	-	-				
Andaman	Ongoing	-	-				
Malaysia	Need Both (ongoing)	All	All	All	Fishery	MPA	All

In 2006, the Marine and Coastal Resources Research Centre (MCRC) of Thailand initiated a project aimed at collecting stranded cetacean carcasses along the coast of Thailand. Since then, approximately 10 humpback dolphin carcasses have been collected along the eastern coast of the Gulf of Thailand each year, most of which were from the Donsak and Khanom coastlines. Data on humpback dolphin abundance, distribution and habitat characteristics, however, are rare in this area. Distribution and population size of the humpback dolphins were only recently investigated in Khanom waters (Jaroensutasinee *et al*., 2010), following the rising popularity of dolphin-watching tourism on the coast of Khanom since 2007. Jaroensutasinee *et al*. (2010) estimated a small population of humpback dolphins in the Khanom Sea, with a total abundance of 49. Besides the frequent collection of stranded humpback dolphin carcasses along the Donsak coastline, the dolphins are also often observed by fishermen or coastal resource regulators in Donsak waters, which includes the waters around the small islands.

Indo-Pacific humpback dolphins were found in both sides of the Andaman Sea and the Gulf of Thailand (Figure 10). The most frequently encountered area is Khanom District, Nakhon Si Thammarat Province (Jaroensutasinee *et al.,* 2010). The area is engaged in several coastal activities, such as coastal fisheries, push net fishing and trawler fishing, ferry piers, mineral transportation piers, an electricity plant, a gas separation factory and a hotel and resort. The abundance of ecology in the study area, such as dolphin habitats, mangroves and sea grass beds, rocky shores and sandy beaches in Donsak District, Surat Thani Province and Khanom District, Nakhon Si Thammarat Province were protected by stakeholders from many organizations. The most effective include the Marine and Coastal Resources Research Centre, Marine and Coastal Conservation Centre, NGOs, Dolphin Eco-Tourism Club etc.

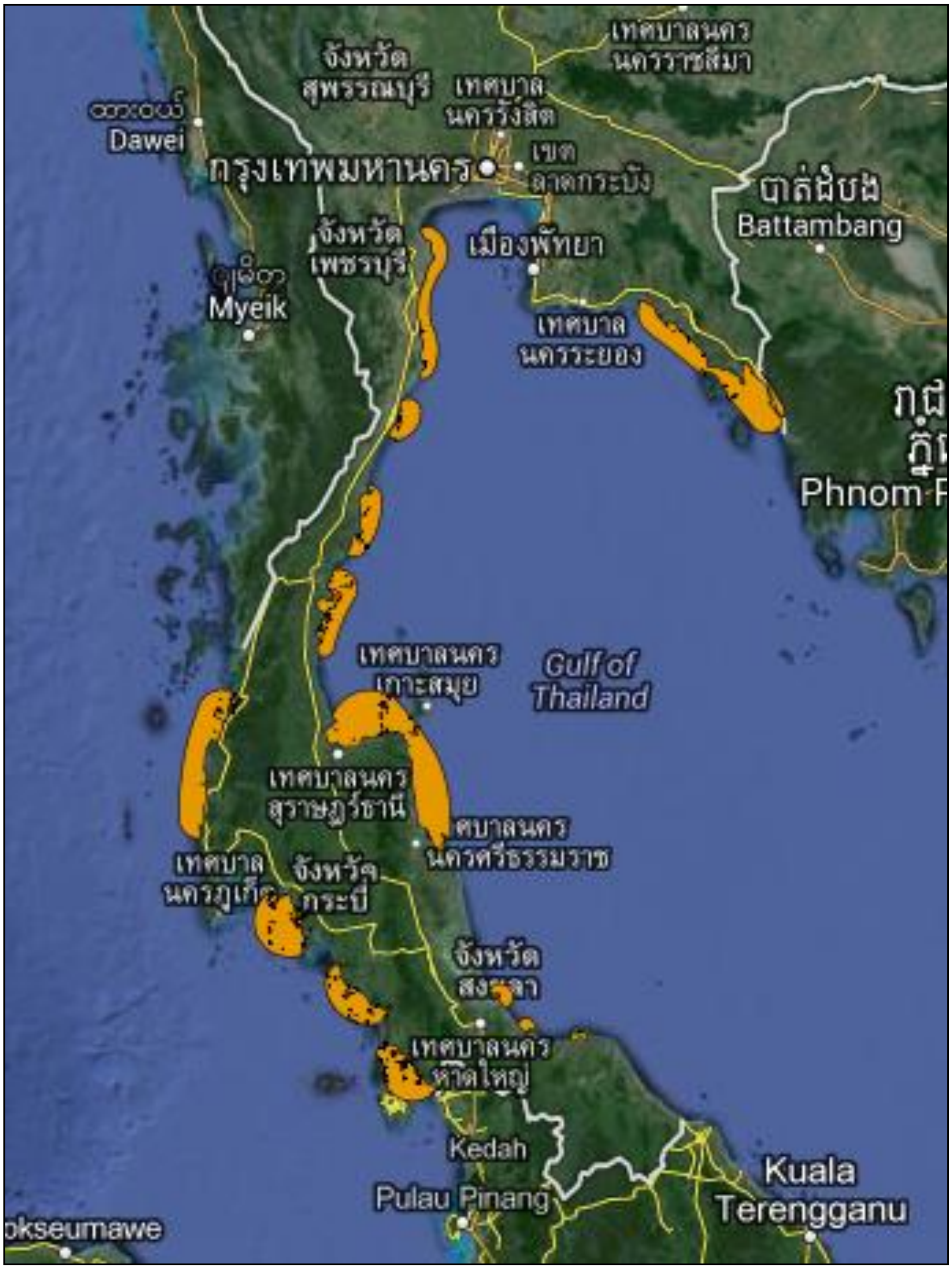


Figure 10 Indo-Pacific humpback dolphins (*Sousa chinensis*) in Thailand, (Central Database System and Data Standard for Marine and Coastal Resources, http://marinegiscenter.dmcr.go.th/gis/, Copyright @2013)

Indo-Pacific humpback dolphin threats:

From 2006-2012, the average mortality of humpback dolphins was 9±2.9 carcasses per year. The humpback dolphin carcasses were stranded along the shoreline from Prachuab Khiri Khan Province to Pattani Province Figure 11. Nevertheless, the causes of death of humpback dolphins are by-catching, illegal transfer, sickness and unidentified (NA) (Figure 12).

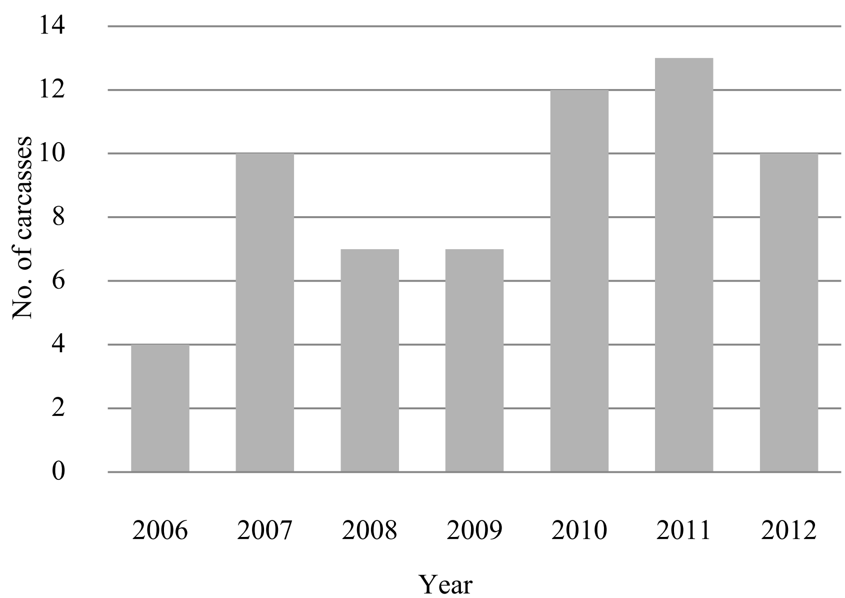


Figure 11 Indo-Pacific humpback dolphin carcasses from 2006 – 2012

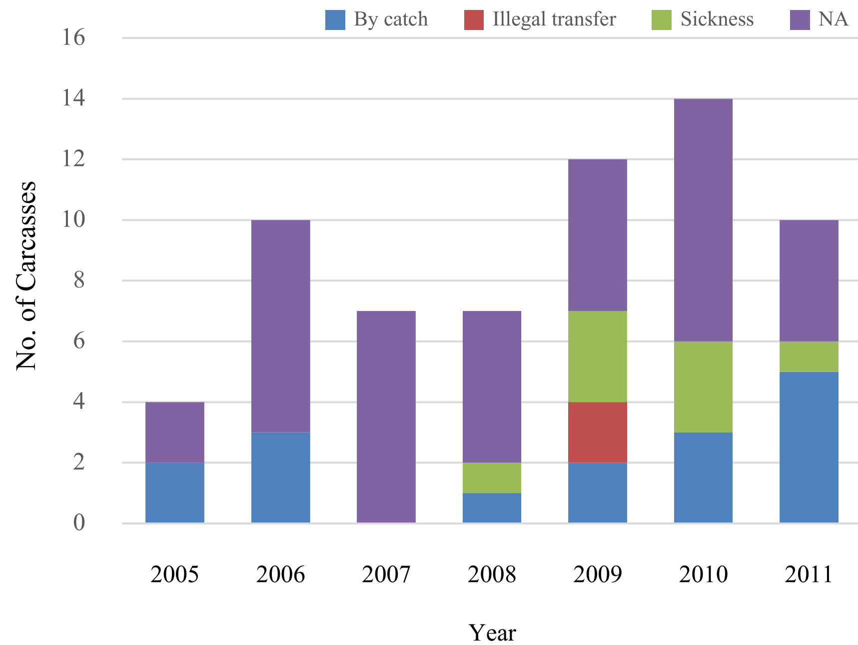


Figure 12 The cause of death of Indo-Pacific humpback dolphins from 2005-2011

MCRC Songkla and Chumporn Provinces collected stranded humpback dolphins from Prachuan Kiri Khun Province to Pattani Province (Figure 13). The most frequent strandings of humpback dolphins were in Surat Thani and Nakhon Si Thammarat Provinces (Figure 14).

Figure 13 Indo-Pacific humpback dolphin carcasses in Khanom District, Nakhon Si Thammarat Province and Donsak District, Surat Thani Province

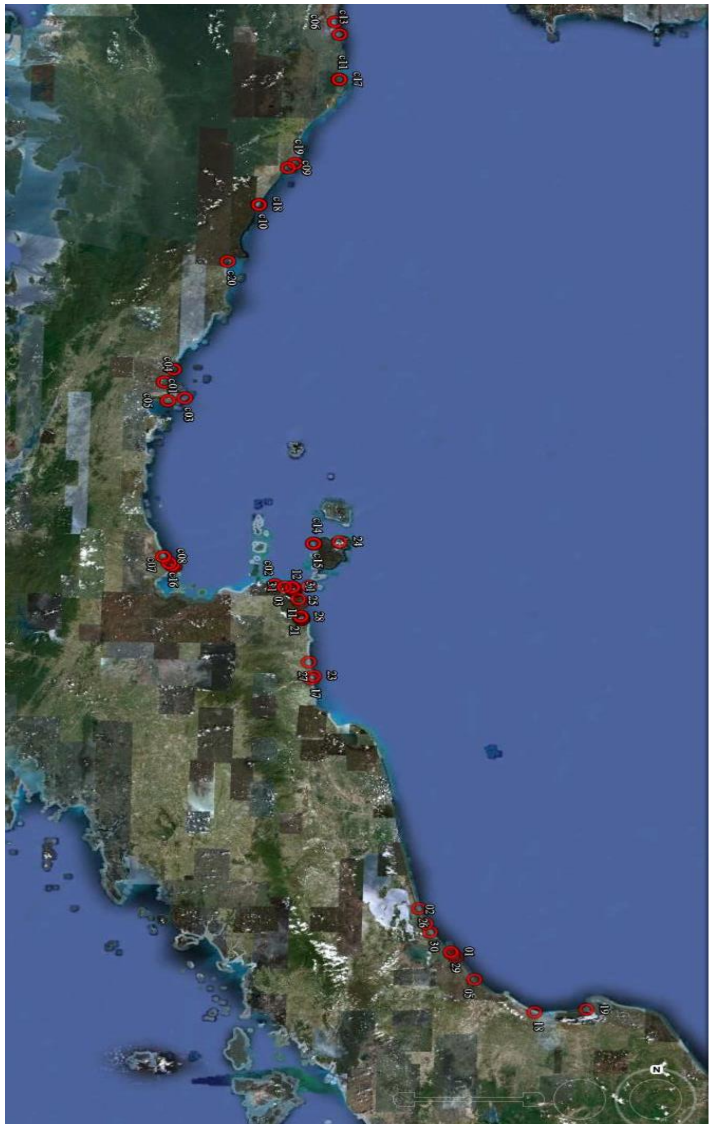


Figure 14 The red circles indicate stranded humpback dolphin carcasses on the coast of the Gulf of Thailand from Prachuab Kiri Khun to Pattani Provinces (Marine and Coastal Resources Research Centre, Chumporn and Songkla Provinces)

One of the dolphin studies concerns the contaminated water pollution from industry that affected the dolphins' health. The study of trace elements in the tissue of the Indo-Pacific humpback dolphins, conducted in Hong Kong (Parsons, 1998), investigated dolphin health. muscle tissue analysis, stemming from the dolphin's consumption of prey items containing elements including As, Cd, Co, Cr, Cu, Hg, Mo, Ni, Pb, Se and Zn. The suggestion of these studies indicated that the concentration of arsenic, chromium, lead, molybdenum and nickel in prey items were higher, resulting in dolphins mirroring these levels. Hong Kong's dolphins may have excreted said trace elements from their body, even though the anthropogenic pollutants are high in Hong Kong (Parsons, 1998).

The richness of complex ecosystems in marine and coastal resources attracts human activities along the coastline, which has caused habitat degradation of marine and coastal resources. The complicated marine and coastal resources ecosystem of Donsak District consists of small islands, mangroves, a coastal community, ferry transportation piers, resorts and hotels, manufacturing and dolphin watching tourist spots. These resources are promoted to motivate tourism activities along the coastlines of Donsak District, Surat Thani Province, where the humpback dolphins habit on the Khanom shoreline and Nakhon Si Thammarat (Jaroensutasinee *et al.*, 2010)

Although many efforts have been made to push for marine and coastal conservation policies, overexploitation is still increasing. More information is required to support the objectives of such policies. Population baseline data, including distribution, abundance and habitat characteristics are still very rare across South-east Asia, though it is supposed that this region may be one of the important habitats for humpback dolphins. Scientific research is an important topic that must include marine conservation issues (Agardy, 2000; Lundquist *et al.,* 2005). Some of the humpback dolphin conservation methods must be based on habitat qualities maintenance (Parra *et al.*, 2004). Currently, although humpback dolphins are known due to various dolphin shows/entertainment in Thailand (Oasis Sea World, Chanthaburi, Thailand) and dolphin watching tourism in Khanom District, Nakhon Si Thammarat Province, there is still a lack of understanding about the importance of marine mammals in the Thailand region. The humpback dolphin population is declining annually. The Marine and Coastal Resources Research Centre (MCRC), Central and Lower Gulf of Thailand has recorded an increase in the mortality rates of humpback dolphins during the period between 2006-

2012. In the Gulf of Thailand, the mortality rate of humpback dolphins was recorded as 24% of 62 stranded humpback dolphins as the result of fishing net entanglement. This evidence shows that there is a critical need for further humpback dolphin study in this region.

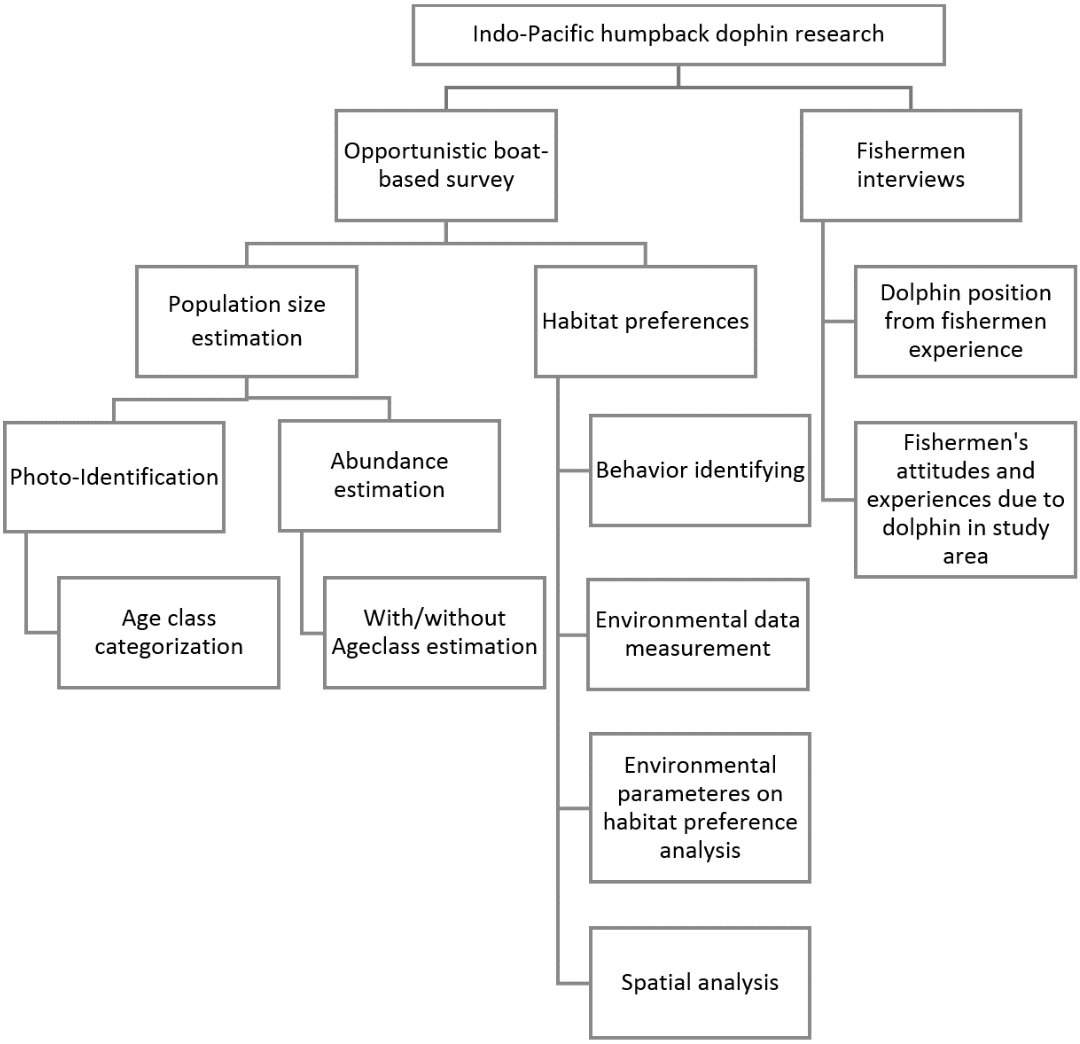
Increases in coastal human activities may have potential adverse impacts on local coastal ecosystems, including the local humpback dolphins. Given the number of potential anthropogenic threats to these dolphins, there is an urgent need for baseline data on their population abundance, distribution and habitat characteristics, in order to assess how human activities may have negative effects on them. In this study, the distribution and habitat characteristics of the humpback dolphins off Donsak were investigated and estimated. Population abundance by photo-ID records was conducted and presented the distribution tendency of the dolphins relating to age-classes, environmental parameters of habitat preferences and dolphin encountered experiences of fishermen. The baseline data from this study will provide important information for dolphin conservation planning in the area.

CHAPTER 2

Research Methodology

2.1 Materials and Methods

Conceptual Framework



2.2 Assumption

1. Some Indo-Pacific humpback dolphin populations might not be estimated in the population size in adjacent areas of Khanom waters.
2. Indo-Pacific humpback dolphins are not only distributed near the coast of mainland Khanom District, Nakhon Si Thammarat Province. There are also Indo-Pacific humpback dolphins near the coast as well as off the shore of Donsak District, Surat Thani Province.
3. The behaviours of Indo-Pacific humpback dolphins are not related to the habitat preference in the study area.
4. The spatial behaviours of Indo-Pacific humpback dolphins are spread around the study area specifically.
5. The fishermen's attitudes and experiences due to dolphin encounters can improve the dolphin conservation and management plan in Donsak District, Surat Thani Province. Fishermen were interviewed about dolphin encounters in the Donsak waters.

Limitation of Survey

Some observations might not end successfully because of weather conditions. For example, several tracking routes and directions had to be changed immediately due to severe weather conditions. Furthermore, the small long-tailed boat, which we rented from local villagers, lacked the power and constant speed necessary to conduct the surveys effectively. Sudden changes in weather conditions prevented us from conducting the survey and tracking continuously.

The fishermen were experienced and had considerable knowledge about the sea in the survey area. They brought us back to the shore whenever the weather conditions turned unfavourable for the safety of the research team. Therefore, checking the weather conditions with the Meteorological Department or the fishermen before going into the sea is the best way to set up survey plans.

Cooperation and coordination amongst the research team was also an important aspect of the surveys because every researcher had to keep watch for dolphin sightings around the boat. First, at least three observers watched in three different directions: to the front, left and right sides of the boat. Observers were changed and alternated whenever they experienced fatigue from continuous observation. Second, when dolphins were encountered, at least two DSLR cameras were used to make sure that we photographed all individuals on each sighting sufficiently. Since the dolphins were usually divided into several groups of a pod, two or more photographers had to be used to capture separate images of almost all individuals. While photographing, other researchers measured the environmental factors and recorded them on the datasheet. Our survey recorded 89 sightings, which is more than the 60 typically needed for distance sampling (Buckland *et al.*, 2001).

2.3 Study Area

The study area is located in the middle part of the Gulf of Thailand, between the boundaries of Donsak District, Surat Thani Province and Khanom District, Nakhon Si Thammarat Province (N9° 19', E99° 44') covering 3 km off the shoreline of a coastal area (CA) and offshore area (OA), as shown in Figure 15.

Coastal Area (CA):

The study was conducted in an area near the coastal zone of Donsak District, Surat Thani Province and Khanom District, Nakhon Si Thammarat Province on the eastern coast of southern Thailand. The natural environment of this area includes rocky shores, sand, rocky cliffs, mud flats (Taled Bay-TB, Thong Nian Bay-TNB, Lak Sor Mountain-LSM), mangroves and sea grass (Tarai Island, TRI) (Figure 15). Fabricated structures, such as Somserm Ferry-SSF, Sea Tran Ferry-STF, Raja Ferry – RF transportation piers (to the famous tourism islands of Samui Island and Pha-ngan Island), coastal fisheries, dolphin-watching tours, factories were also present within the study area.

Offshore Area (OA):

The connected area off the northern coast of the Donsak coastline is located within the small islands of Ri Gun Island (RGI), Nok Ta Pao (NTPI), Som (SI), Chuek (CI), Pa-luai (PLI) Pi Island (PI) and Jae Island (JI). A portion of Pa Luai Island is the Ang Thong Marine National Park. Because of abundant natural marine resources in the Gulf of Thailand, the marine navy base was converted into a national park on 12th November 1980. The Ang Thong Marine National Park consists of 42 small islands with dry evergreen forests, beaches, limestone and mangrove forests (Figure 15).

The eastern portion of the survey area in the present study overlaps with the survey area in Jaroensutasinee *et al*. (2010) (Figure 15). The habitat patterns in CA include rocky shore/cliff, sand, mud flat, mangrove, and seagrass. Major anthropogenic activities include ferries transporting tourists to Samui and Pha–ngan Islands, small-scale and industrial fishing, dolphin-watching boats, and industrial factories along the coast. Pa Luai Island is located within the Ang Thong Marine National Park (N9° 31', E99° 41'). It was established in 1980 due to its abundant natural marine resources. It lies in the northern most edge of the survey area. Rainy season in the study area starts from mid-May to January, while the summer season begins mid-February to mid-May. The annual air temperature ranges from 22.0 to 32.8 °C.

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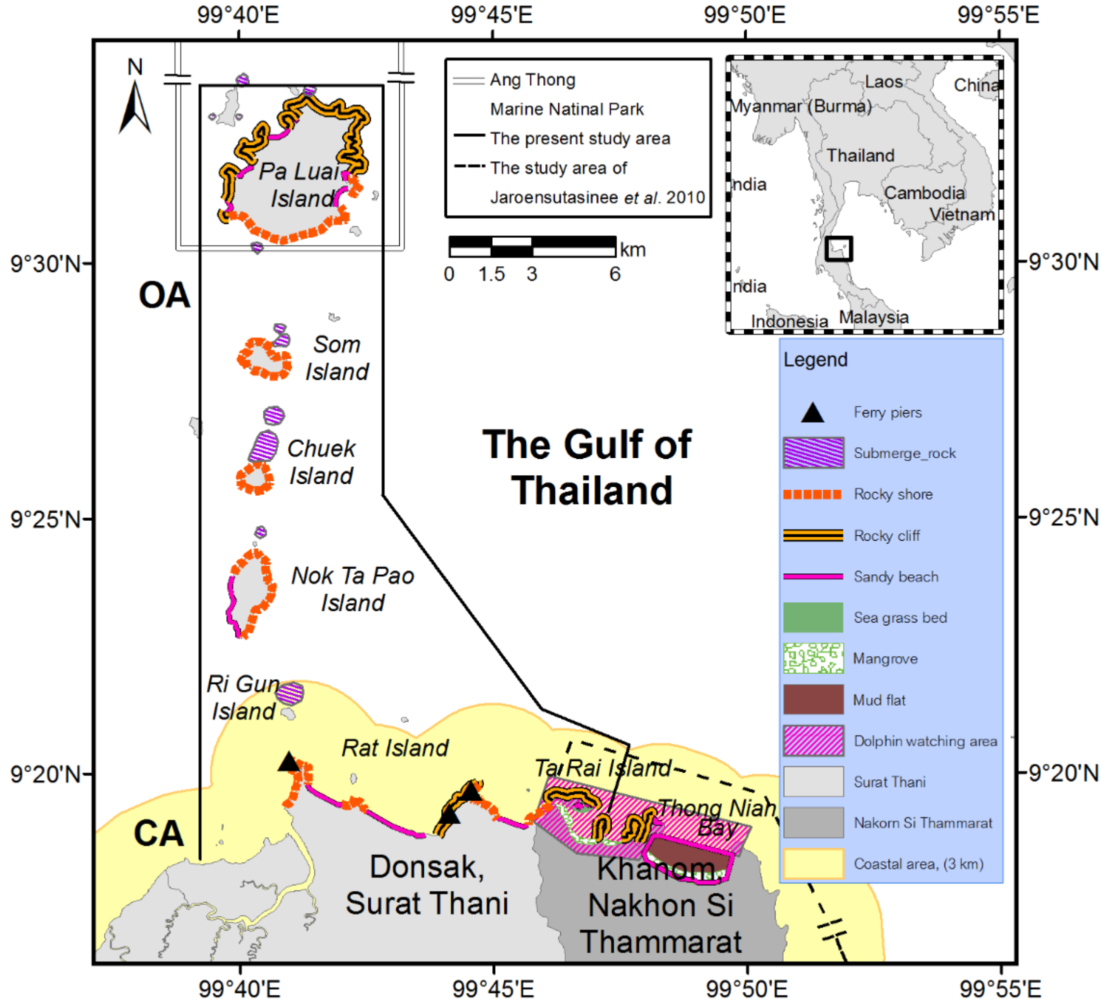

Figure 15 Study area is in the coastal waters of Donsak District, Surat Thani Province and Khanom District, Nakhon Si Thammarat Province, Thailand. The southern part of Ang Thong Marine National Park was involved in this study. The black triangle symbols indicate ferry transportation piers (From the left, Som–Serm Ferry, Sea Tran Ferry and Raja Ferry)

2.4 Time Period

Boat-based surveys were conducted three times per month between December 2011 – April 2013.

2.5 Data Collection

2.5.1 Surveying and Environmental Data Collection

All the survey tracks and encountered dolphin positions were recorded with Garmin eTrex30 GPS (Figure 16). The boat-based surveys were conducted from 08.00-14.00 hours, when Beaufort Sea State 0-2 during December 2011–April 2013. The survey tracks started from Rat Island to either Ta Rai Island on the east or Somserm Ferry on the west (CA area), then headed to the islands around OA until Pa Luai Island and finally back to Rat Island on each survey day. The surveys were carried out off the coast between the coastline and a part of Ang Thong Marine National Park of Donsak District, Surat Thani Province using a fisherman's long-tailed boat with a 175hp outboard engine and an average speed of 15 km/hr. The survey boat reduced speed when encountering dolphins. Water depth (WD), water transparency (Secchi Dish, SD), pH, sea surface temperature (SST), salinity (SN) and Beaufort sea state (BF) were measured and the positions were recorded. The scale of weather conditions is represented in Table 4. Season change was divided into 2 seasonal categories. May 16 to January 31 was categorized as the rainy season and February 1 to May 15 as the summer season in southern Thailand.

RS, MM, MF, SB and SG were abbreviations used for habitat characteristics of dolphin-encountered sites. They were rocky shore, man-made structure, mud flat, sandy beach and sea grass bed, respectively. The rocky shore area consists of fragmented rough stone along the base of rocky cliffs. Non-Parametric environmental characteristics include tidal phase, % cloud cover, wind power, rain and strength of sunlight, as defined in Table 5.

Finally, a distance off the shore (DS) measurement was conducted when the GPS data recorder marked the dolphin encounter positions, which were loaded onto a computer. The shortest distances that are perpendicular to the coastline of the mainland and surrounding islands off the shore were measured by GIS software.

Table 5 Definition scale of non–parametric environmental characteristics, including tidal phase, % cloud cover, wind power, rain and strength of sunlight

Environmental parameters	Conditions	Scale
Tidal (TD)	Low tidal	0
	High tidal	1
% Cloud cover (CC)	< 20 clouds	0
	20–50% clouds	1
	>50% clouds	2
Wind power (WP)	No wind	0
	Little wind	1
	Strong wind	2
Rain (RN)	No rain	0
	Drizzle	1
	Raining	2
Sunlight (SL)	Cloudy	0
	Light	1
	Strong	2

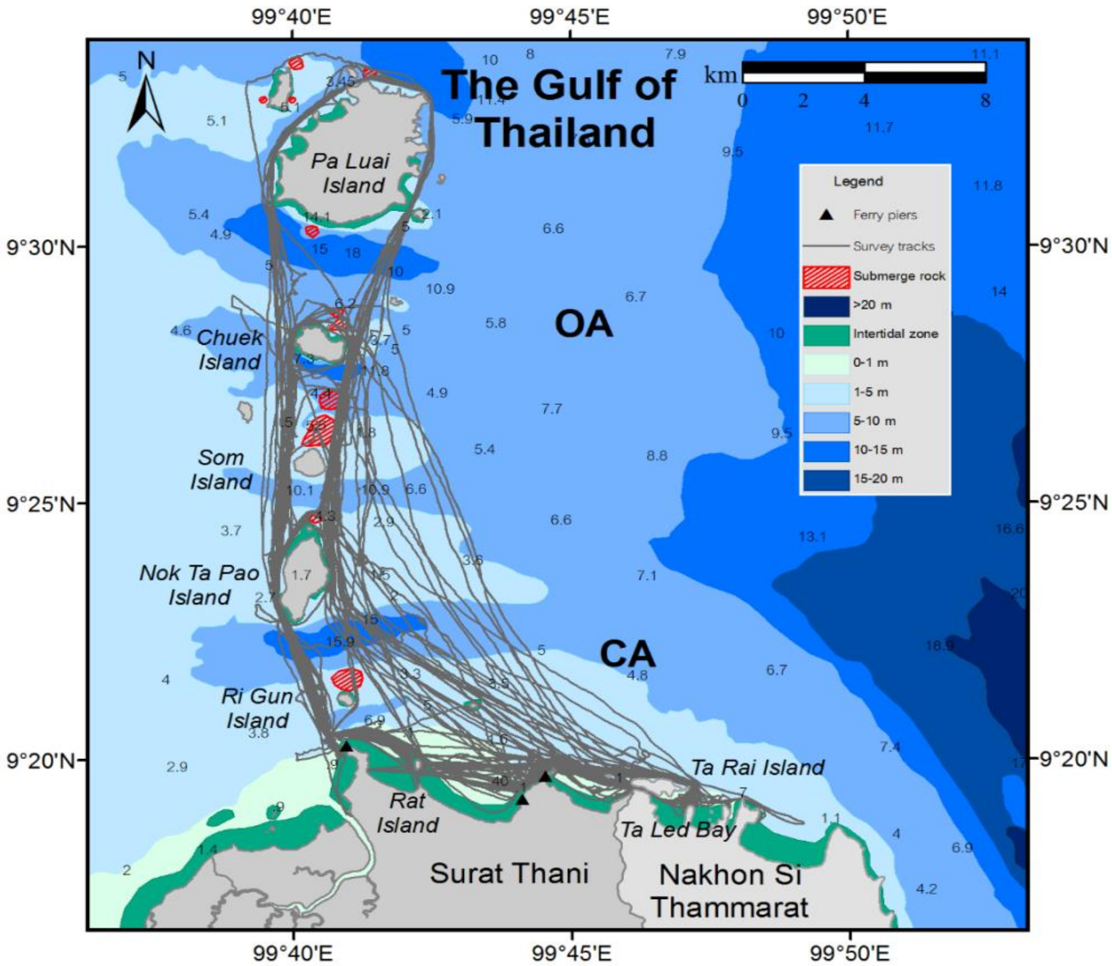

Figure 16 The Indo-Pacific humpback dolphin survey route along the shore of Donsak District, Surat Thani Province, and Khanom District, Nakhon Si Thammarat Province

2.5.2. Photo-Identification for Indo-Pacific Humpback Dolphins

Indo-Pacific humpback dolphin studies were conducted from the photographically identified data used to analyse the group structure, movement patterns, population size, etc (Würsig and Jefferson 1990). The dolphins were photographed in each of the encountered positions for 30-120 minutes depending on group size, sea and weather conditions.

2.5.3. Age Group Classification

Age classes of the dolphins were classified according to their pigmentation patterns and body lengths (Jefferson 2000, Jefferson *et al*. 2012). Unspotted calves (UC), very young dolphins with smooth gray skin colour and body lengths of less than 150 cm, were observed to be paired with adults. Spotted juveniles (SJ) had white spots on gray skin colour with nicks on their dorsal fins and body lengths longer than 150 cm. Spotted adults (SA) were dolphins with less than 50% white colour on gray skin colour, starting from the tip of the dorsal fin. Unspotted adults (UA) were dolphins with more than 50% body skin colour of white or pink colour with small gray spots (Figure 20).

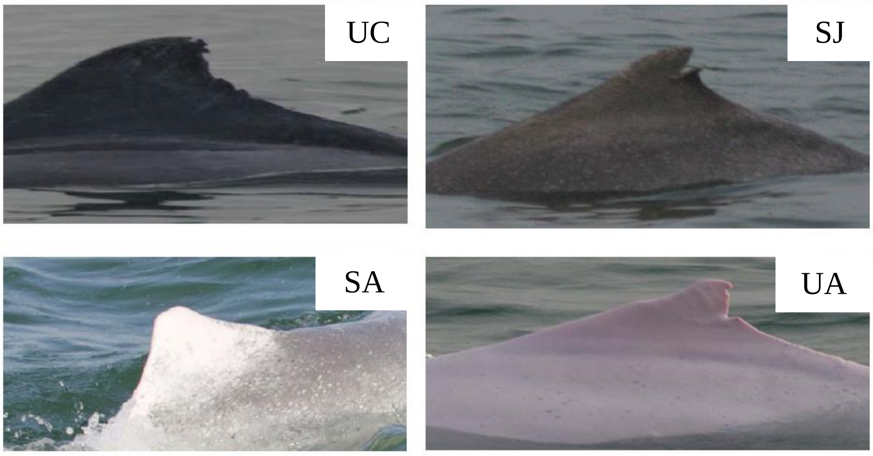

Figure 17 The four age classes of the Indo-Pacific humpback dolphin, discriminated by body colour pattern and approximate body length: Unspotted Calves (UC), Spotted Juveniles (SJ), Spotted Adults (SA) and Unspotted Adults (UA) in Sannieng Bay, Guanxi, China (Wenshi *et al*., 2007)

In this study, the location of any dolphins encountered was marked on the GPS and boat speed decreased each time. Researchers took photographs of all individual dorsal fins in a group that were the most perpendicular to the dolphins' body axis using DSLR D80 D90 and D7000 Nikon DSLR cameras with 70-300 mm lenses. Photo-Identification was conducted with the most perpendicular and clear dorsal fins and newly identified individuals were added to the catalogue by nicks, notches, pigmentation, colour patterns, figures, scars and wounds. '0' and '1' were used in the datasheet to indicate the absence or presence of each individual per sighting.

2.5.4. Dolphin Behaviours Identification

From this study, researchers assigned the multiple behavioural locations of each sighting from observation in the first 30 minutes. The categories of Indo-Pacific humpback dolphins consist of hunting, playing, socializing, nursing and travelling (Karczmarski *et al*., 1997; 2000). The descriptions of Indo-Pacific humpback dolphin behaviours are shown in Table 6.

The behaviours of Indo-Pacific humpback dolphins were identified at each encountered location. The researchers plotted the positions of hunting, travelling, playing, nursing, and socializing behaviours. The minimum convex polygon (MCP) of each preference of behavioural areas was created to cover the behavioural area.

Table 6 Indo-Pacific Humpback Dolphin Behaviours Definition (Karczmarski *et al*., 1997, 2000)

Behaviours	Explanation
Hunting, feeding and foraging	Dolphin herding fish in front of their rostrum, swimming very fast, sea surface trail moving very fast, diving with raised flukes over the sea surface, diving for 2-3 minutes
Playing	The rostrum was raised steeply over the surface of the water, circularly swimming around dolphin groups upside down with flippers raised
Socializing	Superimposed swimming in groups, with some individuals moving to other groups while displaying other behaviours such as feeding or playing.
Nursing	Paired swimming between an adult and a dark gray calf, with the calf swimming parallel with the bigger adult all the time, on the left or right side, beneath the adult's body.
Travelling	Synchronized swimming and diving for 1-2 minutes before surface breathing, including several age classes.

2.5.5. Interview Data

The Thai language questionnaire was adapted from the status, threats and distribution of dugong in the Andaman Sea by The Phuket Marine and Biological Centre. The dolphin experiences of fishermen, their attitudes, period of encounters, encountered positions from any fishery area and the locations of the most frequent sighting areas were interviewed. (Appendix 1).

2.6. Data Analysis

2.6.1. Abundance Estimation

The Jolly Seber Model was used to estimate the abundance of the Indo-Pacific humpback dolphin open population (Seber, 1965; 1981). In these models, animals are captured on i occasions and given a mark with photo-identifications. Time periods were multiple month intervals. After occasion 1, both marked and unmarked animals are caught; photo-identification tag numbers of the marked animals are recorded and unmarked animals are marked. Animals are released back into the population; accidental deaths (losses on capture) are allowed.

Model structure for situation with losses on capture:

p_i = capture probability

q_i = 1- pi = probability of not being captured

$\emptyset_i$ = survival probability

χ_i = probability of not seeing an animal again after occasion i

η_i = probability of release for marked animals (m_i) caught on occasion i

η'_i = probability of release for unmarked animals (u_i) caught on occasion i

Mark		Mark & Resight		Mark & Resight	…	Resight
1	$\xrightarrow{\emptyset_1}$	2	$\xrightarrow{\emptyset_2}$	3	…	n
		p_2		p_3	…	p_n

The patterns of captures were calculated using the values in the m_{ij} array. For example, individuals captured on occasion one, two were recaptured on occasion two, one was recaptured first on occasion three, and one was first recaptured on occasion four. Two individuals were released on occasion two, etc. Use capture histories to produce an m_{ij} array (e.g. ((100), (101) ,(110), (111))) and use the formulas below to calculate the number of marked individuals for animals caught on occasion 1 in 3 occasion study =(u_1):

$$P[X_\omega] = \left[\frac{U_1!}{u_1(U_1 - u_1)} P_1{}^{U_1}(1 - p_1)^{U_1 - u_1}\right]$$
$$\times \left\{\frac{u_1!}{\prod_\omega (\chi_\omega)!(\chi_{\bar{\omega}})!} (\eta_1\chi_1)^{\chi_{100}}(1 - \eta_1')^{\chi_{\bar{1}00}}(\eta_1\emptyset_1 p_2 \eta_2 \chi_2)^{x_{110}}[\eta_1\emptyset_1 p_2(1 - \eta_2)^{\chi_{\bar{1}10}}]\right.$$
$$\times [\eta_1\emptyset_1(1 - p_2)\emptyset_2 p_3 \eta_3]^{\chi_{101}}[\eta_1\emptyset_1(1 - p_1)\emptyset_2 p_3(1 - \eta_3)]^{\chi_{\bar{1}01}}$$
$$\left.\times (\eta_1\emptyset_1 p_2 \eta_2 \emptyset_2 p_3 \eta_3)^{\chi_{111}}[\eta_1\emptyset_1 p_2 \eta_2 \emptyset_2 p_3(1 - \eta_3)]^{\chi_{\bar{1}11}}\right\}$$

Variables:

N_i = total number of animals exposed to sampling on occasion i

M_i = total number of marked animals before sampling occasion i

$U_i = N_i - M_i$ = total number of unmarked animals before occasion i

n_i = total number of animals caught on occasion i

m_i = total number of marked animals caught on occasion i

u_i = total number of unmarked animals caught on occasion i

B_i = number of new animals joining the population between samples i & i+1; animals that entered the population between occasions i & i+1 but died before i+1 were excluded.

The initial binomial term involves the capture of unmarked animals from the total number of unmarked animals on each occasion. This can be seen easily in the likelihood above. This component can be written as follows (here, we're not just working with u_1).

$$P_i(\{u_i\}|\{U_i\}\{p_i\}) = \prod_{i=1}^{K}\left[\frac{U_i}{u_i!(U_i - u_i)!} p_i{}^{u_i}(1 - p_i)^{U_i - u_i}\right]$$

Marked and unmarked animals handled the loss on capture. This can be seen by examining the equation and considering the meaning of η_i and η'_i in the equation. X_ω denotes the number of animals with a capture history that ω were not released following the final capture, e.g., 110. '12' would denote 12 animals that were caught on occasions 1 and 2 but were not released on occasion 2. The recapture of marked animals that were released is modelled in exactly the same way as was done in the Cormak Jolly Seber (CJS) modelling. Trap deaths or research removals can be accommodated throughout. For the example of 3 occasions & animals caught the first time (u_1), if all animals caught are released, the likelihood simplifies to:

$$P[X_\omega] = \left[\frac{U_1!}{u_1(U_1-u_1)} P_1{}^{U_1}(1-p_1)^{U_1-u_1}\right] \times \left\{\frac{u_1!}{\prod_\omega(\chi_\omega)!}(\chi_1)^{\chi_{100}}(\emptyset_1 p_2 \chi_2)^{x_{110}} \times [\emptyset_1(1-p_2)\emptyset_2 p_3]^{\chi_{101}} \times (\emptyset_1 p_2 \emptyset_2 p_3)^{\chi_{111}}\right\}$$

$\hat{N}_i = n_i/\hat{p}_i$, Need $\hat{p}_i$, so the N_i was estimated for i=2,…, K-1

$\hat{B}_i = \hat{N}_{i+1} - \hat{\emptyset}_i(\hat{N}_1 - \hat{n}_i + R_i)$,

where R_i is the number released on occasion i , $- \hat{n}_i + R_i$ simply accounts for the number of animals caught but not released back into the population, need $\hat{N}_I$ and $\hat{N}_{i+1}$, so $\hat{B}_i$ was estimated from *i*=2,…, K-2

We estimated the humpback dolphin population size with a mark-recapture analysis using the Jolly-Seber open population model on MARK software. The probability of survival was calculated as the ratio of number of marked animals at the start of sample *i*+1 to the number of marked animals at the end of the sample. The dilution rate was calculated as an estimate of the number of animals added to the population through birth and immigration. It is the ratio of the actual population size at t+1 to the expected population size at *i*+1 if no additions had occurred.

There are multiple parameters criteria for the Jolly Seber Model on MARK software (Table 7). POPAN, a super population (N) and probability were parameterized by Schwarz and Arnason (1996) into super population on each occasion. Link-Barker, a model re-parameterized with the entry probabilities replaced by recruitment (f), where f_i is interpreted as a per capita recruitment rate, or the net new animals entering the population between occasion *i* and *i*+1 per animal alive at occasion *i*. Burnham Jolly-Seber – Burnham developed a parameterization that provides estimates of the rate of population change (lambda) and the population size on the first trapping occasion (N_i). Convergence is difficult for likelihood and so it has not seen as much use as the others. Pradel models, recruitment parameterization has similarities to the Link-Barker model. Pradel-lambda has similarities to Burnham's JS model that works with lambda.

Table 7 Summary of criteria to choose among the different Jolly Seber formulations

Formulation	losses on capture	Available estimation			
		abundance	net	births	recruitment
POPAN	yes	yes	yes	no	no
Link-Barker- JS	yes	no	no	yes	yes
Pradel-recruitment	no	no	no	yes	no
Burnham JS	yes	yes	yes	no	yes
Pradel - λ	yes	no	no	no	yes

Note: Burnham's Js model implementation in MARK does not converge frequently and is not recommended. The standalone package of POPAN will estimate recruitment and population growth as derived parameters.

POPAN Parameterization on Jolly Seber Model on MARK Software

A super population (N) and the probability of entry (pent) were parameterized by Schwarz and Arnason (1996) on the Jolly-Seber Model. Four parameter index matrixes (PIMs) were created for each group:

$\emptyset$ = apparent survival

p = capture probability given the animal is alive in the study area

b = probability of entry into the population for occasion

N = super-population size

For t occasions, there are t-1 Φ estimates, t p estimates, t-1 b estimates, and 1 N estimate. The t-1 pent estimates correspond to the probability of entry for occasions 2, 3, ..., t. The probability of being in the population on the first occasion is equal to b(0)=1-sum(b(i)). The Mlogit link function gives a constraint that can summarize the b parameters <= 1, with the probability of occurrence in the population on the first occasion as 1-sum(b(t)). The convergent model is problematic unless the MLogit link function is used with the b parameters. The number of animals in the population on occasion 1 is N(1) = b(0) times N. The number of new animals (births, B) entering the population prior to occasions i = 2, 3, ..., t is B(i) = b(i-1) times N. The population size on occasion i = 2, 3, ..., t is N(i) = (N(i-1) - losses on capture) times Φ (i-1) + B(i). The B(i) and N(i) estimations are provided as derived parameters from models with the

POPAN data type. A POPAN data type limitation is using individual covariates. The super-population size (N) includes animals for which the individual covariate is not known because the parameter estimates the number of animals never captured. Therefore, a function of individual covariates is unsuitable for modelling N. Furthermore, the B(*i*) and N(*i*) parameters and the *b*(*i*) and Φ (*i*) parameters are functions of N. Thus, if the *b*(*i*) or Φ (*i*) are modelled as individual covariates functions, the derived parameters will be functions of these individual covariates.

The researchers recorded 89 sightings from all the surveys conducted over a 17 month period. The dolphin occasion matrix data set was made with the occurrence of each individual per site. The population size was estimated by Jolly-Seber live recapture of open population model with age class on POPAN parameterization in MARK Software (White and Burham, 1999) which includes the parameter N - the size of a superpopulation. N can be thought of as either, the total number of animals available for capture at any time during the study or alternatively, as the total number of animals ever sighted in the sampled area between the first and last periods of the study (Nichols 2005). The parameter Φ denotes apparent survival rate, *p* denotes the probability of capture, and *b* denotes the probability that an animal from the superpopulation enters the subpopulation (subpopulation referring to the animals occurring in the study area). Variance was estimated using the delta method as follows:

$$\mathrm{var}(N_{\mathrm{total}}) = N_{\mathrm{total}}^2 (\mathrm{var}\,(N)/N^2 + (1-\theta)/n_{\theta})$$

Where n is the total number of dorsal fins from which θ was calculated. Confidence intervals for N_{total} assumed the same error distribution as the mark-recapture estimates (Wilson *et al*. 1999). The population size was computed by Parm-Specific as Link function, Sin were Φ (*i*) and p(*i*), mlogit(1) was pent(*i*) and logit was N on POPAN parameterization model option on MARK software (White and Burham, 1999) based on individual sighting history in POPAN data type.

2.6.2. Population Estimation on Age Class Categorization

The abundance estimate *N* denotes the size of a super-population, either the total number of animals occurring in the survey area, or the total animals available for capture at any time during the survey period (Nichols 2005). Three parameters, Φ, p and b that represent the apparent survival rate, probabilities of capture and probabilities of entry (Reisinger and Karczmarski, 2010), respectively, describe histories of animal sightings. Each parameter was described by either time $\{t\}$, age classes $\{g\}$, both time and age-classes $\{g \times t\}$ or being unaffected by both *t* and *g*, $\{.\}$. The best-fitted model of $\Phi\{\ \}p\{\ \}b\{\ \}$ combination was selected with a minimal Akaike Information Criterion value (AIC) (Burnham and Anderson 2002).

2.6.3. Habitat Analysis

Habitat characteristics were tested statistically by ade4 (Dray and Dufour 2007) and vegan library packages (Oksanen *et al*. 2008) for Principal Component Analysis (PCA) and Canonical Correlation Analysis (CCA) on R software, respectively. Each sighting was categorized with environmental parameters, Seasonal (rainy and summer), Habitat characteristics, Inshore and Offshore area and Position name. PCA can reduce the multiple dimensions of environmental parameters into two dimensions. PCA will group each category with the ellipses that were calculated based on the Eigen values on R software.

Differences of environmental characteristics among different age classes were tested first by Kruskal Wallis test. Then, a principal component analysis (PCA) was used to transform environmental characteristics, which are related to dolphin distribution, into independent components. Discriminant analysis and a generalized linear model (GLM) was applied to figure the variable that significantly distinguishes different age classes and test the difference among the age classes.

2.6.4. Spatial Analysis

The geographic information system data from the locations of encountered dolphins were analysed with geographic information system software. Because the survey lines near the coastal area were denser than the offshore area, the encountered probability of Indo-Pacific Humpback

Dolphins might be biased by the weight distribution of the survey effort (WDSE). The survey effort standardization was used to calculate the distributed encounter probability by the division of encountered position numbers with track line numbers on each grid. WDSE was calculated with the below equation:

$$E = S/L, \qquad L \neq 0,$$

Where E is the weight of sightings per survey effort,

S is the number of sightings in a 1 km^2 grid,

L is the number of surveyed lines in a 1 km^2 grid.

E value was represented with the value between 0 – 1 that was replaced with graduated colours of quantities. The map showed the density of the weight of survey efforts on each grid. The minimum convex polygon (MCP) was used to find the habitat area of dolphins that can also be categorized with dolphin behaviours.

Animal movement was created with the connected lines of each individual found more than twice (Appendix 2). Furthermore, the water depths around the study area were plotted on a bathymetry map to describe the related habitat preferences of dolphins.

2.6.5. The Fishermen Experiences Data Analyses

The histogram of the interview data was shown in a graph of frequency that could be explained as the relations between field surveys, such as encountered periods, the comparative fish resources on dolphin experiences, dolphin watching tourism periods, etc.

The most frequently found locations and the fishing gear surrounded swimming locations were plotted on a map with geographic information system software. Thereafter, the MCP of each location type was created to locate the dolphin encountered area using the interviews from fishermen.

CHAPTER 3

Results

3.1 Survey Effort

The monthly boat-based survey was carried out between December 2011- April 2013 (Table 8). The total 47 day effort (205 hours) was completed covering 2618 km with an average survey effort of 2.76 days per month and 55.71±20.36 km per day. The average sighting and observed dolphins were 5.24±3.56 sightings per month and 26±20 dolphins per month, respectively.

The daily survey tracks were recorded on round trips from Rat Island, Tarai Island or Somserm Ferry pier to Pa Luai Island. The average cruising speed was 11.26±2.63 km/hr. with a maximum speed of less than 15 km/hr. The survey tracks were overlaid on the study area map, which was separated into 1 km^2 grids. The grid colours represented survey effort intensity (Figure 18).

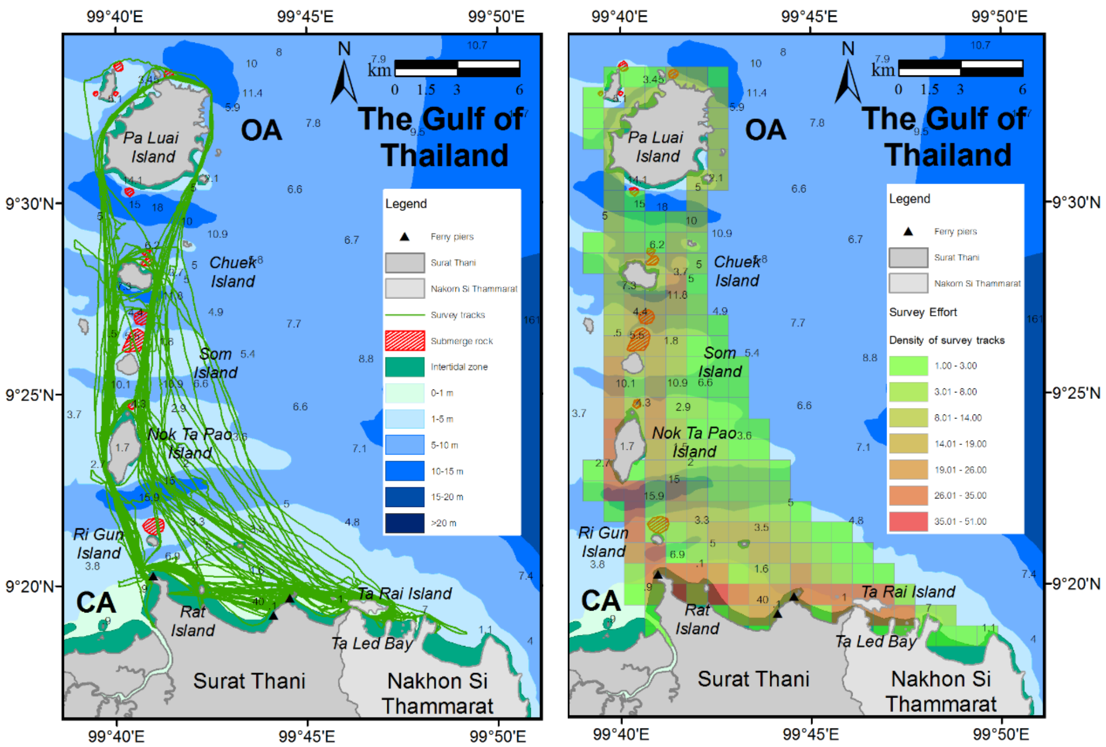

Figure 18 The survey effort intensity was represented by different tone grid colours

3 days out of the 47 days, researchers could not completely survey entire inshore and offshore areas because of severe weather conditions. The sighting numbers were counted on each surveyed day. Survey efforts (days and distance), sighting number and number of animals sighted in each month during the survey period (December 2011 to April 2013) are presented in Table 8. The cumulative number of identified individuals along the survey period is shown in Figure 19.

Table 8 Survey effort and sighting of dolphins between December 2011 - April 2013

Year/Month	No. of survey day	Distance (km)	No. of sighting	No. of dolphins	Average No. of dolphins per Sighting (Mean ± SD)
2011					
December	3	125	3	3	1.33±0.47
2012					
January	3	218	9	40	3.88±1.9
February	2	131	5	36	6.00±0.71
March	4	238	8	61	7.57±4.81
April	3	193	1	8	8.00
May	2	182	2	3	2.00±0.82
June	3	112	2	10	5.25±3.77
July	3	197	1	6	5.00
August	3	223	4	7	2.00±1.00
eptember	3	200	5	40	8.00±5.76
October	2	151	6	27	3.67±2.75
November	3	55	3	28	9.33±0.94
December	2	29	2	1	2.00
2013					
January	2	64	5	22	4.40±2.42
February	3	161	9	35	3.22±1.81
March	3	166	10	59	6.22±3.42
April	3	175	14	56	4.30±1.68

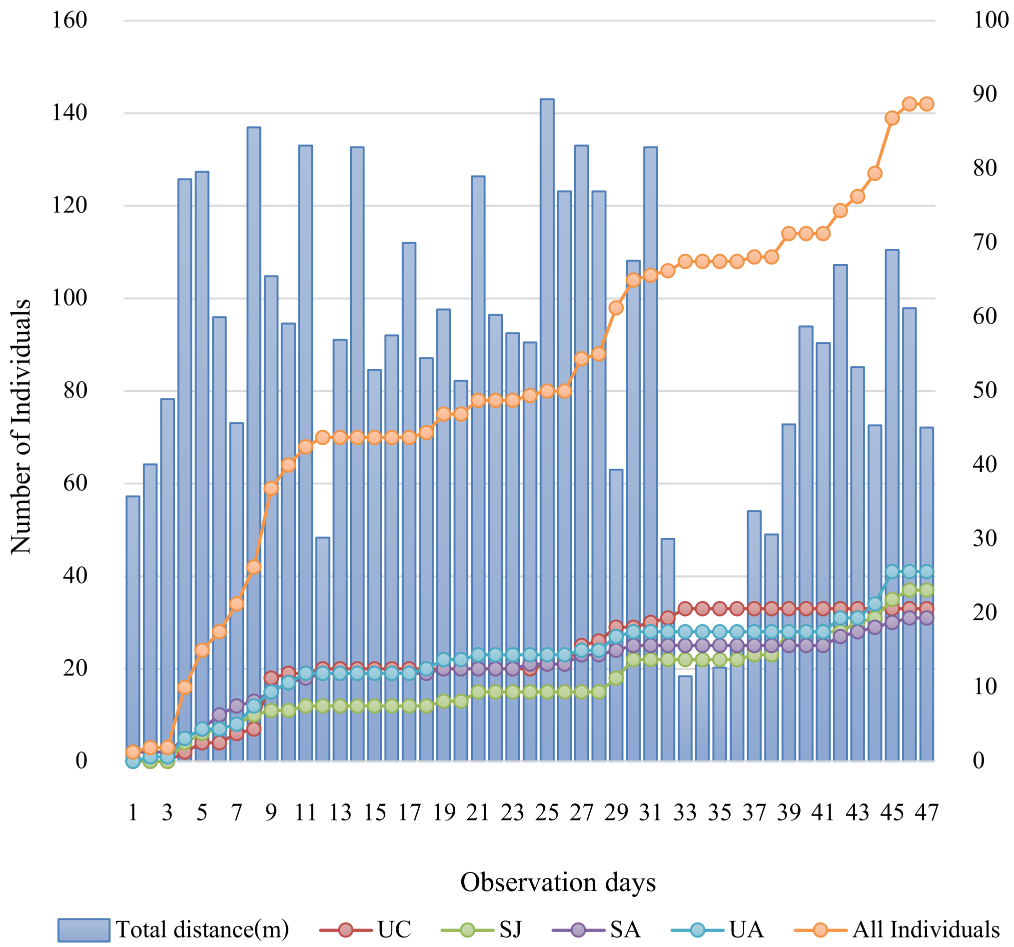

Figure 19 The survey effort for Indo-Pacific humpback dolphins in Donsak water and cumulative number of identified individuals during the survey period, UC: Unspotted Calves, SJ: Spotted Juveniles, SA: Spotted Adults, UA: Unspotted Adults.

3.1.1 The Encountered Area

During the survey period, 89 sightings were recorded from the study area. The encountered positions were plotted on a map separated into 1 km^2 grids. Each encountered position was counted on each grid and represented by various colour tones (Figure 20).

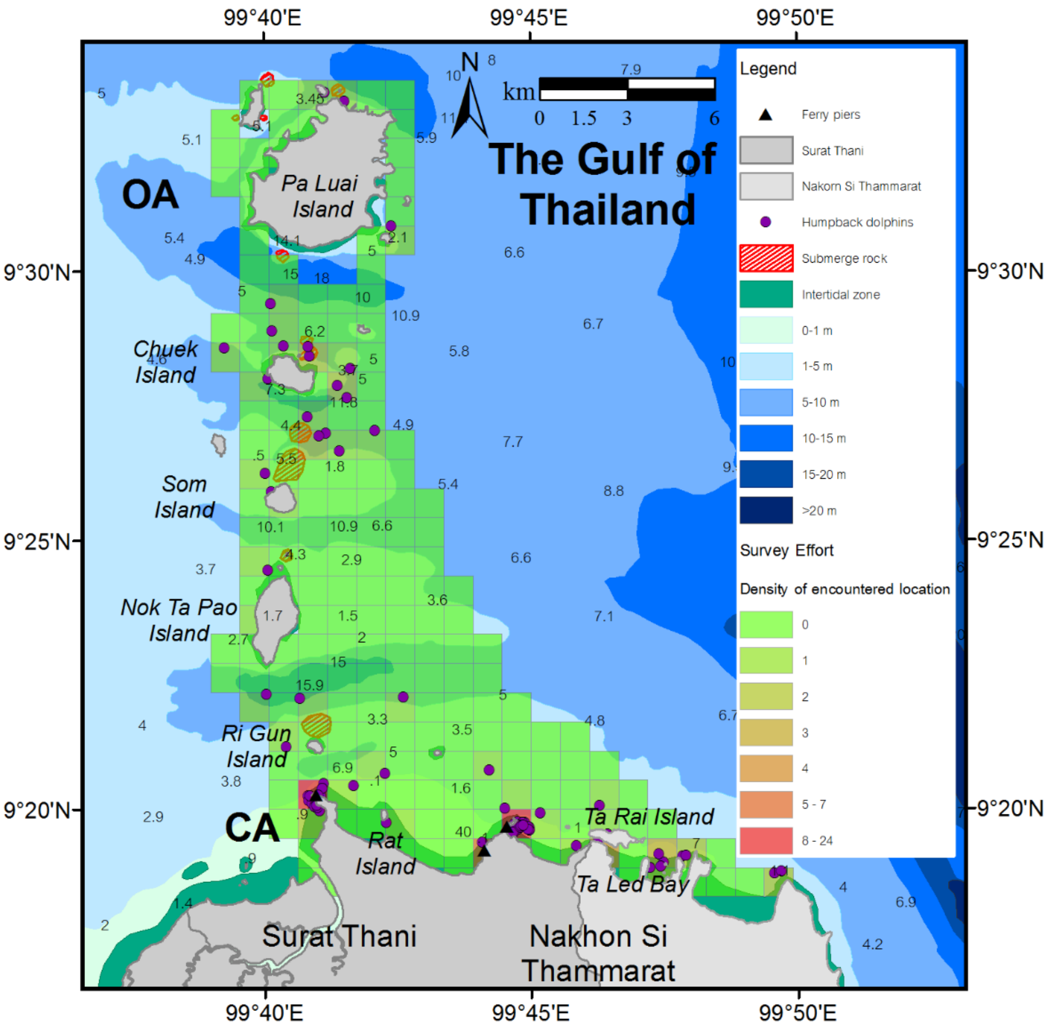

Figure 20 The density of dolphin encounter locations was represented by different tone grid colours.

3.1.2 Survey Effort Standardization

In Figure 21, there is a clear distribution of dolphin-encountered area that was standardized in the study area. It is apparent that the Indo-Pacific humpback dolphin can be found around the island off the shore, especially near Chuek Island and closer to the coast, especially Son Serm Ferry, Sea Tran Ferry, Raja Ferry piers, Donsak District, Surat Thani Province, Ta Led and Thong Nian Bay, Khanom District, Nakhon Si Thammarat Province.

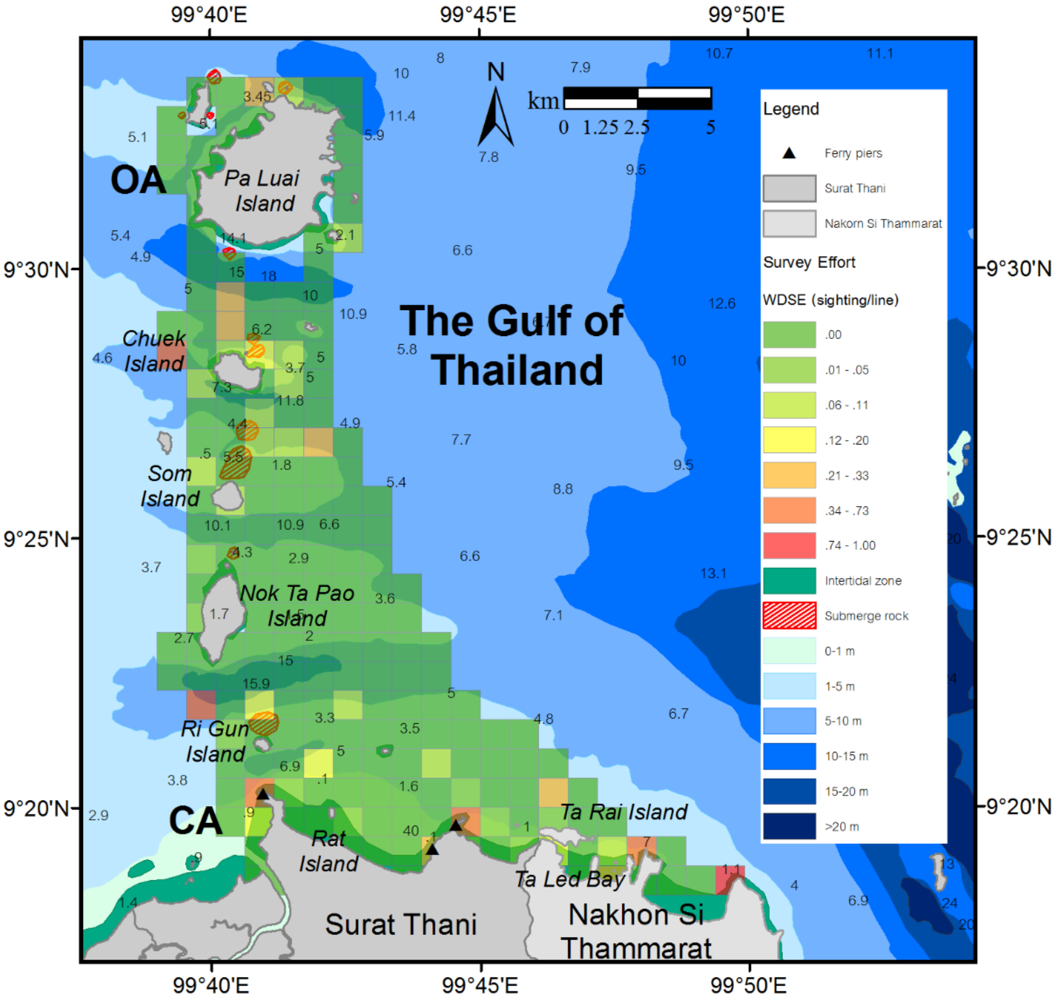

Figure 21 The standardized distribution of Indo-Pacific humpback dolphins in the study area (Dolphin/line).

3.1.3 Encountered Period

The observation boat cruised opportunistically along the shore of the study area. The dolphins were encountered during 08.00-14.00. The frequency of the encounters was grouped in 1 hour increments. The highest period of encounters was during 08.00-09.00 (27 times) and gradually decreased in other periods (Figure 22).

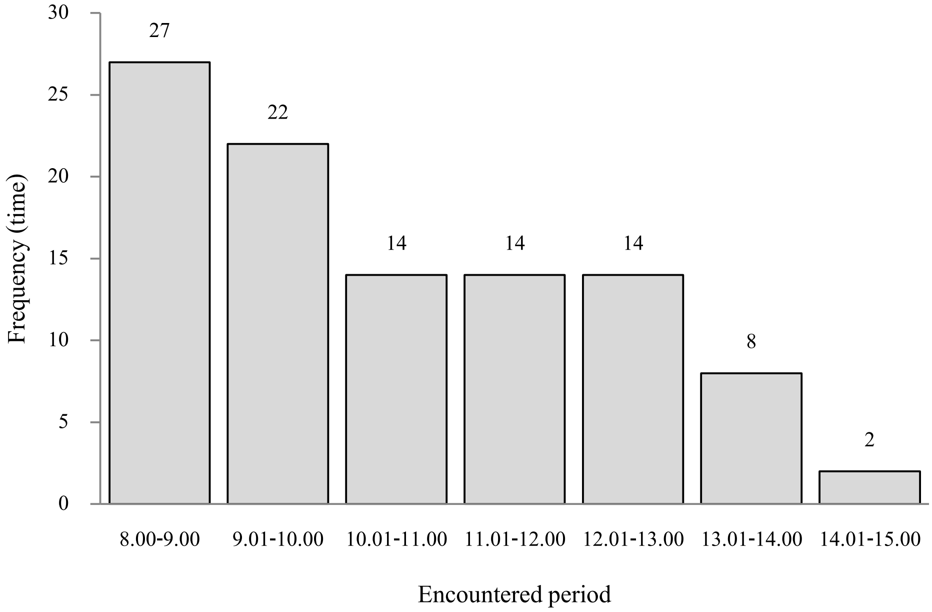

Figure 22 The encountered period of humpback dolphins between 08.00-15.00. The number over each bar shows the number of encounters in each period.

Group size of the humpback dolphins ranges from 1 to 18 with an average of 4.72 ± 3.35 (SD). The solitary and groups of humpback dolphins were encountered in the study areas (Figure 23). Solitary dolphins comprised 14.6% of the 89 sightings (Figure 23). The frequency of each dolphin encounter is shown in Figure 24. 61 individuals (43%) were found once from 142 individuals (Figure 24). The maximum frequency of encounters was 15 times with an indentified dolphin (Figure 24). Of the 142 identified dolphins, the individual sightings of each age class are shown in Figure 25, the sighting number of unspotted calves (UC, Figure 25a) , spotted juveniles (SJ, Figure 25b), spotted adults (SA, Figure 25c) and unspotted adults (UA, Figure 25d) dolphins classified are 33, 37, 31, and 41, respectively.

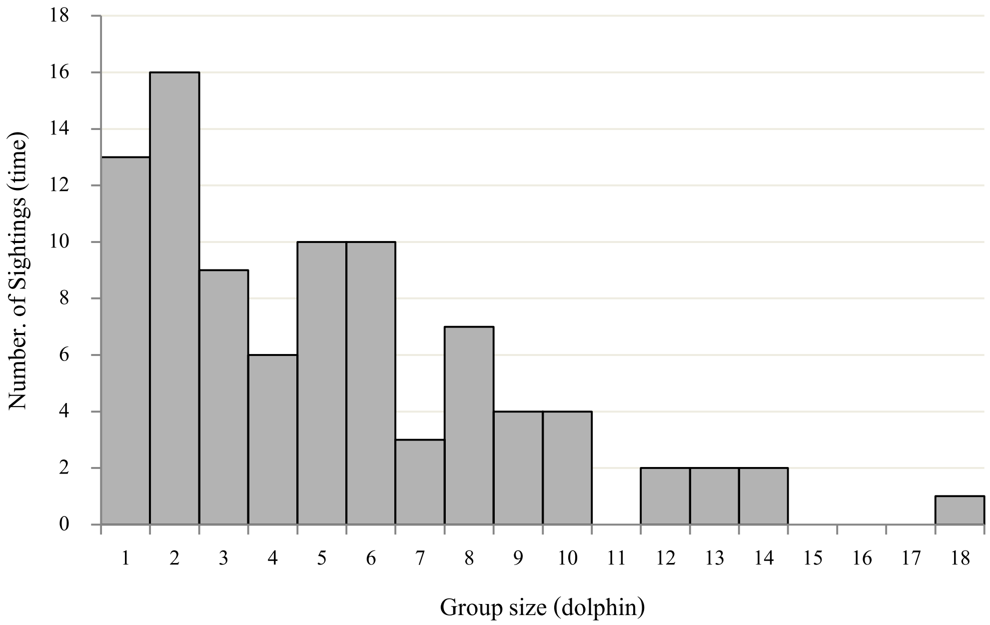

Figure 23 The sighting frequency of Indo-Pacific humpback dolphin group in Donsak water

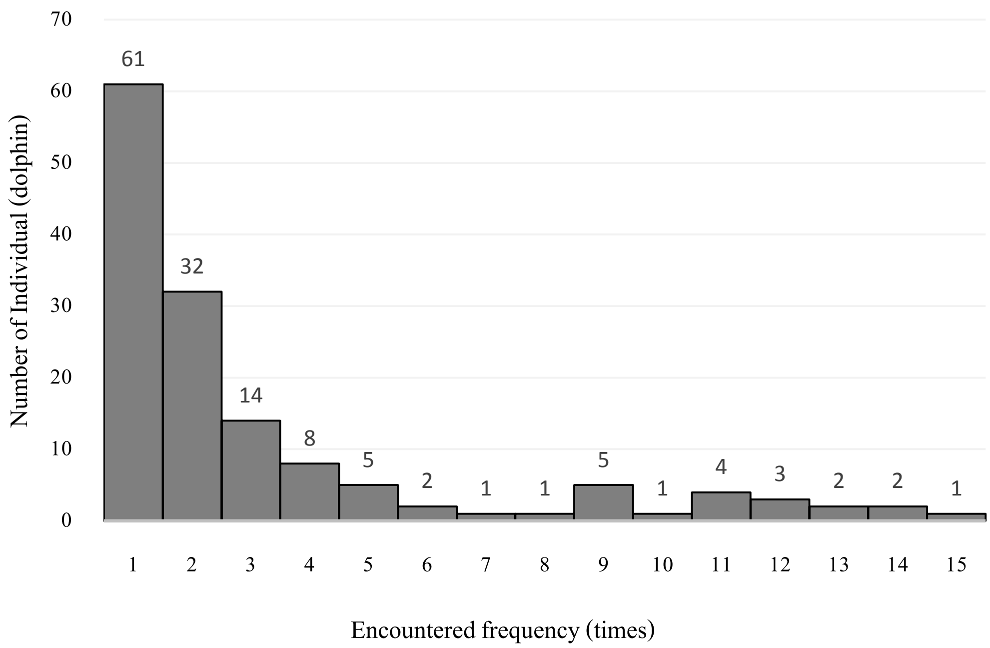

Figure 24 The encountered frequency of individual Indo-Pacific humpback dolphins in Donsak water

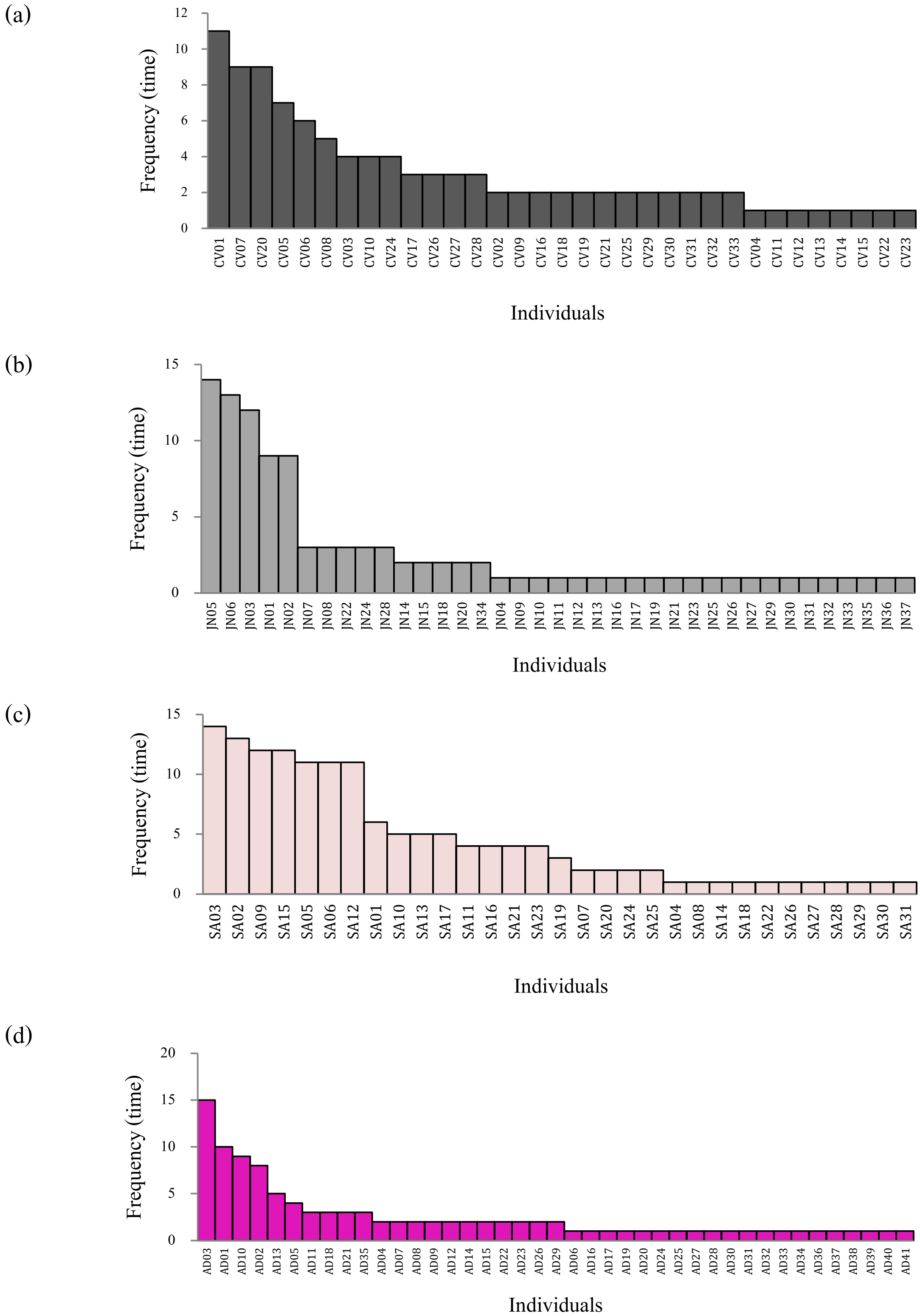

Figure 25 Individual sightings by age class categorization (a) Unspotted Calves (b) Spotted Juveniles (c) Spotted Adults (d) Unspotted Adults

3.2 Environmental Parameters

Because 6 of the sightings faced severe weather conditions, 83 of the 89 data sets of environmental parameters were measured at the location of dolphin encounters (Figure 20). The histogram of the environmental parameters was plotted on a bar chart that showed the frequency of dolphin preferences at the encountered location. The water depth ranged between 1.1-17.0 m (Figure 26). The water visibility ranged between 0.5-3.0 m (Figure 27). The sea surface temperature ranged between 26.6-32.6 °C (Figure 28). pH ranged between 7.99-8.30 (Figure 29). Salinity ranged between 25-35 ppt (Figure 30). Lastly, the geological information system software showed that the distance from the shore ranged between 17-2,976.73 m (Figure 31).

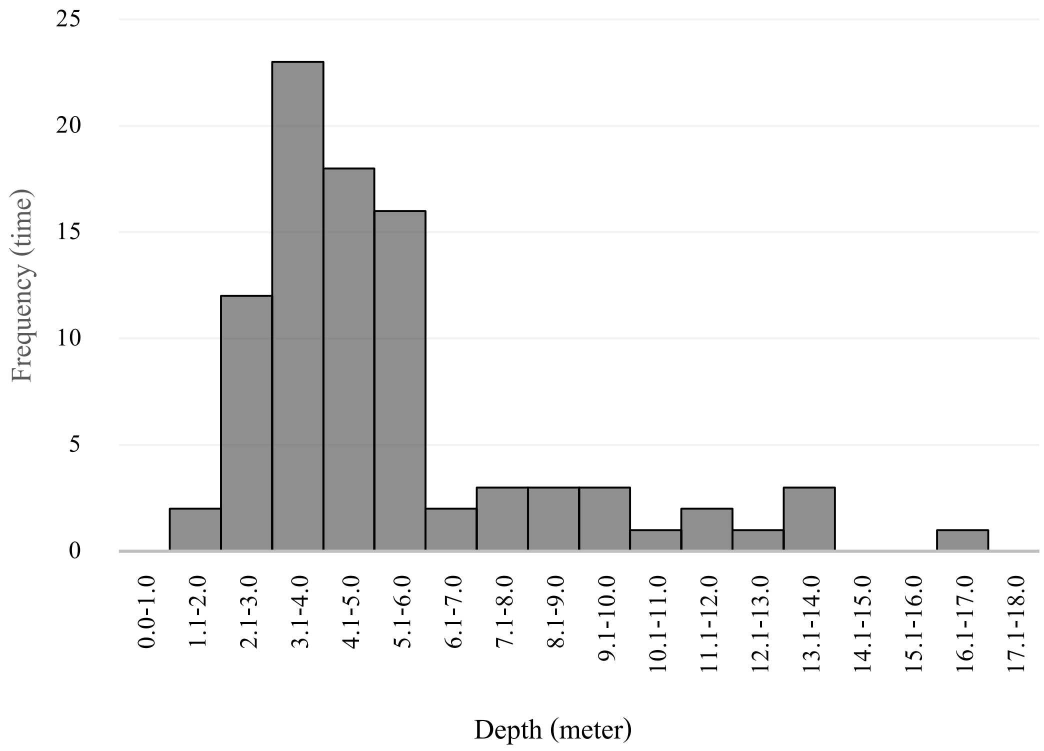

Figure 26 Histogram of water depth at the encounter locations

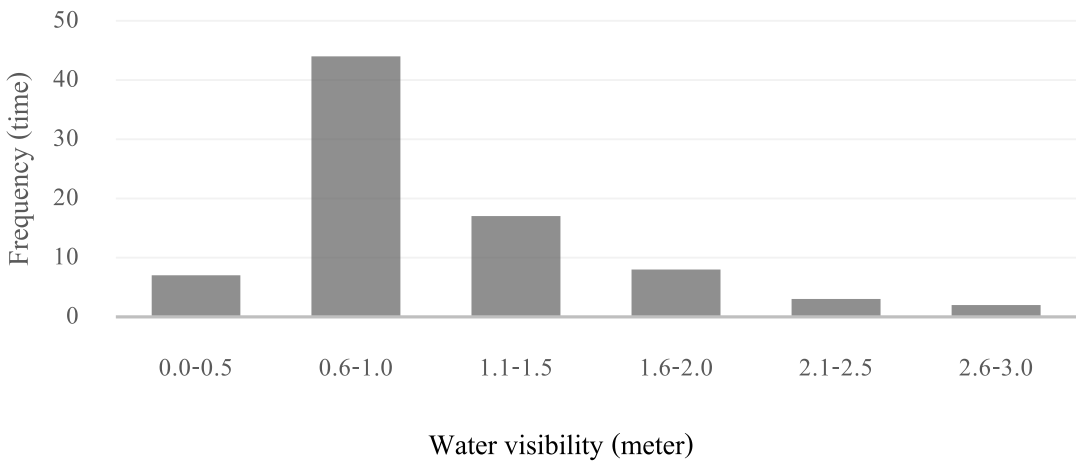

Figure 27 Histogram of water visibility on the encounter locations

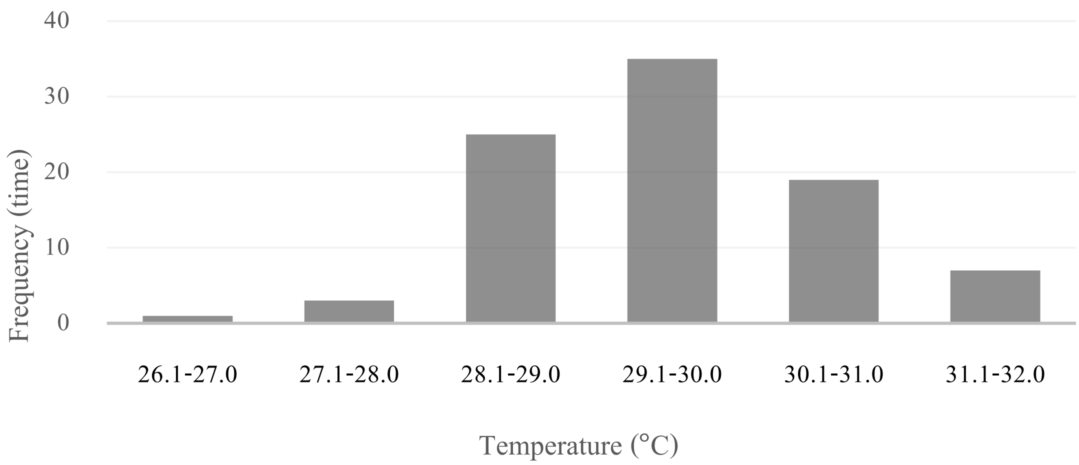

Figure 28 Histogram of sea surface temperature at the encounter locations

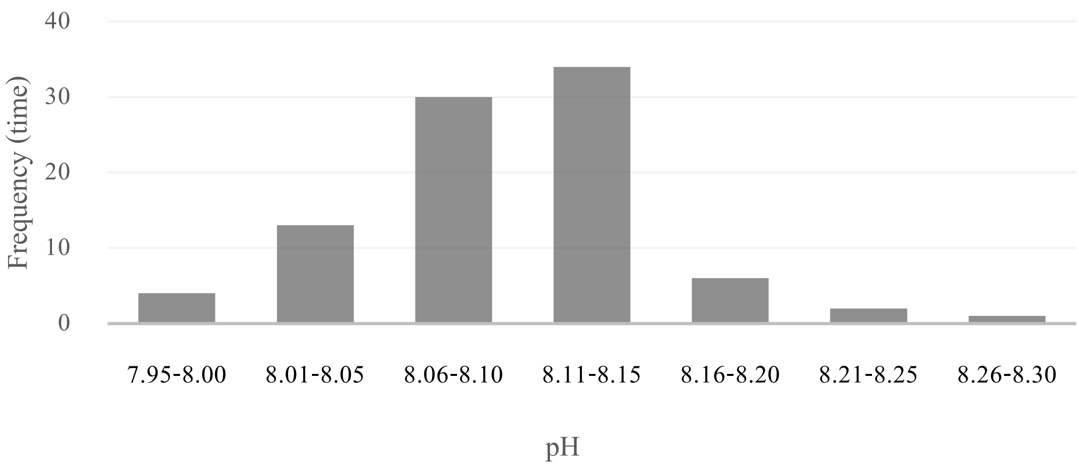

Figure 29 Histogram of pH at the encounter locations

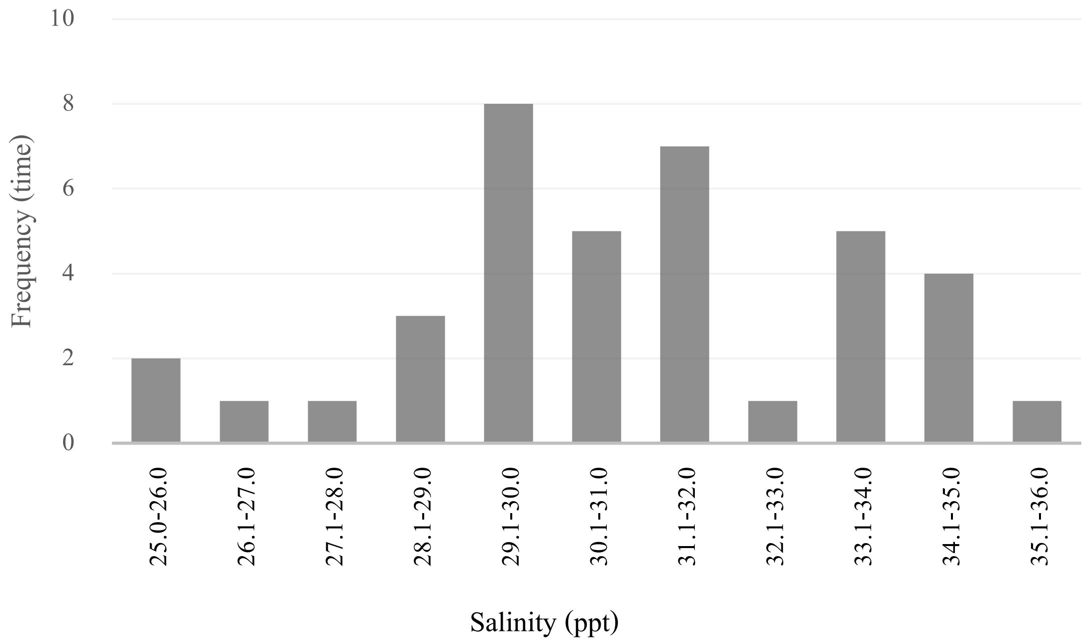

Figure 30 Histogram of salinity at the encounter locations

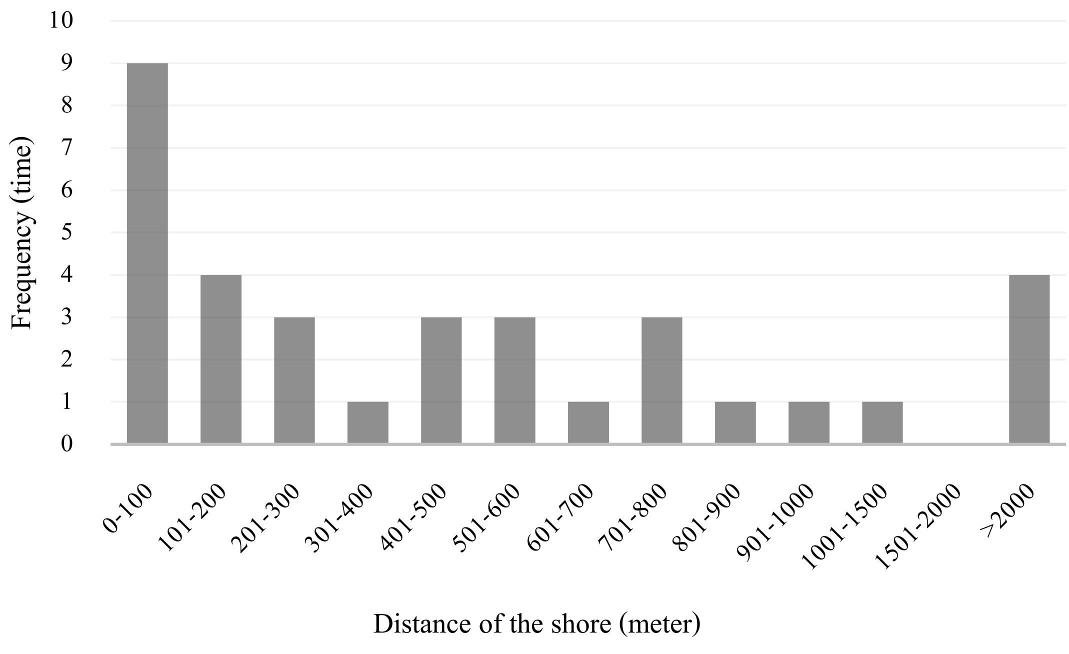

Figure 31 Histogram of distance off the shore at the encounter locations

3.3 Distribution

The locations of the dolphin sightings over the offshore area (OA) and coastal area (CA) area are shown in Figure 15 in purple dots. The highest frequency of occurrences was found in the first five areas, which are Som Serm Ferry, Raja Ferry, Som Island, Nok Ta Pao Island and Ta Led Bay (Figure 32). 22.5% of all dolphin sightings were off the shore.

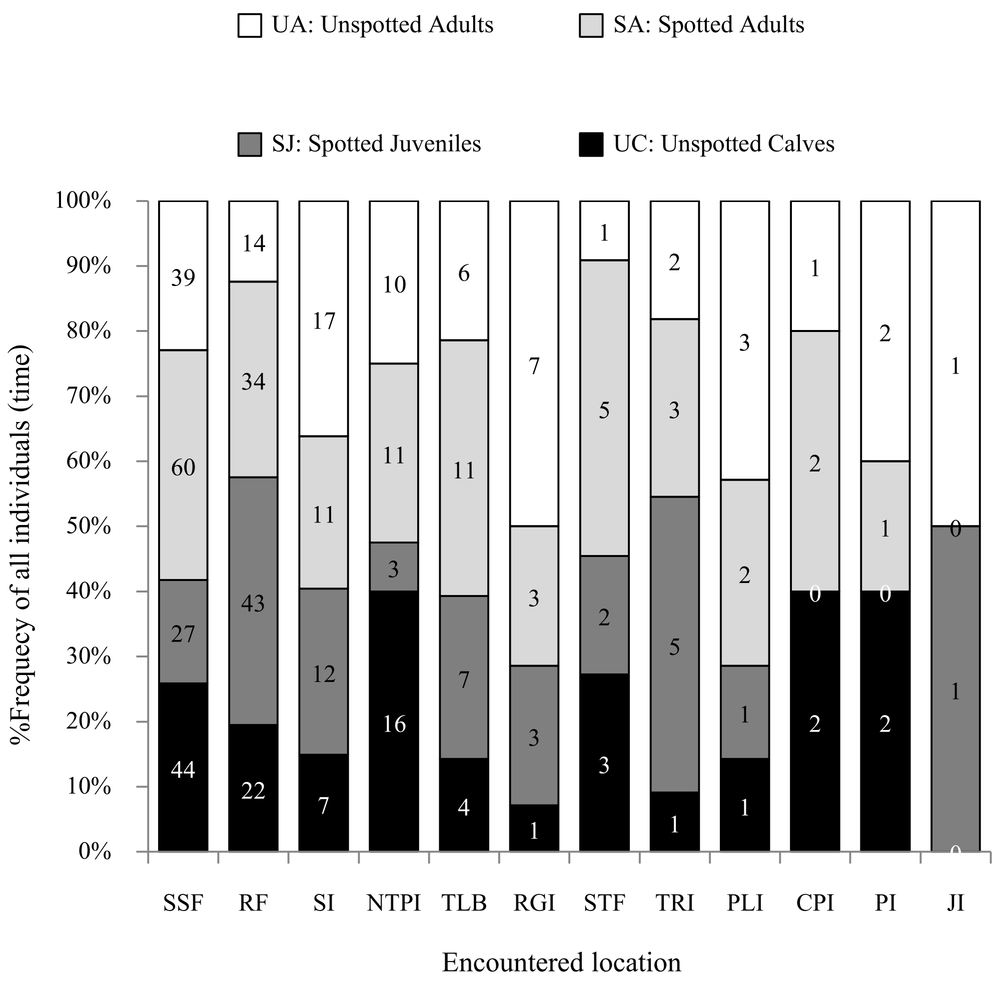

Figure 32 The ratio of sighting number frequency of humpback dolphins in the study area, SSF - Som Serm Ferry, RF - Raja Ferry, SI - Som Island, NTPI - Nok Ta Pao Island, TLB - Taled Bay, RGI-Ri Gun Island, STF - Sea Tran Ferry, TRI - Ta Rai Island, PLI - Pa Luai Island

3.4 Spatial Behaviour Distribution and Movement of Indo-Pacific Humpback Dolphins

The sizes of Indo-Pacific humpback dolphin behavioural areas were calculated as 189.52 km^2, 177.01 km^2, 129.00 km^2, 110.09 km^2, and 110.09 km^2 for hunting (Figure 33), travelling (Figure 34), nursing (Figure 35), playing (Figure 36), and socializing (Figure 37), respectively.

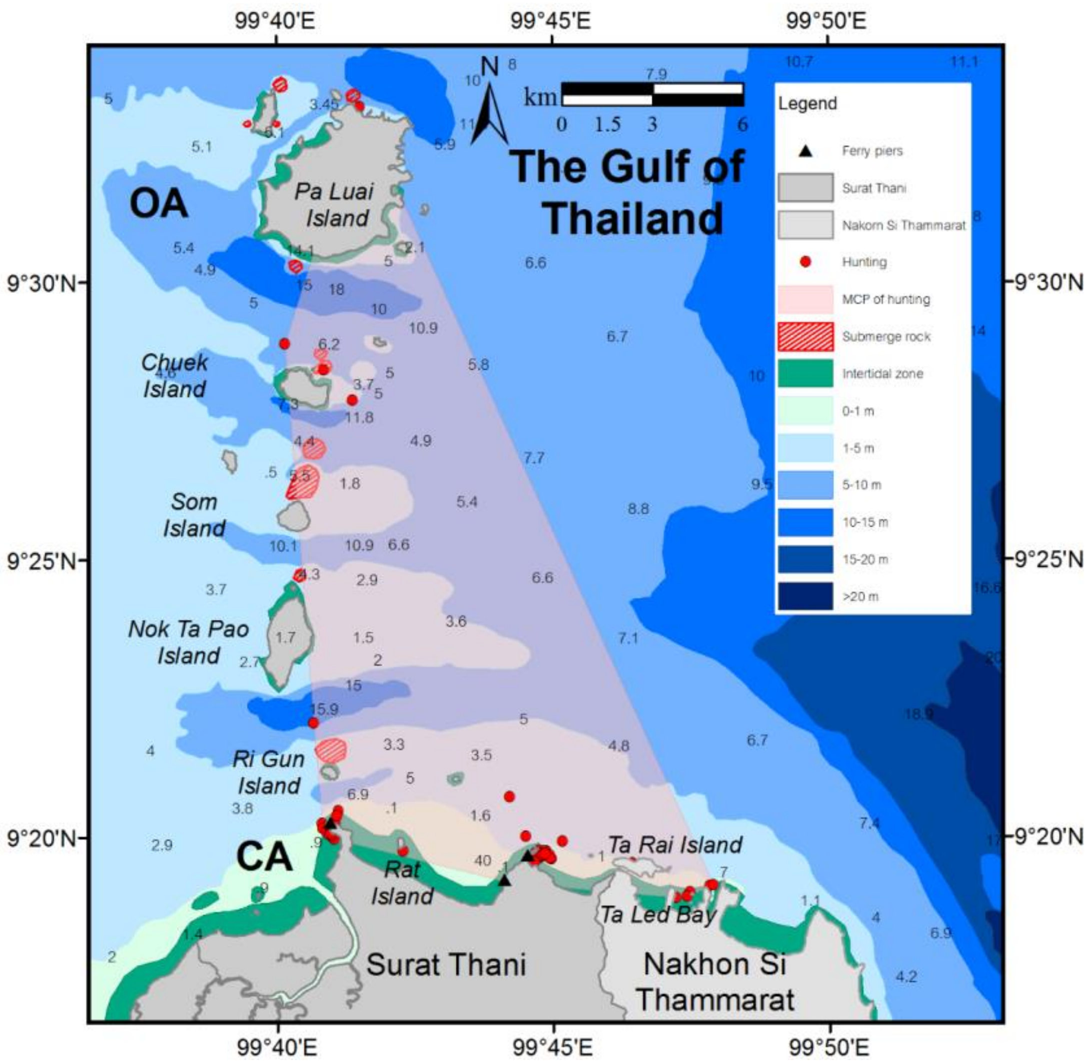

Figure 33 The location of hunting behaviour of Indo-Pacific humpback dolphins

The travelling locations showed less density of travelling behaviours near the coast. On the contrary, the distribution of travelling behaviour locations were found more often around the island off the shore, especially Chuek Island (Figure 34)

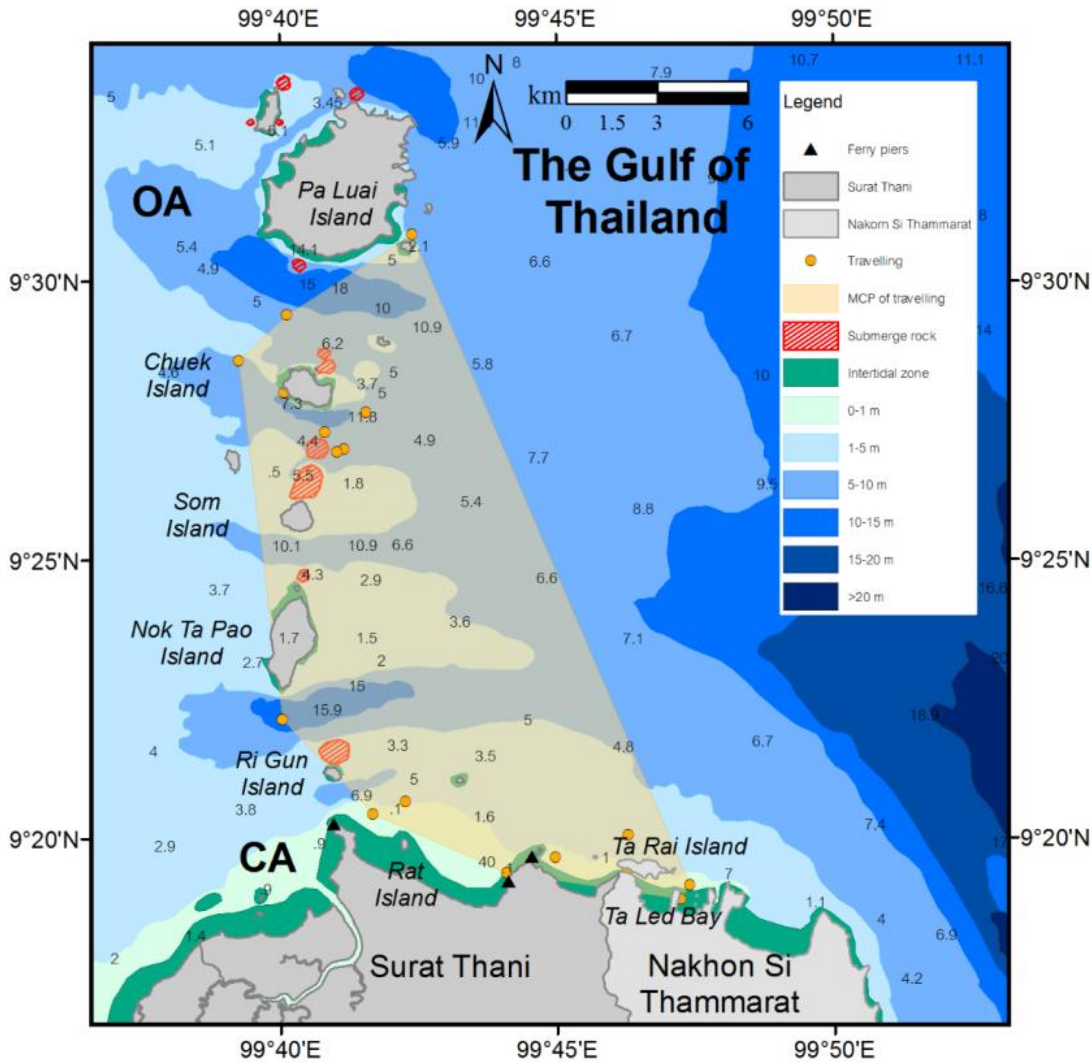

Figure 34 The location of travelling behaviour of Indo-Pacific humpback dolphins

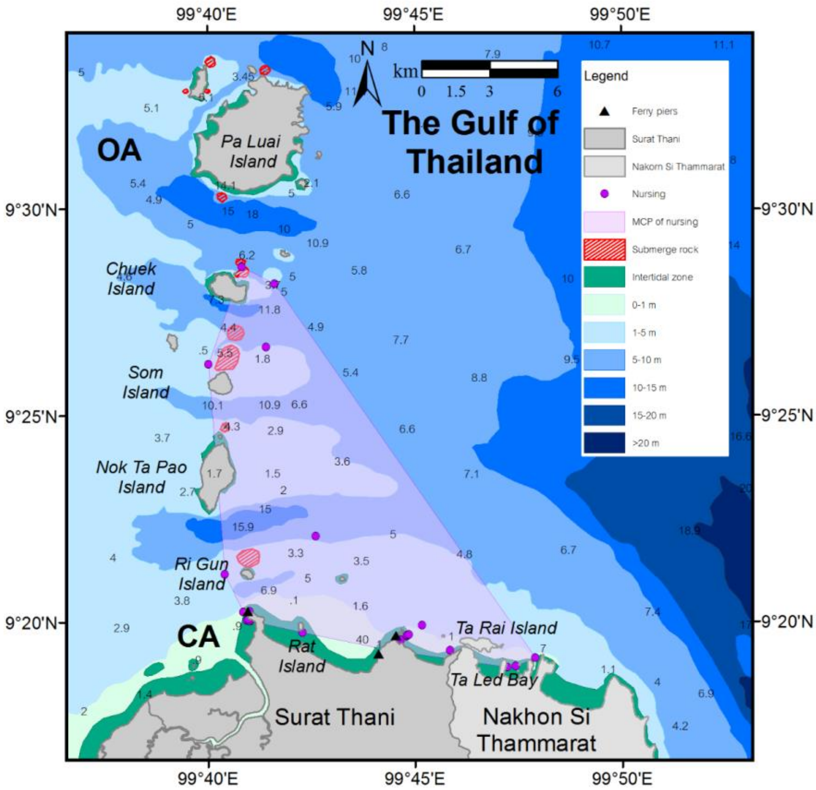

Figure 35 The location of nursing behaviour of Indo-Pacific humpback dolphins

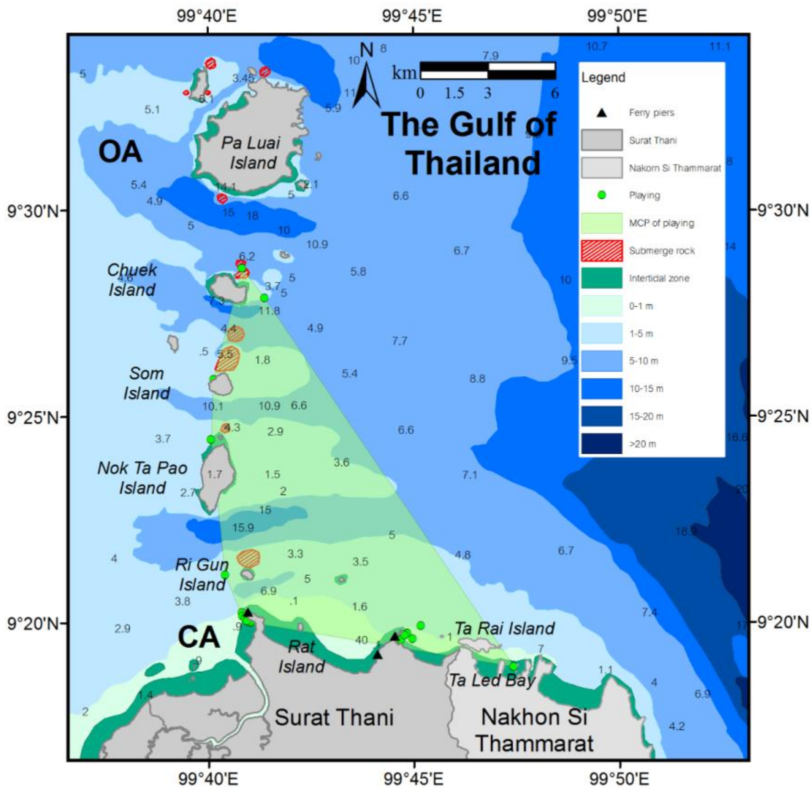

Figure 36 The location of playing behaviour of Indo-Pacific humpback dolphins

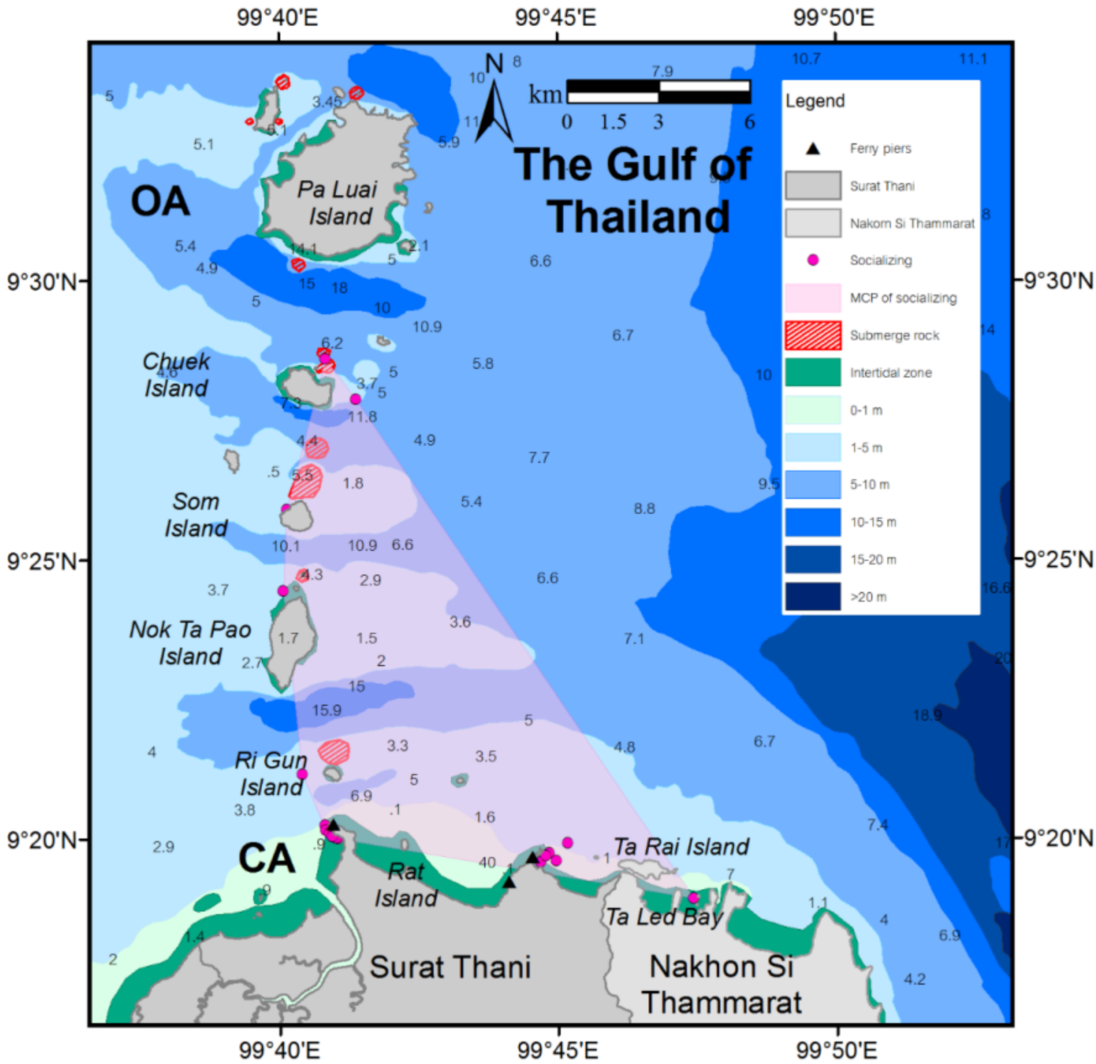

Figure 37 The location of socializing behaviour of Indo-Pacific humpback dolphins

Donsak Indo-Pacific humpback dolphins that were found more than once are shown in Appendix 2, along with the encountered date at each location. It appears that 91.5% of the 142 dolphins in the study were found in almost the same area. 12 individuals moved between CA and OA area, UC26, UC27, UC28, SJ20, SJ22, SA13, SA16, SA19, SA23, UA05, UA14 and UA23 (Appendix 2).

3.5 The Spatial Behaviour Standardization of Indo-Pacific Humpback Dolphins

The encountered behaviour of Donsak humpback dolphins was standardized to decrease the bias of survey effort in the study area (Figure 38-42). This study found that the location of hunting behaviours were distributed near the Som Serm Ferry, Sea Tran Ferry, Raja Ferry, Ta Rai Island, Ta Led Bay, Chuek Island and the North of Pa Luai Island (Figure 38).

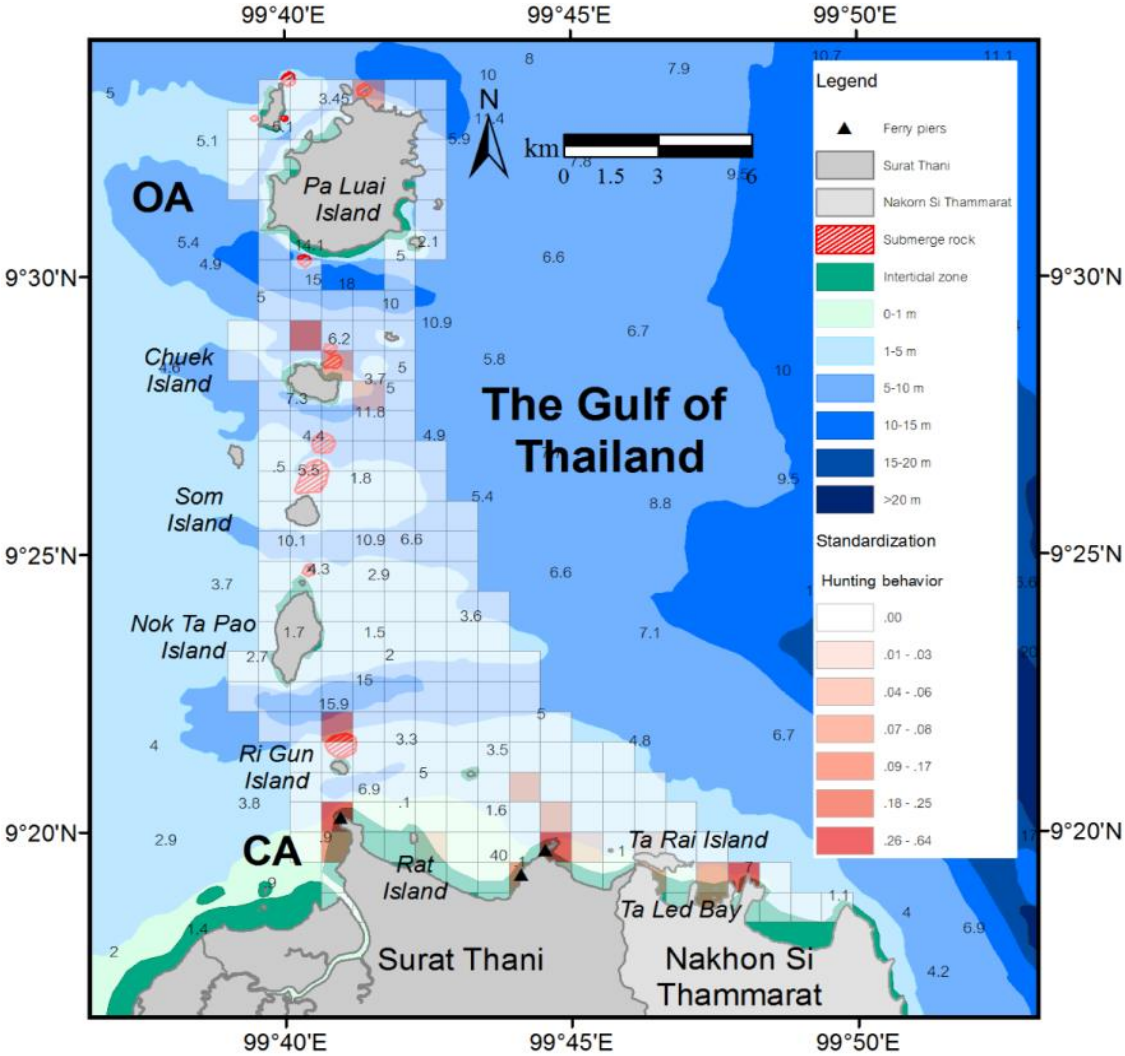

Figure 38 The hunting behaviour standardization of Indo-Pacific humpback dolphins

The standardization of travelling behaviours showed distribution near the Som Serm, Sea Tran and Raja Ferry piers, Ta Rai Island, Ta Led Bay, surrounding Chuek Island, the Southern Pa Luai Island, the western Nok Ta Pao and surrounding Ri Gun Islands (Figure 39).

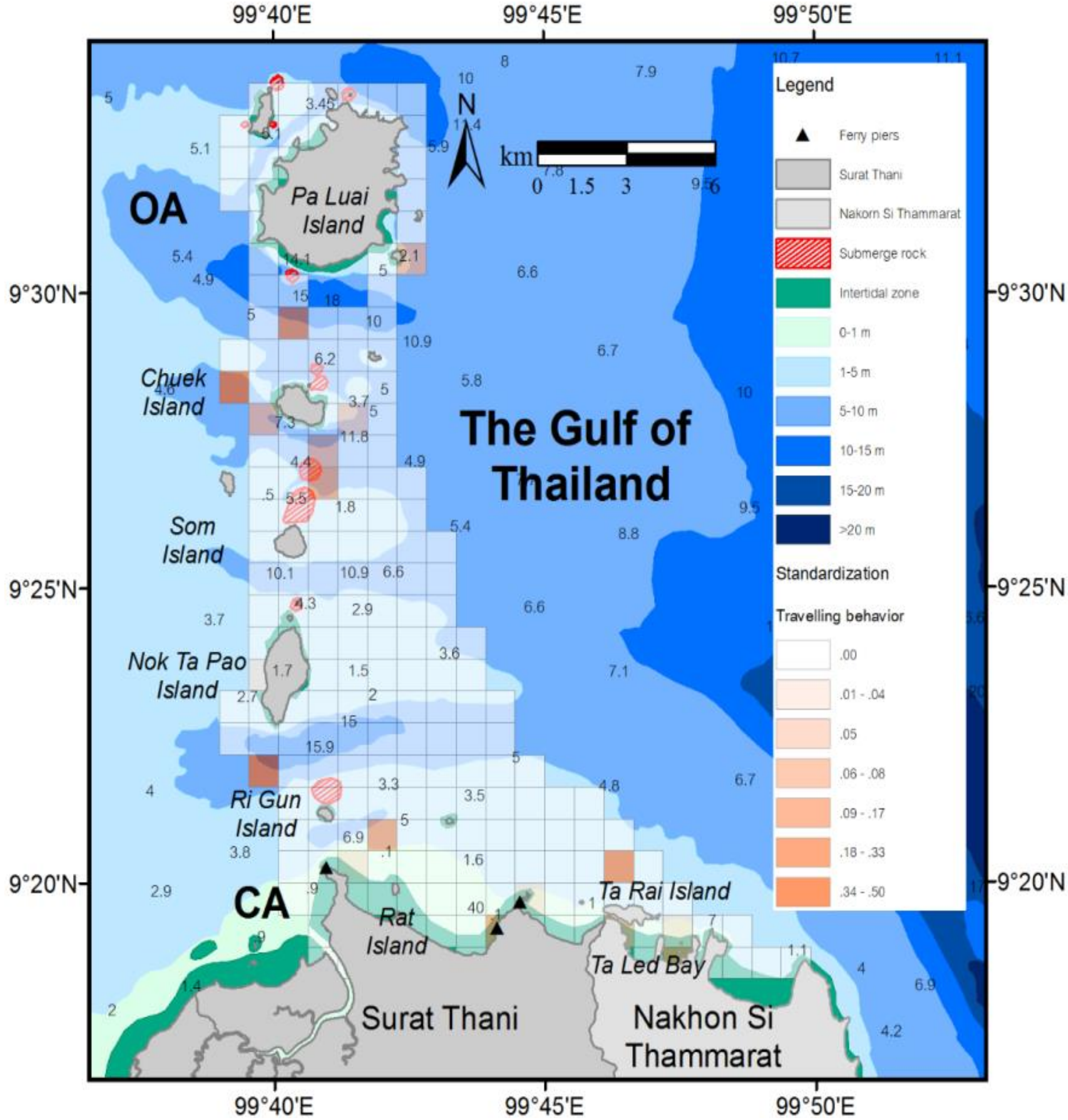

Figure 39 The travelling behaviour standardization of Indo-Pacific humpback dolphins

The standardization of nursing behaviours showed distribution near the Som Serm Ferry, Sea Tran Ferry, Raja Ferry, Ta Rai Island, Ta Led Bay, surrounding Chuek Island, the Southern Pa Luai Island, and the western Nok Ta Pao and surrounding Ri Gun Islands (Figure 40).

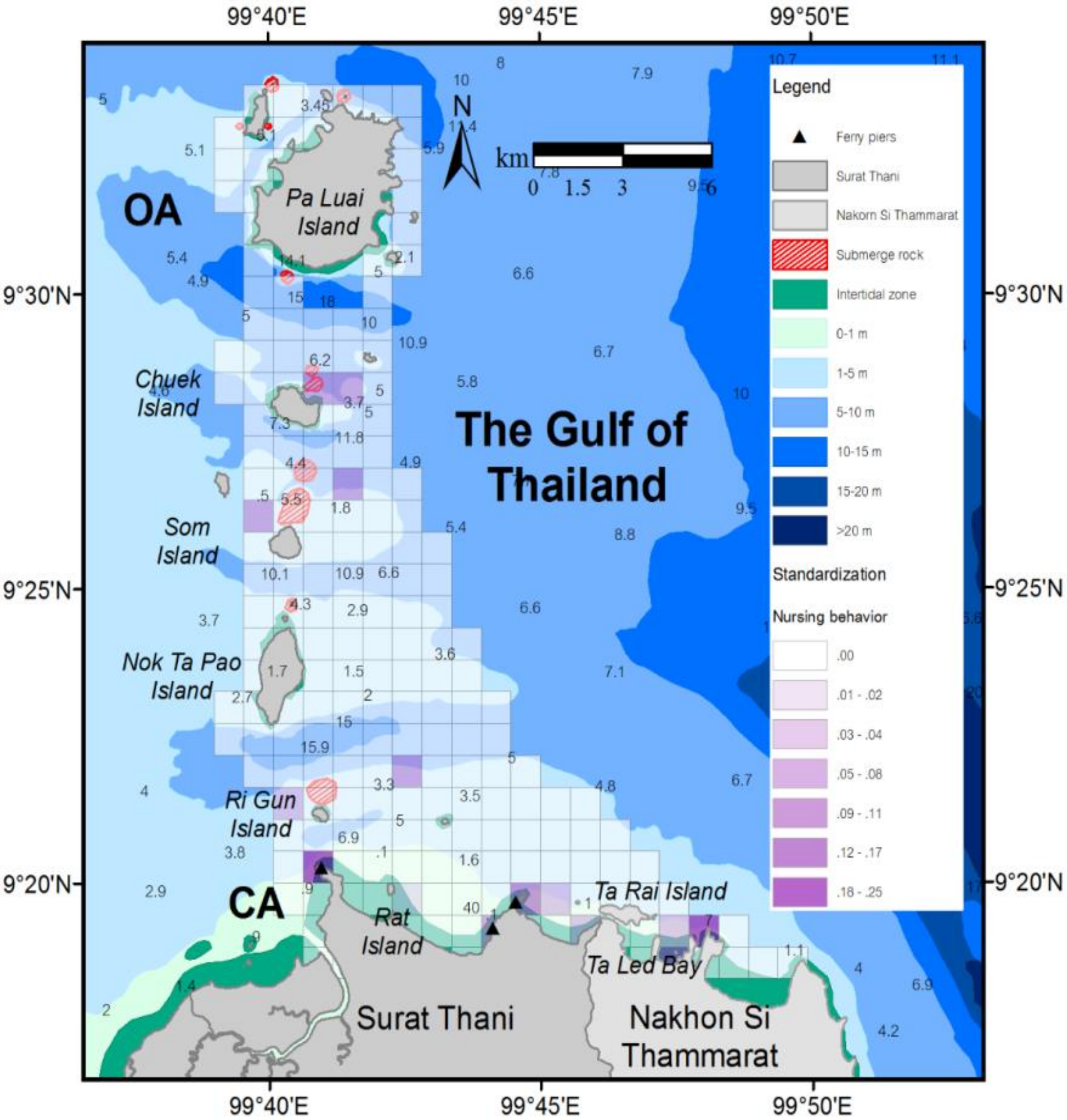

Figure 40 The nursing behaviour standardization of Indo-Pacific humpback dolphins

The standardization of playing and socializing behaviours showed distribution near the Som Serm Ferry, Sea Tran Ferry, Raja Ferry, Ta Led Bay, surrounding Chuek Island, and the northern Nok Ta Pao and Ri Gun Islands (Figure 41, 42).

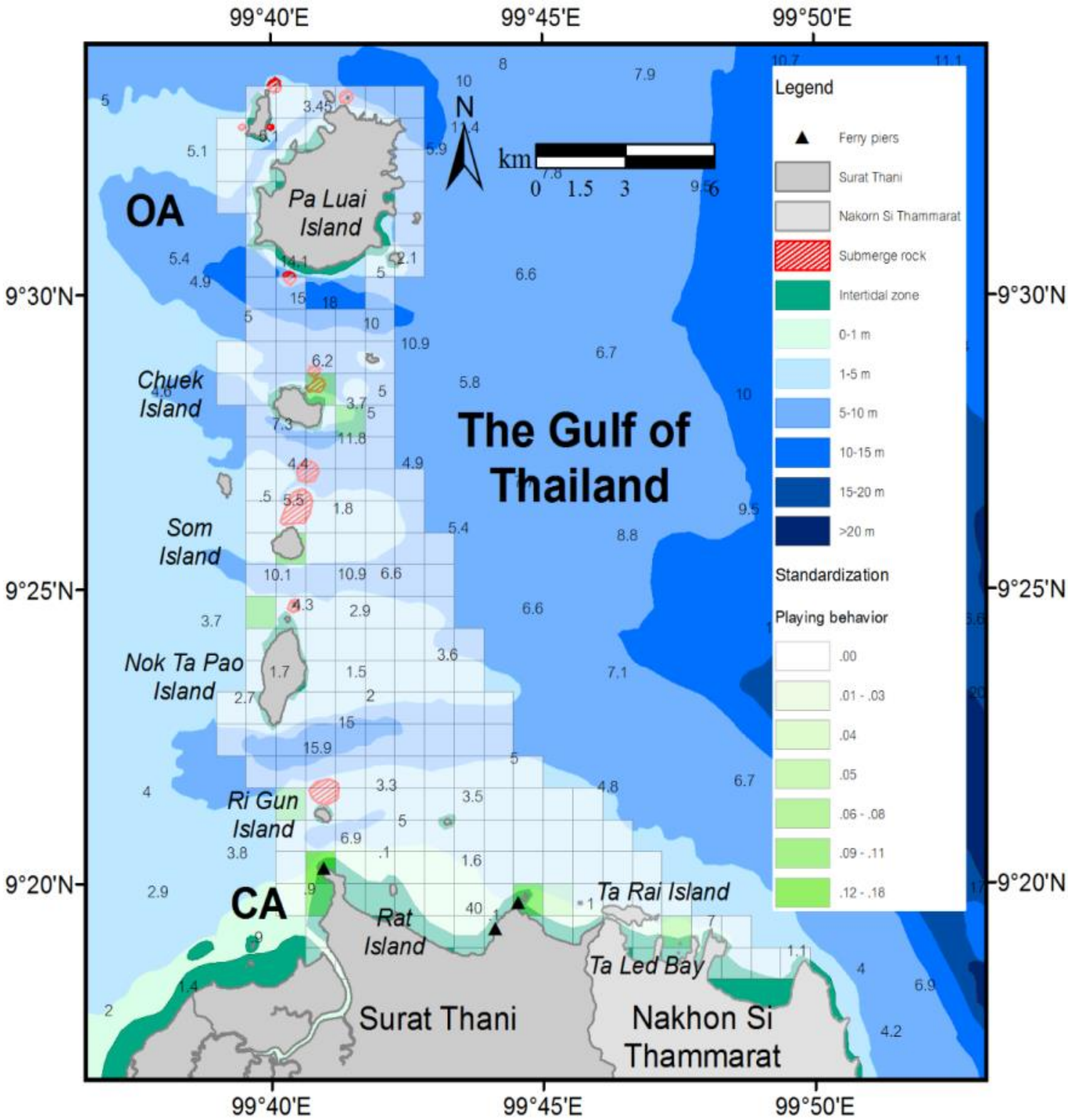

Figure 41 The playing behaviour standardization of Indo-Pacific humpback dolphins

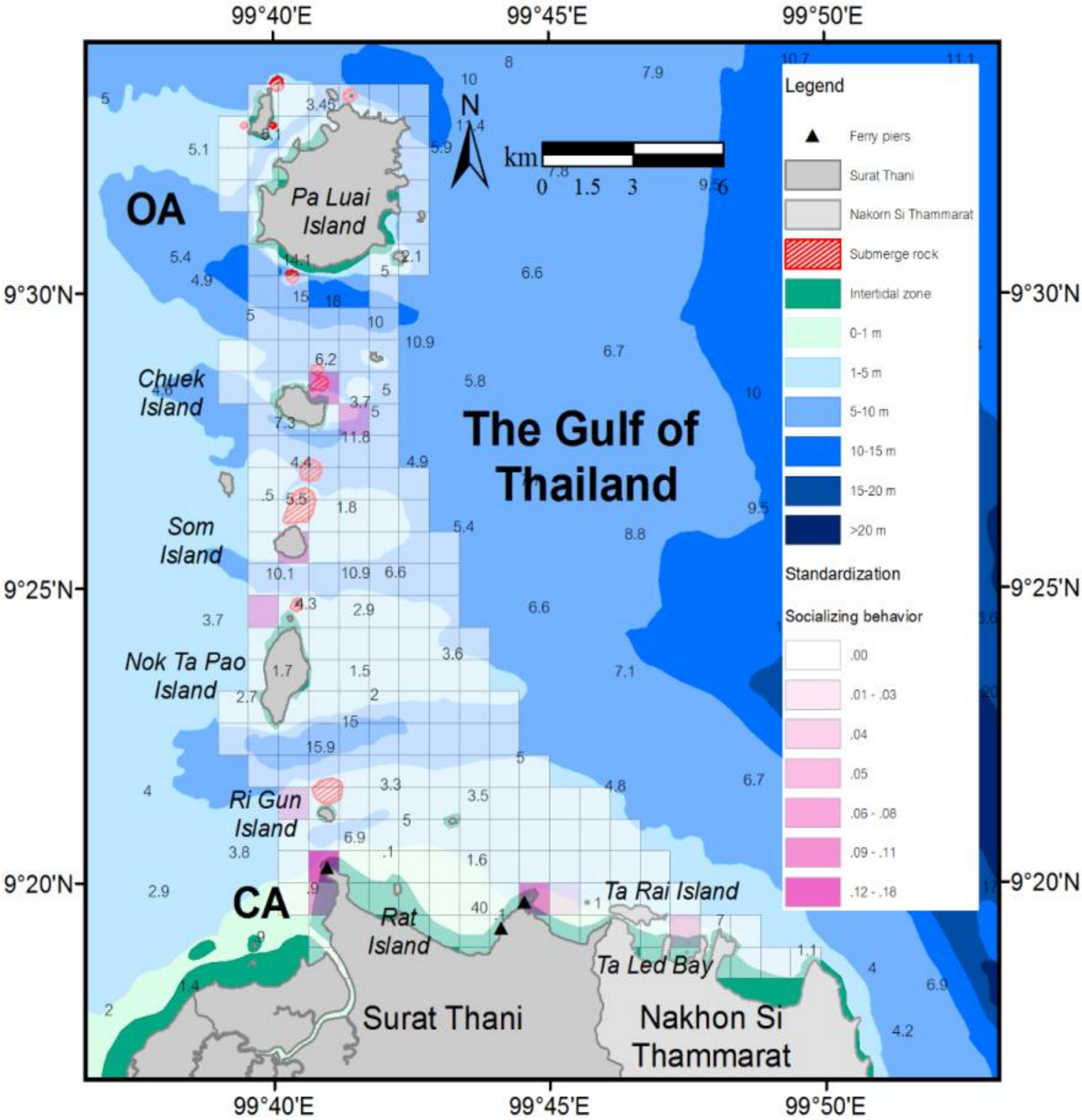

Figure 42 The socializing behaviour standardization of Indo-Pacific humpback dolphins

3.6 Photo-Identification

Over 45,000 photo images were taken, from which 142 individuals in total were identified with clear and perpendicular dorsal fin photos from both sides. Among the 142 identified individuals, 15 individuals were matched with previous reports in Jaroensutasinee *et al*. (2010). Figure 43 shows the category of Indo-Pacific humpback dolphins in Donsak water.

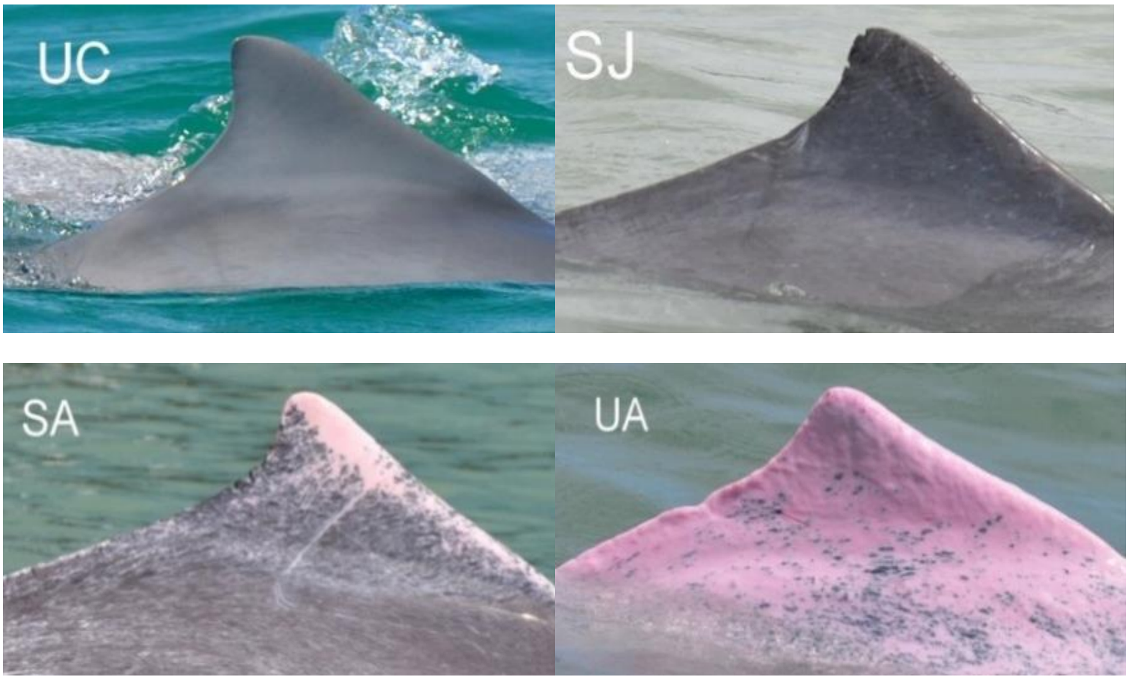

Figure 43 Indo-Pacific humpback dolphin age classes in Donsak water, UC: Unspotted Calves, SJ: Spotted Juveniles, SA: Spotted Adults, UA: Unspotted Adults

3.7 Population Size Estimation

3.7.1 Estimation of the Population Size from all Individual Sightings History

The 89 sightings of dolphin occurrences recorded 142 individuals in the study area that were used to calculate with basic POPAN parameterization on MARK software by Parm-Specific as Link function, Sin were Φ and P, mlogit(1) were b and logit was N. The Indo-Pacific humpback dolphin population size was 160 individuals with 152 – 178 at 95% CI.

3.7.2 Estimation of the Population Size with Age-Class Model

Individual sighting history of Indo-Pacific humpback dolphins were categorized into 4 age classes as 33 unspotted calves (UC), 37 spotted juveniles (SJ), 31 spotted adults (SA) and 41 unspotted adults (UA). Abundance (N, 95% CI) of the humpback dolphins was estimated using POPAN models in MARK software, presented in Table 9. Of the POPAN model tested, three parameters, Φ, p and b represent the apparent survival rate, probabilities of capture and probabilities of entry (Reisinger and Karczmarski, 2010), respectively, describe histories of animal sightings. Each parameter was described by either time $\{t\}$, age classes $\{g\}$, both time and age-class $\{g \times t\}$ or being unaffected by both t and g, $\{.\}$. $N\{g\} \cdot \Phi\{.\} \cdot P\{.\} \cdot b\{.\}$, $N\{g\} \cdot \Phi\{t\} \cdot P\{t\} \cdot b\{g\}$ and $N\{g\} \cdot \Phi\{g \times t\} \cdot P\{g \times t\} \cdot b\{g \times t\}$ did not reach numerical convergence that was the error of calculated results from unavailable parameters. $N\{g\} \cdot \Phi\{g\} \cdot P\{g\} \cdot b\{g\}$ was selected as the best fit model with the minimum of AICc (Table 9). The N (95% CI) estimated for different age classes based on this model was 36 (34 – 44), 58 (48 – 77), 40 (35 – 52), and 59 (51 – 75) for UC, SJ, SA, and UA, respectively. The total estimated number of dolphins was 193 with a 95% CI of 167–249.

Table 9 Abundance (N, 95% CI) of the humpback dolphins in Donsak, estimated by using POPAN model in MARK software. UC—unspotted calves, SJ—spotted juveniles, SA—spotted adults, UA—unspotted adults.

Model	AICc	ΔAICc	N (95% CI)	UC	SJ	SA	UA
$\Phi\{g\}\cdot p\{g\}\cdot b\{g\}\cdot N\{g\}$	48533	0	193 (167–249)	36 (34–44)	58 (48–77)	40 (35–52)	59 (51–75)
$\Phi\{t\}\cdot p\{g\}\cdot b\{g\}\cdot N\{g\}$	58363	9830	1178 (513–3036)	194 (92–474)	427 (184–1070)	203 (84–585)	354 (153–907)
$\Phi\{t\}\cdot p\{.\}\cdot b\{t\}\cdot N\{g\}$	58369	9836	914 (431–2215)	214 (101–520)	240 (113–580)	194 (91–475)	266 (126–640)
$\Phi\{.\}\cdot p\{g\}\cdot b\{t\}\cdot N\{g\}$	58419	9886	344 (235 – 578)	70 (52–105)	124 (76–231)	51 (40–75)	99 (68–167)
$\Phi\{g\}\cdot p\{g\}\cdot b\{t\}\cdot N\{g\}$	58420	9887	318 (224 – 520)	66 (50–99)	111 (71–202)	51 (40–75)	90 (64–144)
$\Phi\{.\}\cdot p\{.\}\cdot b\{t\}\cdot N\{g\}$	58421	9888	282 (218 – 398)	66 (51–95)	74 (57–104)	60 (46–86)	82 (64–114)
$\Phi\{g\}\cdot p\{.\}\cdot b\{t\}\cdot N\{g\}$	58423	9890	275 (213 – 386)	65 (50–93)	71 (56–99)	60 (46–86)	79 (62–108)
$\Phi\{.\}\cdot p\{.\}\cdot b\{.\}\cdot N\{g\}$	58453	9919	198 (171–249)	46 (40–59)	52 (45–65)	42 (36–54)	58 (50–71
$\Phi\{g\}\cdot p\{.\}\cdot b\{g\}\cdot N\{g\}$	58454	9921	196 (170–246)	46 (40–58)	51 (44–63)	42 (36–54)	57 (50–70)
$\Phi\{g\}\cdot p\{g\}\cdot b\{.\}\cdot N\{g\}$	58456	9923	203 (172–263)	46 (39–58)	58 (48–77)	40 (35–52)	59 (51–75)
$\Phi\{.\}\cdot p\{g\}\cdot b\{.\}\cdot N\{g\}$	58457	9924	201 (172–258)	46 (39–58)	56 (47–72)	41 (35–54)	58 (50–73)
$\Phi\{.\}\cdot p\{g\}\cdot b\{g\}\cdot N\{g\}$	58457	9924	201 (172–259)	46 (39–59)	56 (47–73)	41 (35–55)	58 (50–74)

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3.8 PCA Analysis of Environmental Parameters

The environmental parameters were measured 83 times out of 89 sightings, which were enumerated for 440 records of parameters on every individual. PCA showed the group of each category in Figures 44-48. The ellipses surround the group of environmental parameters that were categorized with encountered position, coastline and offshore, habitat characteristics and season. The ellipses showed the probability of environmental parameters that were close to each category.

The offshore islands, Jae Island (JI), Pa Luai Island (PLI), the area between Chuek and Paluai Island (CPI), Som Island (SI) and Nok Ta Pao Island (NTPI) were grouped separately from the encountered positions on the coastline, Sea Tran Ferry (STF), Som Serm Ferry (SSF), Raja Ferry (RF), Ta Rai Island (TRI), Ta Led Bay (TLB) and Pi Island (PI) (Figure 43, 44).

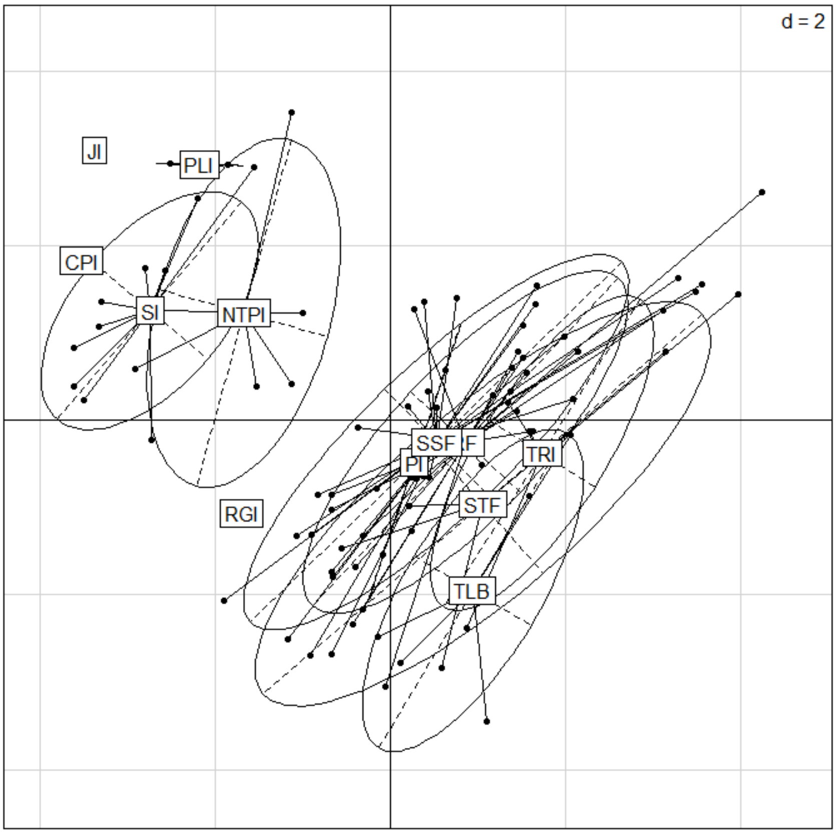

Figure 44 PCA analysis with encountered position name, SSF - Som Serm Ferry, RF - Raja Ferry, SI - Som Island, NTPI - Nok Ta Pao Island, TLB - Taled Bay, RGI-Ri Gun Island, STF - Sea Tran Ferry, TRI - Ta Rai Island, PLI - Pa Luai Island, CPI - between Chuek and Pa Luai Island

Figure 45 Representation of the PCA analysis showed the group of Indo-Pacific humpback dolphins clearly found near the coastline more than those of the offshore area

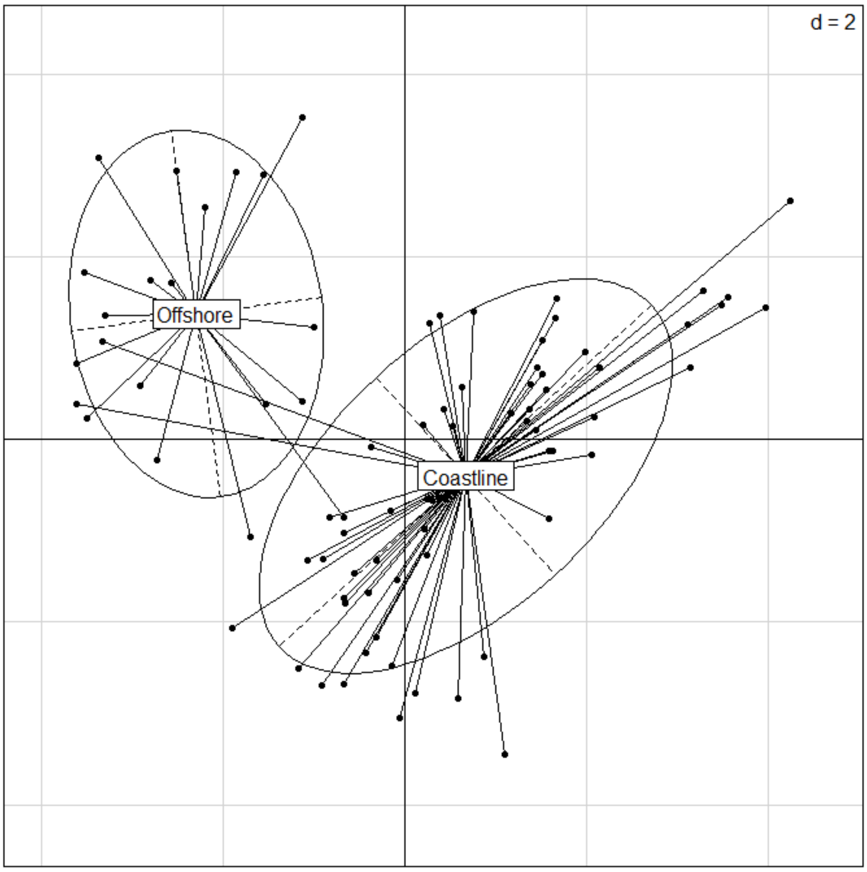

Figure 45 PCA analysis with coastline and offshore area of encountered locations of Indo-Pacific humpback dolphins in the study area

In case of habitat use, the categorization of the habitat area showed the group of dolphins having a habitat in a man-made structure, mud flat and sea grass area in the same group. On the other hand, lower numbers of dolphins were found in rocky shores and sandy beach areas (Figure 46). The rocky shores (RS) and sandy beaches (SB) were surrounded with two ellipses that were not overlapped with mud flats (MF), man-made structures (MM) and sea grass beds (SG) (Figure 46).

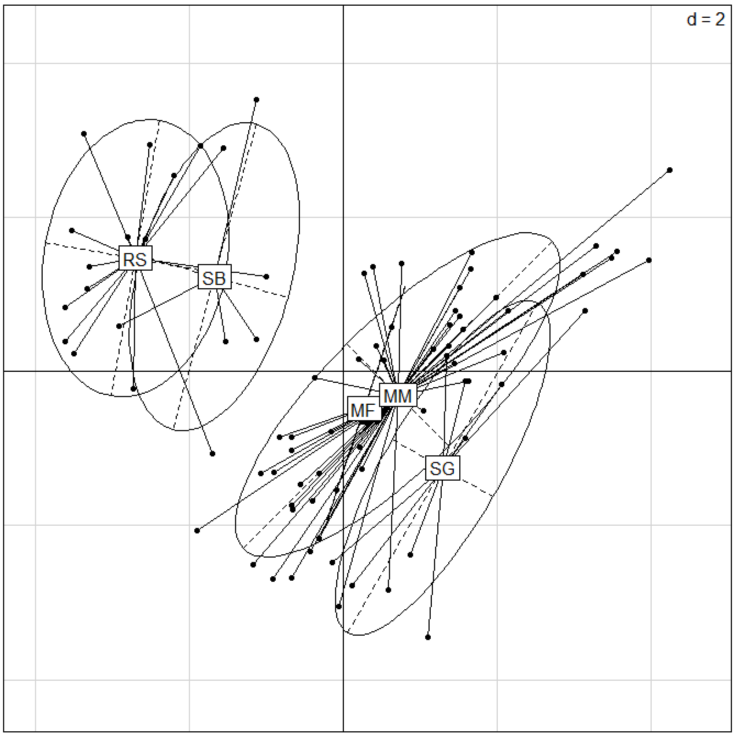

Figure 46 PCA analysis with habitat characteristics (RS: rocky shores, SB: sand beaches, MF: mud flats, MM: man-made structures and SG: seagrass area)

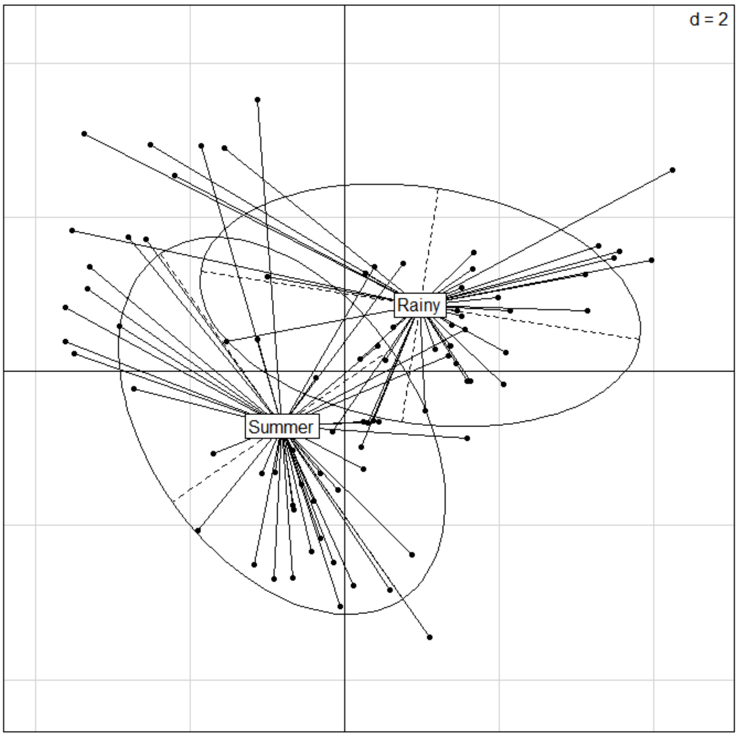

Figure 47 PCA analysis with seasonal data

The partial overlap of two ellipses between the rainy and summer seasons are shown in Figure 47. The climate in southern Thailand was separated into 2 seasons (rainy and summer). Figure 47 represents the occurrences of dolphins that were grouped in the seasonal PCA analysis. It shows the possibility of encountered behaviour between 2 seasons similarly. Furthermore, Figure 47 implies the chances of encountering dolphins in different environmental parameters of 2 seasons all year long.

The five ellipses of behaviours on PCA analysis were overlapped. It is possible that the environmental parameters were not related to each dolphin behaviour or that there are no specific groups of environmental parameters that show the behaviour individually (Figure 48).

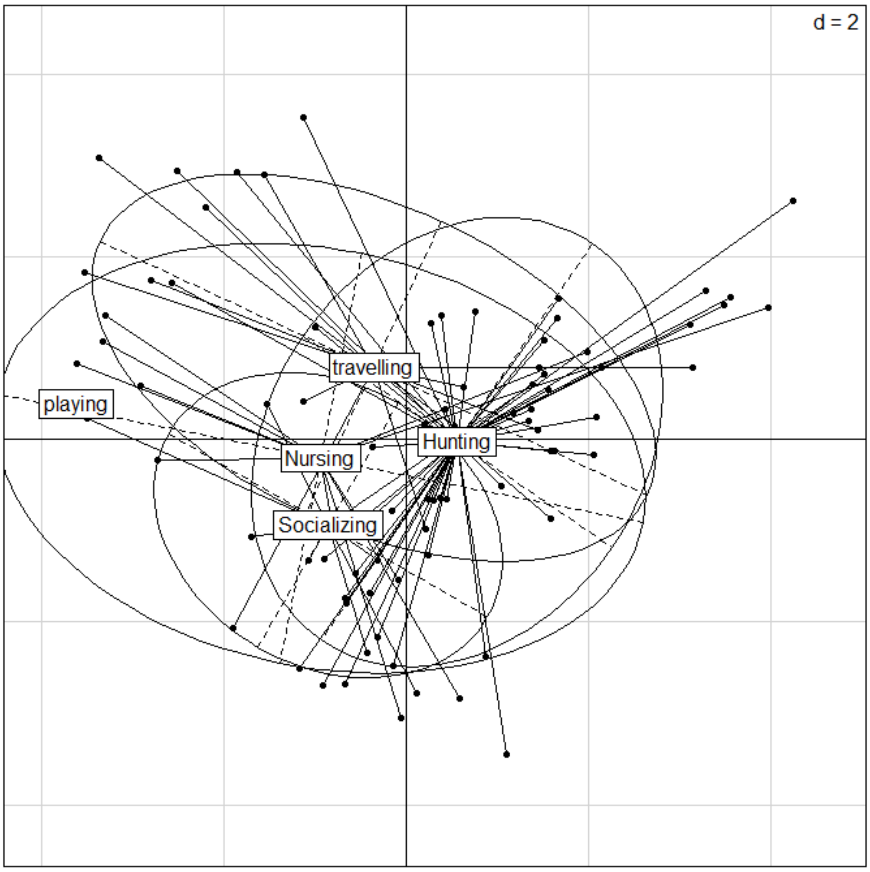

Figure 48 PCA analysis with encountered behaviours (playing, travelling, nursing, hunting and socializing)

The CCA showed that DS, WD and SD were significantly different from the habitat characteristics of the humpback dolphin population in the study area (Table 10).

Table 10 Range, Mean (SD) and CCA of environmental characteristics

Factors	Range	Mean ± SD	CCA		r^2
			Axis1	Axis2	
DS (m)	17–2,976.73	468.21±603.06	-0.633	-0.774	0.2692***
WD (m)	1.70–16.40	4.92±2.73	-0.999	0.037	0.4884***
SD (m)	0.5–3	1.27±0.61	-0.999	0.019	0.4243***
SST (°c)	26.60–32.60	29.95±1.38	-0.920	0.392	0.0126
pH	7.15–9.07	8.22±0.31	0.257	0.967	0.0101
SN (ppm)	25-35	30.22±2.28	0.987	0.163	0.0366
TD	0–1	0.67±0.47	-0.523	0.852	0.0509
CC	0–1	0.08±0.28	0.549	0.836	0.0187
WP	0–1	0.35±0.48	0.727	0.686	0.0150
SL	0–2	1.65±0.57	-0.927	0.375	0.0662
RN	0–1	0.02±0.11	0.368	0.930	0.0187
BF	0–2	0.33±0.50	0.999	0.051	0.0063

***: $P < 0.001$, **: $P < 0.01$, *: $P < 0.05$, .: $P < 0.1$, : $P < 1$

DS – Distance of the shore, WD – Water depth, SD – Sechi Disc (Water transparency), SST – Sea surface temperature, SN – Salinity, TD – Tidal, CC – Cloud cover, WP – Wind power, SL – Sunlight, RN – Rain, BF – Beaufort sea state

3.9 Environmental Characteristics on Age Classes Categorization

Table 11 summarizes the environmental characteristics recorded during the sightings for different age classes. For environmental characteristics, six out of the 89 total sightings were not measured and were excluded from analysis because of bad weather conditions (Beaufort Sea State, BF > 2) during those sightings. Out of 11 examined environmental characteristics, four were significantly different among the four age classes: the distance off the shore, DS (Kruskal Wallis, $KW = 11.20$, $P < 0.05$), secchi disc, SD (Kruskal Wallis, $KW = 16.17$, $P < 0.01$), sea surface temperature, SST (Kruskal Wallis, $KW = 16.17$, $P < 0.1$), and pH (Kruskal Wallis, $KW = 16.17$, $P < 0.1$) (Table 11).

Table 11 Age classes (n: Sample size), Range, Mean (SD) and Kruskal–Wallis test of environmental characteristics among different age classes (DS—distance off shore, WD—water depth, SD—secchi disk (turbidity), WT—water temperature, TD—tidal, CC—cloud cover, WP—wind power, SL—sunlight, RN—rainy, BF-Beaufort sea state)

Parameters	UC (101)		SJ (103)		SA (137)		UA (98)		
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	χ^2
DS (m)	17.00-2976.73	501.80±559.46	17.00-2556.00	438.19±553.32	28.45-2976.73	527.8±589.16	53.00-2556.00	597.86±618.21	11.20*
WD (m)	1.90-12.70	4.58±1.99	1.70-16.40	4.73±2.41	1.70-16.40	4.75±2.78	1.70-16.40	5.42±3.12	3.99
SD(m)	0.50-3.00	1.33±0.57	0.50-3.00	1.29±0.56	0.50-3.00	1.18±0.54	0.5-3.0	1.43±0.63	16.17**
WT (°C)	27.30-32.60	29.91±1.31	27.30-32.60	30.22±1.33	26.60-32.60	29.82±1.36	27.30-32.60	30.22±1.24	9.65*
pH	7.15-9.07	3.19±0.28	7.15-9.05	8.20±0.27	7.15-9.07	8.18±0.29	7.89-9.06	8.20±0.25	9.68*
TD	0.00-1.00	0.59±0.49	0.00-1.00	0.69±0.46	0.00-1.00	0.66±0.47	0.00-1.00	0.69±0.46	3.52
CC	0.00-1.00	0.11±0.31	0.00-1.00	0.08±0.27	0.00-1.00	0.12±0.32	0.00-1.00	0.05±0.22	3.83
WP	0.00-1.00	0.30±0.46	0.00-1.00	0.39±0.49	0.00-1.00	0.39±0.49	0.00-1.00	0.34±0.47	2.82
SL	0.00-2.00	1.56±0.65	0.00-2.00	1.66±0.58	0.00-2.00	1.55±0.67	0.00-2.00	1.72±0.51	5.76
RN	0.00-1.00	0.03±	0.00-1.00	0.02±0.14	0.00-1.00	0.03±0.17	0.00-1.00	0.01±0.10	1.29
BF	0.00-2.00	0.27±0.46	0.00-2.00	0.35±0.52	0.00-2.00	0.34±0.50	0.00-1.00	0.32±0.47	1.51

*: $P < 0.05$, **: $P < 0.01$

UC – Unspotted calves, SJ – Spotted Juveniles, SA – Spotted Adults and UA – Unspotted Adults

Based on PCA, the 11 examined characteristics were transformed into three independent components, PC1, PC2 and PC3 (Table 12). Stepwise discriminant analysis revealed that PC3 (F = 3.459, P < 0.05) was the only variable that was significantly different among the four age classes (Wilk's λ = 0.977, P < 0.05) while the other two were not (F = 1.734 and 0.864, P = 0.16 and 0.46 respectively).

Table 12 Principal component analysis for environmental characteristics at the sighting points

Parameters	PC1	PC2	PC3
DS	0.0623	0.0507	0.7303
WD	0.0531	0.2079	0.7542
SC	0.1923	-0.2536	0.7835
SST	0.4669	-0.2706	0.4120
pH	0.3333	-0.5819	-0.1832
TD	-0.1623	0.6142	0.2931
CC	-0.8546	0.1042	-0.1631
WP	0.0693	0.8855	-0.1444
SL	0.8188	-0.0853	0.1510
RN	-0.7490	-0.1164	0.0304
BF	0.1121	0.8185	-0.1876
eigenvalue	2.3783	2.3849	2.1114
% variance explained	21.62%	21.68%	19.19%

Mean (SE) of PC3 (primarily determined by DS, WD and SC) in different age classes of the humpback dolphins are shown in Figure 49. UA had a significantly higher PC3 than the other three age classes (Generalized Linear Model: GLM, ANOVA F = 3.459, P < 0.05) while the difference of PC3 among UC, SJ and SA was not statistically significant (Table 13).

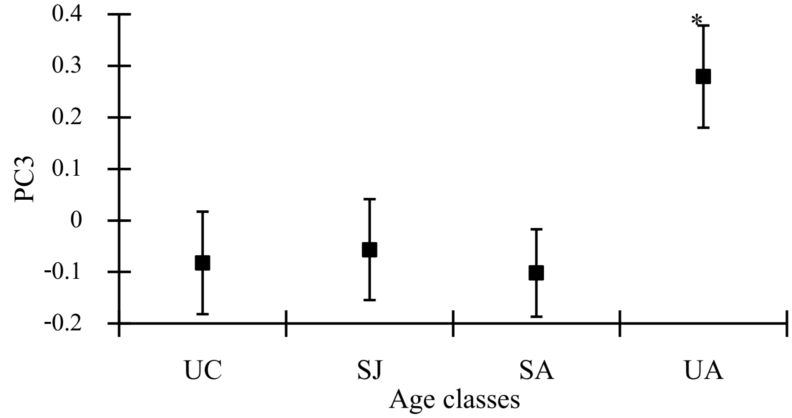

Figure 49 Mean (SE) of PC3 (primarily determined by DS, WD and SC) in different age classes of the humpback dolphins. PC3 of UA was significantly higher than the other three age classes (Generalized linear model–GLM, ANOVA $F = 3.459$, $P < 0.05$).

Table 13 Difference (F-matrix) of PC3 among different age classes tested by discriminant analysis

	UC	SJ	SA
SJ	0.034		
SA	0.022	0.122	
UA	6.605 *	5.814*	8.523*

*: $P < 0.05$

3.10 The Experiences of Fishermen

3.10.1 The Opportunity for Dolphin Encounters by Fishermen

By the end of the survey period, data had been collected from 82 fishermen, comprising 73 males and 9 females. They were interviewed from two districts, Donsak District, Surat Thani Province and Khanom District, Nakhon Si Thammarat. The fishermen were interviewed between January 2013 – December 2013. The fishing areas of the interviewed fishermen were off the shore of Donsak District, Surat Thani Province and Khanom District, Nakhon Si Thammarat Province. Their fishing gear were used for many species such as fish, crabs, shrimp, rays, squids etc.

The dolphin encounter opportunities of fishermen are shown in Figure 50. 41% of the 82 fishermen found dolphins every time they went fishing. The encountered periods of fishermen experiences were separated into every 3 hours and dolphins were found between 06.01-21.00. The highest period of dolphin encounters was between 06.01-09.00, which accounted for 41% of the time (Figure 50). 1 % of 82 fishermen never found dolphins while they were fishing. 41% of fishermen found dolphins in the study area every time (Figure 51). The dolphins were found by fishermen during the entire year, but the best opportunity to find dolphins was in May and the fewest was in March (Figure 52).

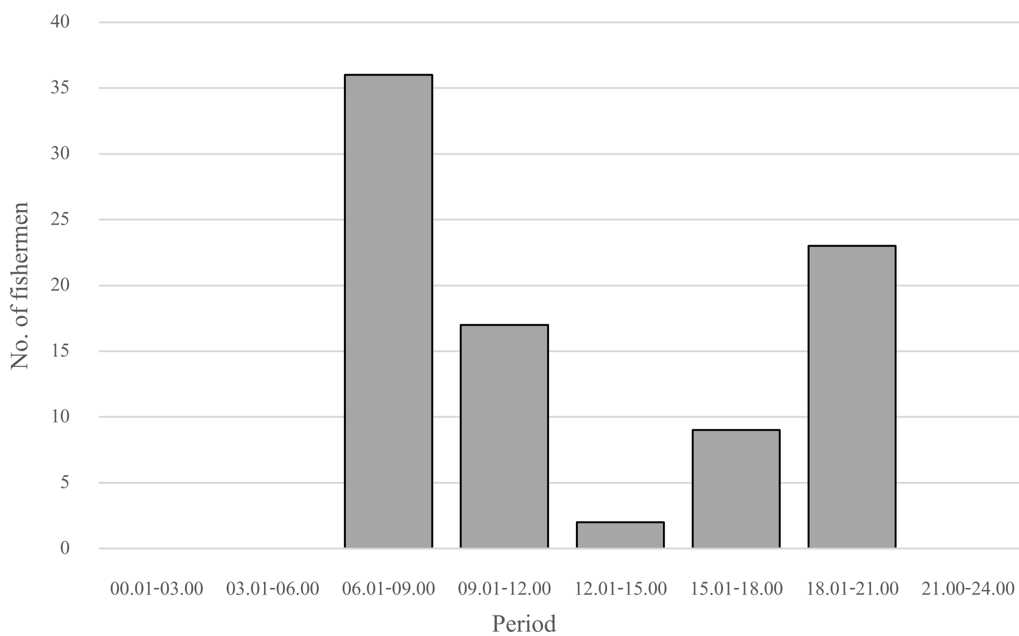

Figure 50 The encountered period from fishermen experiences

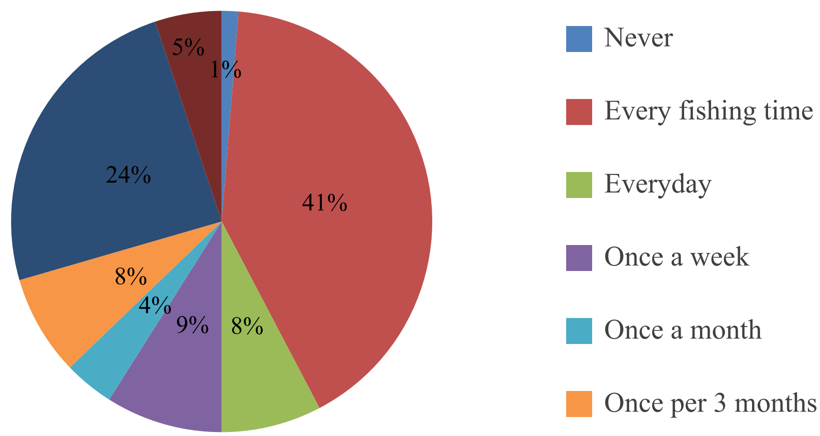

Figure 51 The chances of dolphin encounters by fishermen interviews

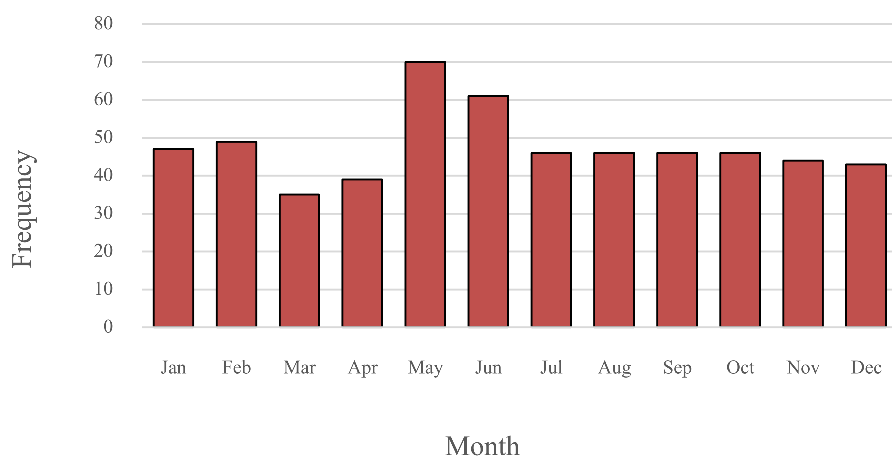

Figure 52 The period of opportunity to find dolphins during the entire year

3.10.2 The Fishermen and Dolphin Relationships

75% of the 82 fishermen found dolphins swimming around their fishing gear (Figure 53). 16% didn't know what the dolphins were doing in the fishing area and 8% thought that the dolphins were herding fish into the fishing gear (Figure 53). Only one percent never saw dolphins while fishing in the study area. The responses of the 82 fishermen, due to the fact that dolphins were encountered, are shown in Figure 54. 49% threw fish to the dolphins, 34% didn't mention the dolphins and continued fishing, while 17% expelled them away from fishing gear.

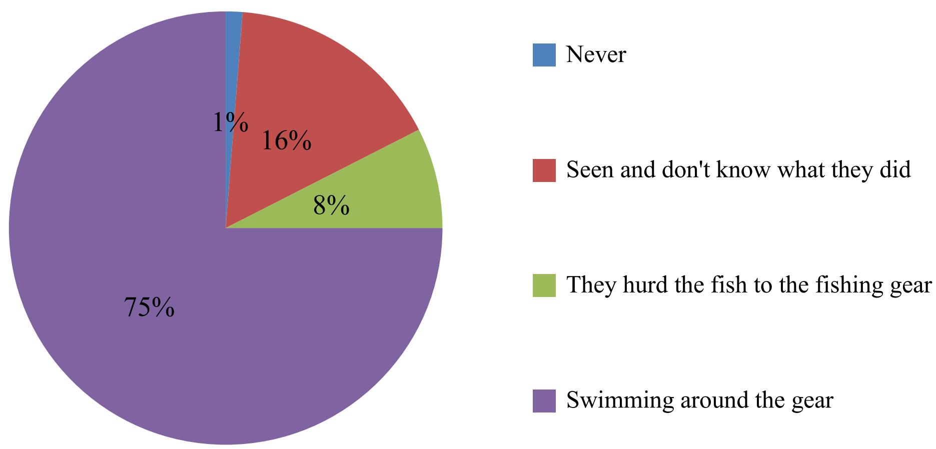

Figure 53 The fishermen found that the dolphins swam around fishing gear

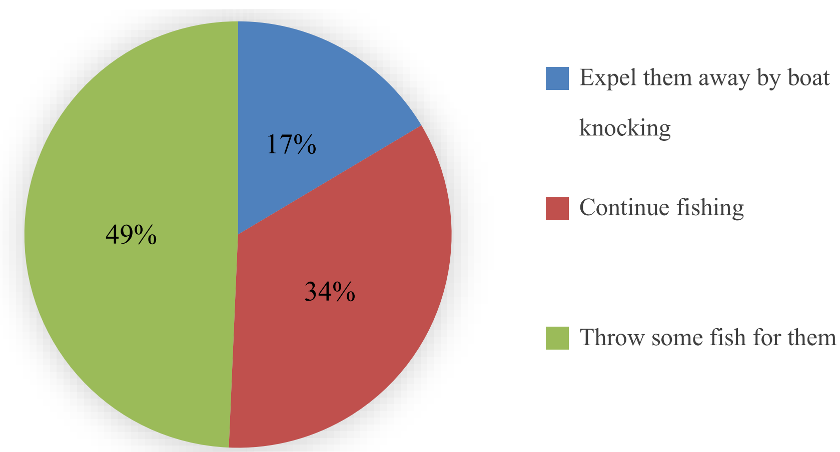

Figure 54 The responses of the fishermen when they found that the dolphins swam near fishing gear

The amount of fish between the presence and absence of dolphins around the fishing gear was compared to determine the attitude of fishermen and shown in Figure 55. 58% of fishermen didn't see a difference between the amount of fish. 41% thought that they had gained more fish if they found dolphins around the fishing gear. In addition, the positive attitudes of fishermen about dolphins include fish resources being shared by throwing the lower price fish to feed the dolphins in the study area (Figure 56).

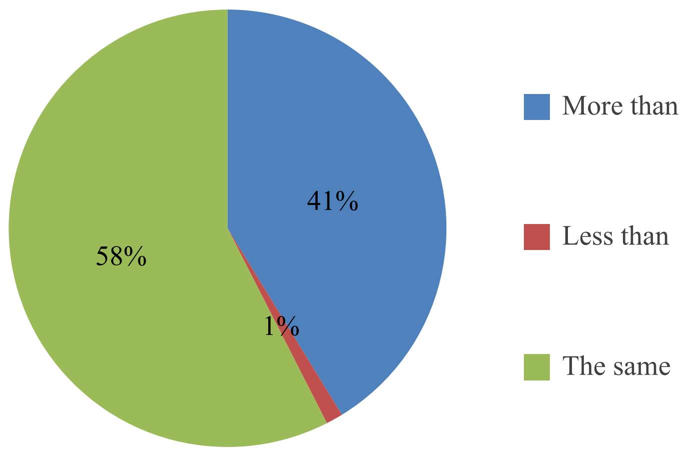

Figure 55 The opinion of fishermen that the amount of fish related to the presence or absence of dolphins surrounding fishing gear

29% of fishermen threw fish that they caught because they sympathized with the dolphins and 29% of other fishermen threw fish because they thought the fish they caught were too small to sell in the market (Figure 56). Both 15% of fishermen threw the fish because the prices of some fish species were low and they thought it was a good chance to see the dolphins (Figure 56).

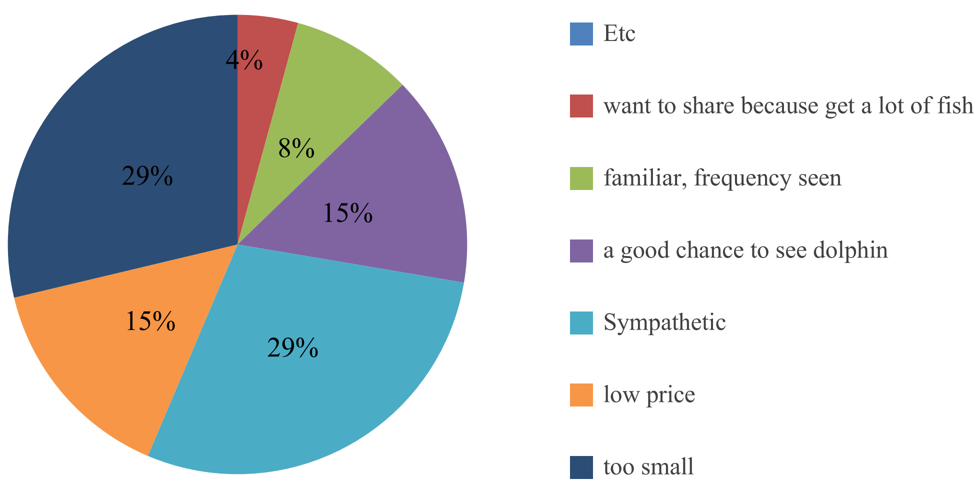

Figure 56 The reasons why fishermen feed fish to dolphins

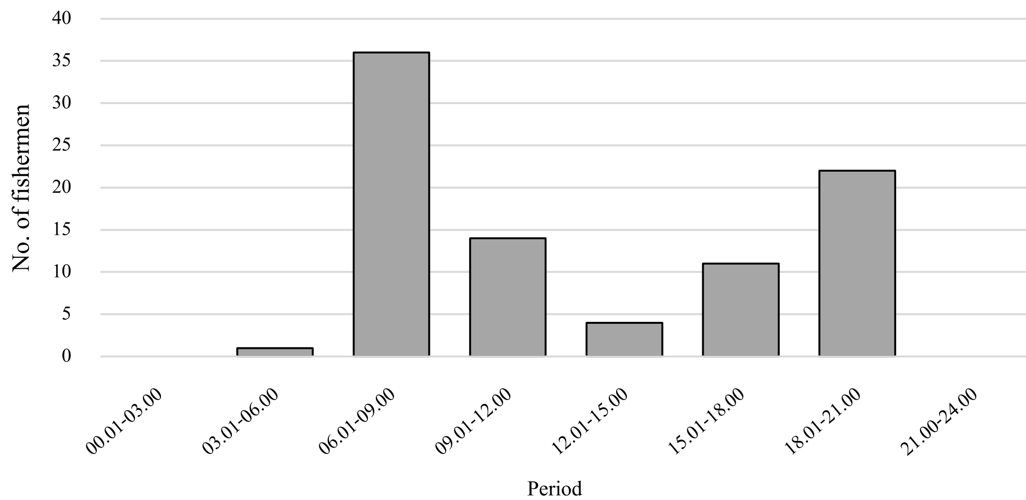

Figure 57 The period that fishermen found dolphins surrounding fishing gear

3.10.3 The Dolphin Tourism Period from Fishermen Interviews

The fishermen in Khanom District, Nakhon Sit Thammarat could be tour guides when they have spared time. The fishermen cruised their long tail boats around Taled Bay. Dolphin-watching tourism started from 06.00 – 16.00, but the highest frequency of tourism was during 08.01 – 10.00 (Figure 58).

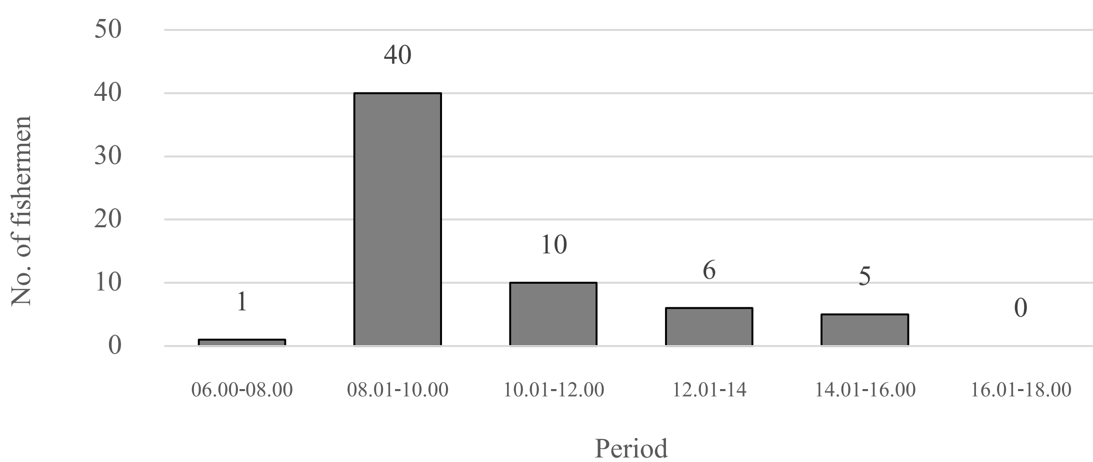

Figure 58 The period of dolphin tourism at Khanom District, Nakhon Si Thammarat Province

The fishing period of fishermen in the study area was between 03.00-21.00 (Figure 57). 50% of the 82 fishermen waited for the fishing gear they left in the water for 2-6 hours, while 31% and 19% waited less than 2 hours and for 7-12 hours, respectively (Figure 59).

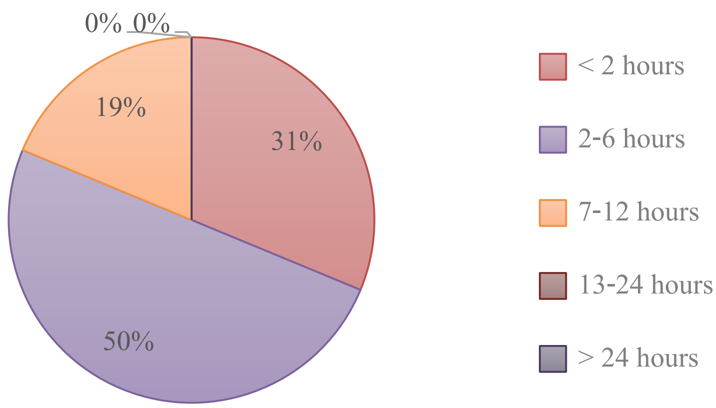

Figure 59 The waiting time for fishing gear leaving.

3.10.4 Dolphin Distribution from Fishermen Interviews

The 82 fishermen marked their fishing areas on the overlaid 1 km^2 grid map of the study area. All dolphin positions from two questions were plotted by geographic information system software. The map of dolphin positions from fishermen explained dolphin distribution in the study area. Firstly, the position of frequency found an area that the fishermen didn't fish. They passed through and saw them swimming around the study area frequently. Secondly, the dolphins swam around the fishing gear area (Figure 60). The fishermen were familiar with the dolphins in the fishing area. The MCP of frequently found area was 138.11 km^2 and the MCP of dolphins that swam near the fishing area was 497.94 km^2. The intersected area is close to the shore and covers the islands off the shore, Ri Gun, Nok Ta Pao, Som and Chuek Islands (Figure 60).

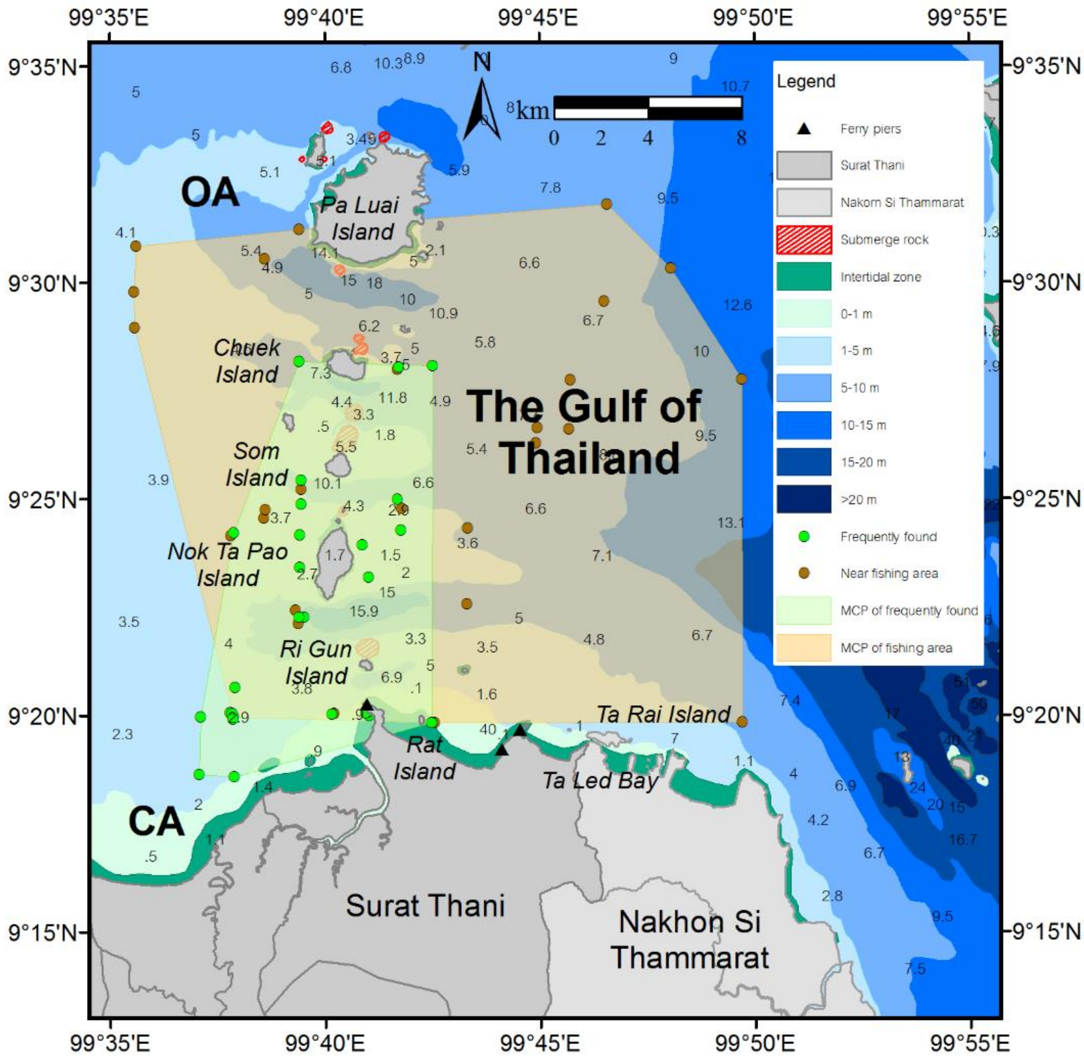

Figure 60 The overlapping area of distribution from fishermen interviews

CHAPTER 4

Discussion

4.1 Survey Effort Standardization, Encountered Period and Encountered Frequency

It would have been more effective to describe the Indo-Pacific humpback dolphin distribution without the bias of survey efforts. In coordination with survey lines in coastline encounters were more prominent near the west side of coastal areas (Figure 18) but were standardized to distribute the encounter probability by dividing with the number of encounters.

The results of this study indicate that the probability of the encountered locations were not restricted to the coastal area (Figure 21). Although the Donsak humpback dolphins were found more frequently near coastal areas rather than offshore, survey effort standardization showed the probability of encounters in the areas surrounding Chuek and Som Islands (Figure 21). The coastal area was observed every day of the survey, but opportunistic survey occurred around the offshore islands, sometimes when turning back at the Pa Luai, Chuek, Som, and Nok Ta Pao Islands. Hence, the dolphin encounters between coastal and offshore areas are biased. The survey effort standardization can explain more reliably than the normal encountering data. The standardised encounter rate revealed aggregation of humpbacked dolphins near the coastal area as well as the offshore area around Chuek Island (Figure 21). Within the study period (08.00-14.00 hr), the encountered rate was highest during 08.00-09.00.

During the period of recorded study, dolphin sightings near mainland shores occurred between 08.01- 09.00. The researchers headed to the islands off the shore between 10.00- 11.00 and then cruised back to Rat Island before 14.00. The seventeen months survey period was too short because only 61 individuals were recaptured (Figure 24). A longer period between capture and recapture would have improved the estimated future population sizes.

4.2 General Habitat Information of Donsak Indo-Pacific Humpback Dolphins

This study showed that Donsak humpback dolphins had the same characteristics. They inhabited the coastline ranging 0.17-2.9 km, at an average 0.47 km distance off the shore and 4.9 m depth, with mostly less than 3.0 m water visibility, which supports previous findings of humpback dolphin habitat characteristics (Ross *et al.,* 1994; Hung *et al.,* 2004; Wang *et al.*, 2004, Wang *et al.,* 2007; Karczmarski *et al.,* 1999).

Nevertheless, the results show significant differences in habitat characteristics in humpback dolphins (DS, SC and WD, Table 12). In addition, Som Serm Ferry and Raja Ferry, which are near the Donsak River mouth with appropriate water depth and habitat characteristics (man-made structure similar to rocky shore where this species forages), were identified as the areas with the highest probability of finding dolphins in the study area. Furthermore, other environmental parameters, which are also Donsak humpback dolphin habitat characteristics; 26.60-32.60°C, average 29.92°C the sea surface temperature, pH ranging 7.99-8.33, average 8.10 pH, 25-35 ppt, average 31.50 ppt salinity. Donsak humpback dolphins live with these habitat characteristics as well.

From the present study, the habitat characteristics evidence clearly shows the group of each environmental factor from position (Figure 39). The distribution of Donsak humpback dolphins was related to the geographic and environmental characteristics between the group of offshore and the coastal position. The high-density encountered area in Figure 45 and 46 is the inshore area (Coastline with man-made structure, mud flat area and seagrass beds), despite the small island group (offshore with sand beach and rocky shore area). Humpback dolphins are found year round regardless of the seasonal conditions, but the occurrences of dolphin encounters in the summer and rainy seasons differ in habitat characteristics (Figure 47). Although the environmental parameters in the summer uniquely differ from the rainy, the Donsak humpback dolphin habits during both seasons.

4.3 Distribution of Donsak Indo-Pacific Humpback Dolphins

The limits of Indo-Pacific humpback dolphin distribution were confined to the survey routes in the study area by many conditions, such as boat speed per survey distance, weather conditions, geographic characteristics and human activities etc. The offshore area is a risk zone for researchers who faced severe weather. Efforts in the offshore area were not constant like in the coastal area. Hence, the distribution of dolphins in study area may be smaller than it should and bias of encountered areas was possible.

The results of this study explain the occurrences of these adverse assumptions. The surrounding area of Chuek Island, the area between Ri Gun Island and Som Serm Ferry, Raja and Sea Tran ferry, Taled and Thong Nian Bay were available areas to find dolphins in the present study (Figure 21). Surprisingly, the average water depth around Chuek Island appeared deeper than the coastal area, but the dolphins could habit off the shore. From observation, the surrounding area of Chuek Island is a fishing area for fishermen, which indicated the abundance of food resources for dolphin. It is interesting to note that the surrounding area of Chuek Island might also be an appropriate area for a dolphin habitat in the study area.

4.3.1 The Dolphin Distribution Based on Fishermen Interviews

The interview data showed a wider distribution range from the survey data (Figure 60). Therefore, it might be possible that the dolphin population may be larger than the previous estimation. Consequently, the line-transect method is needed to study more in the future. Furthermore, the frequently found areas by fishermen were narrower than the fishing area (Figure 60), including the smaller area surveyed by the researchers. Both evidence sources, from surveying and interviewing, can be used to define the marine protected area for the dolphins in the study area.

4.3.2 Spatial Behaviour

The hunting behaviour used the widest area out of all other behaviours. From the encountered area, Indo-Pacific humpback dolphins can feed in almost all of the study area.

Dolphins habit the ridge between the islands off the shore in a 3.6-15.9 m water depth channel (Figure 33).

The travelling behaviour was found a bit far from the shore, where the Indo-Pacific humpback dolphins swam for travelling in the deeper water off the shore (Figure 34). The area of nursing behaviour is supposed to be the potential area for reproductivity, which were the surrounding areas of Chuek Island, Som Serm and Raja Ferries and Ta Led Bay (Figure 35). The playing and socializing behaviours were in smaller areas than hunting and travelling behaviours. Indo-Pacific humpback dolphins selected special areas for playing and socializing behaviours, choosing to play and socialize in the smallest area (Figure 36, 37).

4.3.3. The Standardization of Spatial Behaviours

The results of this study showing the spatial behaviours showed the probable dolphin behaviour area. (Figure 38-42). The sub-merged rocks that surround the islands off the shore, particularly Chuek Island, found occurrence of every behaviour. Particularly, the man-made structures, Som Serm, Sea Tran and Raja ferry piers appear similar to a natural rocky habitat. The differentiation of area use for each behaviour is marked with intensity of colour. The five majors area for hunting, nursing, playing and socializing behaviours habit closely to the shores of Chuek Island, Rigun Island, Som Serm Ferry, Raja Ferry and Ta Led Bay (Figure 38, 40, 41, 42). The location area of travelling behaviour is further from the shore than the other behaviours about 1 grid block (1 km^2) (Figure 39). It is possible that the deeper water in the study area is more suitable for dolphin travelling.

4.3.4 The Influence of Geographic and Weather Conditions on Dolphin Distribution

The geographic characteristics along the coast of Donsak District, Surat Thani Province and Khanom District, Nakhon Si Thamarat are rocky headlands, rocky cliffs and mountains that maintain the shoreline changing (Figure 15). The habitat of the dolphins in study area consists of the bay and high mountains that conceal the waves and wind from the east. Furthermore, the abundance of food resources for dolphins was indicated by the small-scale fishery present along the shore of the study area. Som-Serm Ferry or Laem Tuad, near the

Donsak estuary were the highest frequency of encountered location, where mullet fish were caught by throwing fishing nets almost the entire year (Figure 33, 61, 62). The combination of appropriate geographic characteristics of Indo-Pacific humpback dolphins caused the dolphin inhabit in study area, which supports the previous findings of humpback dolphin habitat characteristics (Ross *et al.,* 1994; Hung *et al.,* 2004; Wang *et al.*, 2004; Wang *et al.,* 2007; Karczmarski *et al.,* 1999).

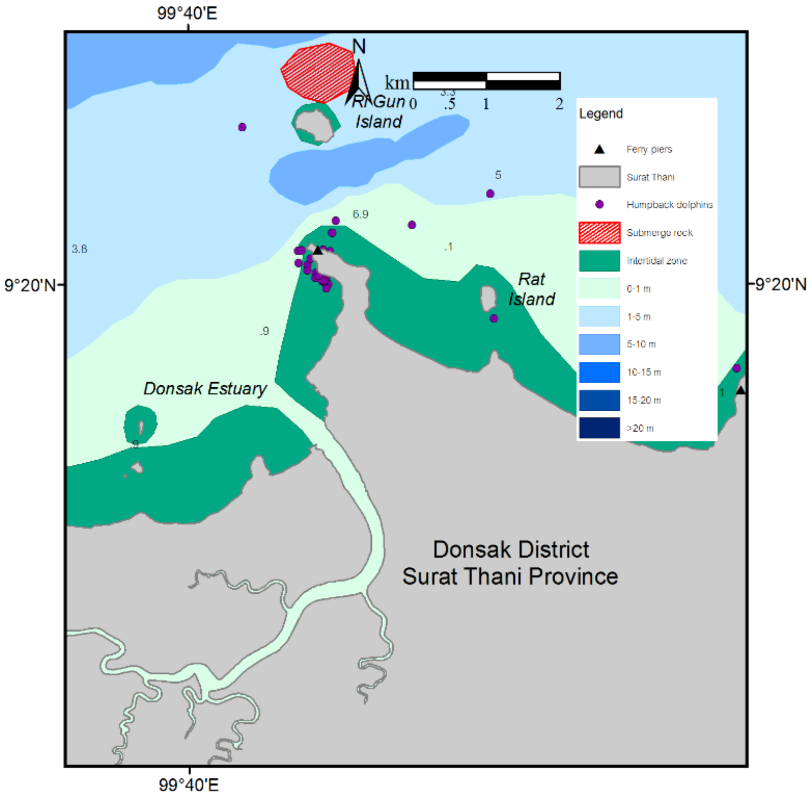

Figure 61 The encountered dolphin area around Som Serm Ferry Pier, Donsak Estuary, Donsak District, Surat Thani Province

Figure 62 The fishermen throwing nets for mullet fish at the Som Serm Ferry Pier (near Donsak Estuary)

4.4 Population Size

4.4.1 Uncertainty in Population Size Estimation

The principal assumptions in capture-mark-recapture experiments to estimate population size include the absence of "tag-loss" and tag-induced mortality. Violation of the above assumptions often leads to severe bias and lower precision in abundance estimates (Arnason and Mills, 1981; Seber and Felton, 1981; McDonald *et al*., 2003; Cowen and Schwarz, 2006).

The photo-ID technique, which is frequently used in cetacean census (Wilson *et al*., 1999; Currey *et al*., 2009; Verborgh *et al*., 2009; Reisinger and Karczmarski, 2010), is operated by distinguishable marks on animals rather than artificial tagging; meanwhile the animals are not physically captured or recaptured by investigators in photo-ID process. Tag-induced mortality isn't really relevant in the photo-ID process since the animals are not physically tagged.

The 'tag-loss' event could occur on the cetaceans in capture-mark-recapture experiments in photo-ID during individual growth. Evolving notched-marks on dorsal fins and progressively changing body colours between different age classes in some species, such as the humpback dolphins, could duplicate identification of the same individual. The probability of such 'tag-loss' bias, however, could be very low in this study as the temporal scale (17 months) may not be long enough for the emergence of new, unidentified marks on the identified individuals. Photo-ID experiments on the humpback dolphins with longer temporal scales, however, should be cautious about bias from the evolving marks.

4.4.2 The Indo-Pacific Humpback Dolphin Population Size Selection

This study estimated that there were 160 (95% CI. 152 – 178) and 193 (95% CI: 167 – 249) humpback dolphins in the survey area. The appropriate model selection to estimate the dolphin population size was the situation. The smaller number of dolphin population size should be used for the minimum population size estimation in the study area. The smaller number accurately showed the population size was closer to the actual population size of 142 identified dolphins. The bigger number showed actual size of age category in dolphin demography. The age category estimation model displays the population size of unspotted calve (UC), spotted juveniles (SJ), the spotted adults (SA) and unspotted adults (UA). The number of age categories can be used for many benefits, such as future investigation of UC population size, the possible expanded number of dolphin population from potential reproductivity age on SA and UA.

The actual population size estimate of the humpback dolphins of Donsak, however, is very likely higher than the current estimate, as the accumulative sighting curve (Figure 19) is still progressively ascending and does not reach an asymptotic stage. A higher population size estimation could be anticipated if the survey period extended until the accumulative sighting curve reached an asymptotic stage.

This estimation was much higher than that in the neighbouring Khanom waters previously estimated by Jaroensutasinee *et al*. (2010). The difference in accumulative sighting curve between surveys in the waters of Donsak (this study) and Khanom (Jaroensutasinee *et al*. 2010) may imply a distribution pattern of the humpback dolphins in the Donsak and Khanom waters. In the Khanom waters, the humpback dolphins have been identified fully, according to the asymptotic sighting curve (Jaroensutasinee *et al*. 2010). The distribution of these humpback dolphins may be confined to the surveyed Khanom waters and surrounding water, or alternatively, the dolphins may have a wider distribution range, periodically migrating between Khanom waters and neighbouring habitats. In either case, humpback dolphins were observed to routinely return to the Khanom waters and were 'captured-recaptured' by Jaroensutasinee and colleagues (Jaroensutasinee *et al*., 2010). The asymptotic status of accumulative sightings since the middle of the study period in Jaroensutasinee *et al*. (2010) indicated that no humpback dolphins off the Khanom waters were unidentified. Based on the monthly sampling frequency (Jaroensutasinee *et al*., 2010) and very rare observation/report of humpback dolphin occurrences in the southern Khanom coast, we prefer the hypothesis that the distribution of the humpback dolphins of Khanom may be confined to the waters off/surrounding Khanom, which remains to be solved through successive survey.

In contrast, the humpback dolphins of Donsak may have a wider distribution than the survey area. The progressively increasing accumulative sightings (Figure 19) indicated that unidentified dolphins continuously and periodically entering this region were 'captured'. Some of the unidentified dolphins might have come from the waters of Khanom as the eastern part of the present survey area partially involved that area (Figure 15). Of the 49 humpback dolphins off Khanom (Jaroensutasinee *et al*., 2010), 15 were re-identified in the present study. More unidentified dolphins may come from the habitat outside (to the west of) Donsak and Khanom waters. The humpback dolphins migrated between Donsak-Khanom waters and adjacent habitats across a relatively long temporal scale. The pattern of accumulative sighting curve, a stage-wise increasing pattern, perhaps displays the above migratory rhythm. Unfortunately, the temporal scale of this study may not be long enough for this analysis. Successive surveys to disclose site-fidelity of the humpback dolphins in the survey area are needed.

This study gives a larger humpback dolphin population size estimation than that of the adjacent study site reported by Jaroensutasinee *et al.* (2010) of the east coast of Gulf of Thailand. The overlapped area, from Raja Ferry piers to Thong Nian Bay in this study, showed at least 15 individuals to be the same individuals from the present study area. It is therefore probable from this evidence that the dolphin population may be potentially higher than 142 identified dolphins. Compared with the sub-population from known population size, the humpback dolphins in Thailand might be ranked between Gulf of Kachch, India (Sutaria and Jefferson, 2004) and Leizhou Bay, China (Zhou *et al*., 1999). (Table 1)

4.5 General Environmental Characteristics with PCA Analysis

From the present study, an analysis of environmental factors (Figures 44-46) indicates that high densities of dolphins occur in inshore areas (mud flats, seagrass areas close to man-made structures) as opposed to off shore island groups. Humpback dolphins may be found all year round without seasonal differences in numbers. However, different groups of dolphins occur during the summer and rainy seasons. (Figure 47)

Nevertheless, our results show significant differences in habitat characteristics of humpback dolphins, such as distance off the shore (DS), water transparency (Secchi disc, SC) and water depth (WD). The results show significant differences of habitat characteristics in humpback dolphins (DS, SD and WD). In addition, Som Serm Ferry and Raja Ferry, which are near the Donsak river mouth, have appropriate water depth, sediment transportation and nourishment for aquatic animals. Moreover, the habitat characteristics (man-made structure similar to rocky shore where this species forages) were identified as the areas with the highest chance of finding dolphins in the study area.

Donsak Indo-Pacific humpback dolphins have no specific area for living (Figure 48) due to environmental parameters that cannot be separated with the specific environment for behaviour preferences. Surprisingly, no differences were found where the habitat characteristic related to the Donsak Indo-Pacific humpback dolphin behaviours.

4.5.1 Habitat Preference on Age Classes Categorization

Within the survey area, the humpback dolphins were often observed in the shallow water near shore, similar to the distribution of humpback dolphins investigated elsewhere (Ross *et al.,* 1994; Karczmarski *et al.,* 1999; Hung and Jefferson, 2004; Wang *et al.,* 2004; Wang *et al.*, 2007). Multivariate analysis, however, indicated a subtle difference of habitat preference among different age classes in this study. The PCA of transformed environmental characteristics were grouped into three independent components: PC1, PC2 and PC3. The component loadings (Table 11) indicated PC1 related to weather, PC2 related to sea-surface conditions and PC3 related to habitat conditions. For PC3, distance off the shore (DS), water depth (WD) and water transparency (SC) are the most influential parameters. Only PC3 is found distinguishable among age classes (Table 11).

The UA dolphins tend to have higher PC3 than UC, SJ, and SA dolphins, indicating a farther (DS > 518 m) and clearer-water (SC > 1.29 m) distribution tendency for the UA dolphins. Off the Donsak waters, the UA dolphins frequently occur at rocky shore, sand beach and man-made structures; generally, these areas are deeper and clearer than the sea grass and mud flat areas where the UC, SJ and SA dolphins are more commonly sighted. The relation between habitat use and behaviours shows the frequency of Indo-Pacific humpback dolphin behaviour of the dolphins living along the study area are hunting, travelling, playing, nursing and socializing behaviours, respectively.

It is remarkable that the particular habitat related to hearing loss in the UA age class.

The reasons for the age-class dependent distribution tendency are not clear. Recent studies on the hearing of humpback dolphins indicated that a stranded old humpback dolphin showed possible age-related hearing loss (presbycusis) and corresponding change in echolocation parameters compared to those of a specific younger individual (Li *et al*., 2012; 2013). Perhaps old humpback dolphins in the wild also suffer presbycusis and consequently, potential compromised echolocation abilities. Distribution tendency to deeper and clearer waters for the UA dolphins may benefit the old dolphins to have a relatively better visual view, which complements their compromised echolocation abilities for environmental perception. Alternatively, old dolphins may be aware that the risk of stranding or being entangled by fishing nets could be higher in the shallower and more turbid waters relative to the deeper and clearer waters due to their potential compromised echolocation abilities.

4.6 The Experiences of Fishermen

4.6.1 Dolphin Encounters

The entire encountered period year between the survey and the fishermen interviews are different because the survey efforts were less than the experiences of fishermen. All interviewees confirmed that they encountered dolphins in the study area, although they found the dolphins in different periods and frequency (Figure 51).

The longer periods of fishermen work hours defined the available periods that dolphins were found in the study area (Figure 50). The results showed that dolphins were found frequently in the early morning hours during 8.00-9.00 with the limit of weather conditions that the wind and waves were stronger in the afternoon. The fishermen also found the dolphins between 18.00-21.00 in the evening (Figure 50). It is possible that the 18.00-21.00 period might be an appropriate time for squid hunting.

4.6.2 The Relationship between Fishermen and Dolphins

The attitudes of interviewees were positive due to the interaction of the fishermen, who were not threatened by the dolphins when they found them swimming around fishing gear. On the contrary, the fishermen were familiar with the dolphins and 49% fed them with the fish they got from fishing. 34% didn't mention the dolphin behaviour around the fishing gear (Figure 54).

Furthermore, dolphins might indicate the fish resources around the fishing area for fishermen (Figure 55), as 41% of interviewees caught more fish when they found the dolphin swimming around the fishing gear. The sympathetic feelings of fishermen were shown by the fish thrown to the dolphins, even though 44% of the fish thrown were the lower price and smaller fish (Figure 56).

It might be possible that fishermen fed dolphins around the study area 06.01-09.00 and 18.01-21.00 frequently (Figure 50). 75% of fishing hours per day might be risky for dolphin entanglement by fishing net in the study area because of the fishing gear waiting time during 03.01-21.00, although some of the fishermen watched out for the fishing gear. A possible explanation for this might be that dolphin themselves get along with fishing activities.

Actually, at the small-scale fishery in this study area, the fishermen would leave the gear in the sea and go back to the villages for awhile. Afterwards, the fishermen went back to the fishing point after 2 hours at least. The risk of dolphins getting entangled with the fishing net without fishermen monitoring in the study area is high.

4.6.3 Dolphin-watching Activity

The tourism areas were concealed from the waves and wind at Taled Bay (Figure 15) which are the edges between Donsak District, Surat Thani and Khanom District, Nakhon Si Thammarat. Dolphin wildlife watching tourism in the study area is available from 06.00 – 16.00, but the highest chance to encounter dolphins was during 08.01-09.00 in the morning.

The tourism is dependent on the weather conditions. The eastern winds are stronger in the afternoon. Hence, the encountered dolphins in this area from the tourism activities will be related to the period of this study (Figure 22, 58). Related to the encountered time in the fishing period, the dolphins might be active in the morning (Figure 22, 57, 58).

The dolphin watching tourism in the study area might change the behaviour of the dolphins. Considering the feeding activity, the villagers sold fish to the tourists to feed dolphins. The dolphins might be infected from contact with other than fresh fish, germs or bacteria from humans. Moreover, the distances of the boats to the dolphins were not appropriate. Researchers found a number of watching boats cruised too close to groups of dolphins several times. Dolphins in the study area were attracted by the sound of boat knocking and fish feeding. Dolphins will adapt themselves by the benighted training that will change dolphin behaviour. If the dolphins are familiar with the watching boats and swim too close to the boats, the boats may strike dolphins with their propellers, injuring the dolphins. The stakeholders who take care of the dolphin conservation in this area should monitor this activity frequently, particularly between 08.01- 09.00. The dolphin watching activities in the area should be monitored and strictly controlled by the local authorities, like in Shanniang Bay, Guangxi Province, China (Wenshi *et al.,* 2006). Even though there is no evidence of stranded cases from dolphin watching activity, a precautionary policy should be enacted for wildlife awareness in the group of fishing tour guides. The integrity of fishermen tour guide understanding in eco-tourism protocol will improve Indo-Pacific humpback dolphin conservation in the study area.

4.7 Implications for Conservation

The potential of Donsak humpback dolphin reproductivity is suspected to be increasing because of many marine conservation policies. Although the adjacent areas of the study site were Ang Thong Marine National Park, Moo koh Tha Lae Tai marine protected area, corporate social responsibility activities (CSR), mangroves area, seagrass area and dolphin watching tourism that promoted dolphin conservation and awareness in coastal communities, there is no specific evidence suggesting that protected areas can improve dolphin reproductivity. A longer period of survey should be conducted continuously in the study area. However, the overall dolphin population around the world is declining rapidly due to many threats including overfishing, accidental catches, pollution, vessel traffic and wildlife tourism (Parra *et al.,* 2004).

The study area has much evidence that suggests that humpback dolphins are also facing these threats in the same way, such as habitat degradation, ferry transportation and dolphin watching tourism (Hung and Jefferson, 2004; Wenshi *et al.,* 2006; Chen *et al.,* 2011). Som Serm Ferry is adjacent to the Donsak Estuary, where humpback dolphins are predominantly encountered with evidence showing that dolphins and coastal fishermen forage at the same time and 24% of 62 stranded dolphins (Unpublished data, MCRC) were at risk of accidental by-catch from fishermen nets.

IUCN Red List of Threatened Species classified the Indo-Pacific humpback dolphins as Near Threatened (NT) (Reeves *et al*., 2008). However, information on the extent of occurrence and abundance is actually still very rare and lacking in most of the South-east Asia range. This study presents first-hand information on a previously unstudied group of humpback dolphins, and partially fills the information gap of humpback dolphin occurrence in South-east Asia. In South-east Asia, rapid economic growth without adequate attention to environmental impact may be leading to marine environment and habitat degradation, which could substantially alter the coastal environments that are essential for the humpback dolphins.

Our results suggest relatively more inshore and shallower water distribution for the UC, SJ and SA humpback dolphins, namely, the younger humpback dolphins, than the UA dolphins. This implies that the coastal alteration following uncompensated economic development may have an impact on the younger dolphins, in particular. Off the Donsak and Khanom coasts, the humpback dolphins are currently facing various kinds of anthropogenic impact due to proximity to human activities (Figure 63). The humpback dolphins are frequently sighted very close to fishing nets (Figure 63a), suggesting a risk of incidental mortality due to net entanglement (Figure 63b). 5% of the 142 sighted humpback dolphins presented with scars from propeller cutting (Figure 63c), possibly caused by high-speed ferries or dolphin-watching boats (Figure 63d).

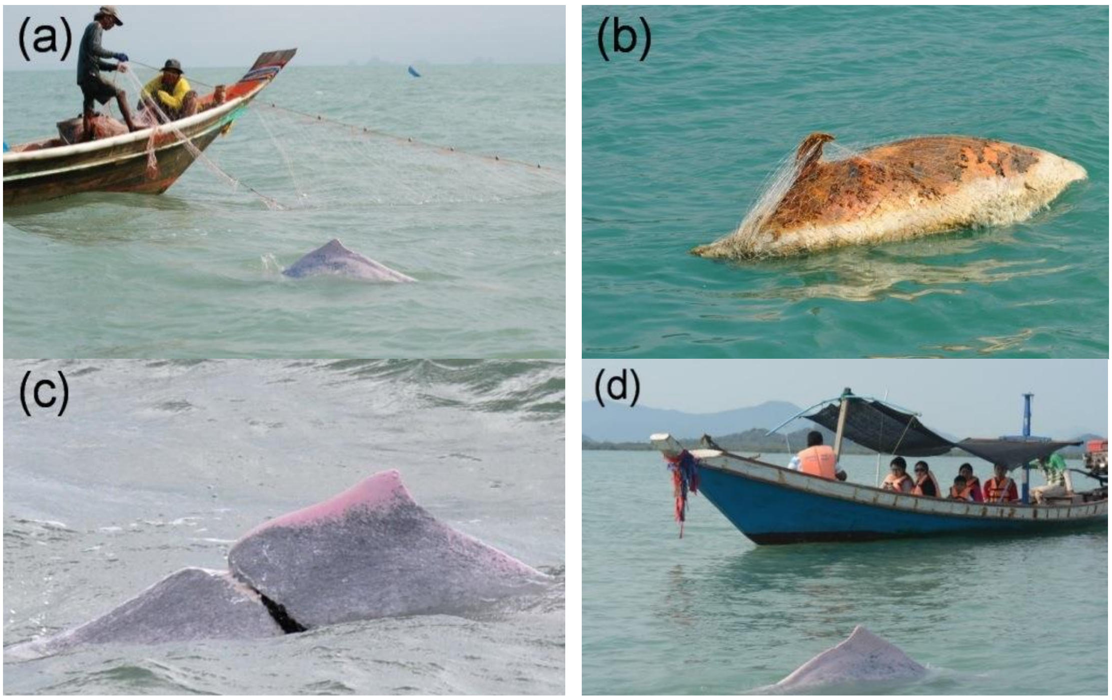

Figure 63 The anthropogenic impact off the Donsak waters, which the humpback dolphins are currently facing: (a) extreme proximity to fish-nets; (b) fish-net entanglement mortality; (c) scars made by propeller cutting (pointed by arrow); (d) proximity to dolphin-watching

Other threats, such as water pollution and coast modification/alteration, may also weaken humpback dolphin viability off the Donsak and Khanom waters in an implicit but chronic pathway. From 2006 to 2012, 24% of 62 stranded humpback dolphins resulted from different types of fishing nets (such as surface net, sea bass net, stingray net, butterfish net, etc.) entanglement (Marine and Coastal Resources Research Centre: MCRC, unpublished data). The incidental mortality rate from net entanglement could actually be higher than 24% (MCRC, unpublished data), but it is difficult to estimate based on the current data, which is not quantitative enough.

Though the POPAN model provides an estimate of apparent survival rate (Φ), this estimate includes both biological survival and immigrating/emigrating rates. As the accumulative sighting curve does not reach asymptotic stage in this study, individual immigration/emigration could play an important role in estimating Φ. Given the relatively small abundance estimated in this study and the Khanom study (Jaroensutasinee *et al*., 2010), immediate actions are needed as precautionary measures to mitigate and minimize the obvious threats mentioned above, even if the assessment impact on population viability is still unavailable.

Designation of marine mammal protected areas (MMPA) is traditionally considered an ultimate resolution to mitigate anthropogenic impact in an integrative perspective (Slooten *et al.,* 2006; Slooten, 2007; Ross *et al*., 2010; Gormley *et al*., 2012; Hoyt, 2012). Extending the existing Ang Thong Marine National Park southward (Figure 15) to encompass the distribution range of the investigated humpback dolphins may provide a framework for humpback dolphin conservation off the Donsak and Khanom waters. Implementation and enforcement, however, are more complicated in practice because the dolphins' home range falls within intensive fishing and sea use areas (Figure 20, 60).

The primary conservation strategies should include increased local awareness, introducing alternative fishing gear reinforced by constant and adequate enforcement and defining boat-traffic and dolphin-watching regulations in dolphin-distribution areas (Flores and Bazzalo, 2004; Kreb, 2005). The above strategies need to be integrated into current management tools.

This report provides us with considerable understanding and insight about humpback dolphin ecology, which can directly guide marine and coastal resources management for dolphin conservation in Thailand. At the same time, a longer study period of dolphin population trends and impact of anthropogenic threats to dolphins is required for dolphin abundance assessment.

CHAPTER 5

Conclusion

This dissertation has investigated the population size, habitat characteristics by age category and spatial behaviours of Indo-Pacific humpback dolphins in the study area. Additionally, it has studied the general attitudes of fishermen based on their experiences with dolphins in the study area. This study can improve baseline information data for dolphin conservation, particularly for the unspotted adult dolphins (UA), which habit further off the shore where fishing gear from local fishermen might entangle them easily. Also of mention is the fact that UA dolphins have reproduction potential for the Indo-Pacific humpback dolphin's population size. The Donsak Indo-Pacific humpback dolphin was categorized into a small population size for the present study. This study also probably shows a minimum area of Donsak Indo-Pacific humpback dolphin distribution, whereas need exists to explore more in a wider area. The spatial behaviour of the Donsak Indo-Pacific humpback dolphin can improve the criteria to define the core area of a marine protected area. The area used for hunting and nursing behaviours of Indo-Pacific humpback dolphins can potentially explain where the dolphin can best reproduce. Furthermore, the area used for dolphin behaviours are potential data that can support the criteria to identify where stakeholders should create a marine protected area.

The complexity of the marine area used in the study includes ferry piers, coastal fisheries and wildlife tourism businesses in the coastal zone. The offshore area has a small-scale fishery around the small islands, which may be a safer zone for dolphins living in the present study. Especially in the most frequently encountered areas, such as the ferry to Chuek Island, Som Serm and Raja Ferries and Ta Led Bay, dolphin-protected areas should be defined.

The results of this study indicate that the Chuek Islands and Ta Led Bay are potential areas for protected marine habitats. Because there is no large marine vessel traffic around Chuek Island and Ta Led Bay, dolphins live in the area without anthropogenic disturbance. Both of the two surrounding areas have only a small-scale fishery and dolphin-watching tours.

The surrounding area of Chuek Island, an area for a small-scale fishery, is far from the coastal anthropogenic activities, lacks vessel traffic from ferries and possesses low impact from anthropogenic activities. Therefore, it might be a potentially effective conservation area for dolphins.

The data from attitudes and experiences of fishermen can also support the survey data. The period and area of fishing defines the smaller scale of the government's role in monitoring of the study area. Fishermen are also a good network for dolphin monitoring because they spend the majority of their time in and around the sea, unlike the stakeholders. The perception of wildlife and marine ecosystem conservation emphasis should be announced for fishermen. The unearned income from dolphin-watching tours of fishermen in Kwaeng Pao, Laem Pra Thub, and Nang Gum Villages, hotel and business owners in Khanom District, Nakhon Si Thammarat.

Although tours might disturb the dolphin habitat in Ta Led Bay, the positive attitude of communities can support the conservation plan or marine protected area policy. Any conflict of interest from the stakeholders in both areas is lessened, except for the three dolphin-watching groups (Nang Gum, Laem Pra Thub, and Kwaeng Pao villages). Ta Led Bay, Khanom District, Nakhon Si Thammarat is a seagrass bed protected area near Ta Rai Island (MCRC, lower gulf of Thailand) which was accepted by the three communities (Nang Kham, Thong Nian, and Kwaeng Pao Villages). The fishing villagers should be educated in the value of wildlife, dolphin ecology and biology, threats and regulations to improve the value of tourism activities and better the understanding of tourists.

5.1 Donsak Indo-Pacific Humpback Dolphin Management

A marine protected area should be considered for the present study area. The consideration of a critical habitat, ecosystem and precautionary plan should be included with the collaboration of a provincial plan, research unit from a university, the Department of Marine and Coastal Resources and coastal communities. Chuek Island and the coastal zone of Donsak District, Surat Thani Province, Ta Led Bay, Khanom District, Nakhon Si Thammarat Province should be considered a marine protected area under IUCN category IV (IUCN 2003). The small population of Indo-Pacific humpback dolphins are the major species in the study area, which consists of healthy habitat area, mangroves, seagrass protected area on Ta Rai Island, Khanom District, Nakhon Si Thammarat Province and habitat protected area for dolphins in Nang Gum Bay, Donsak District, Surat Thani Province by the Department of Marine and Coastal Resources (DMCR, Thailand). Particularly in Ta Led Bay, dolphin-watching activities should be monitored and regulated. In addition, scientific and social science research is needed to define the critical habitat of Donsak Indo-Pacific humpback dolphins and avoid any conflict of interest from stakeholders. Community perception of dolphin conservation awareness should be educated in the long term. The governors or stakeholders can educate the fishermen about general information about dolphins, their threats and habitat degradation for the dolphin conservation awareness motivation. The collaboration between stakeholders should be conducted with the understanding of ecosystem-based management. A precautionary plan for dolphin threats and habitat degradation should be instigated as soon as possible. Figure 64 shows the designation of conceptual framework for sustainable management and integration for marine resources, habitat and dolphin conservation plans and policies in the present study.

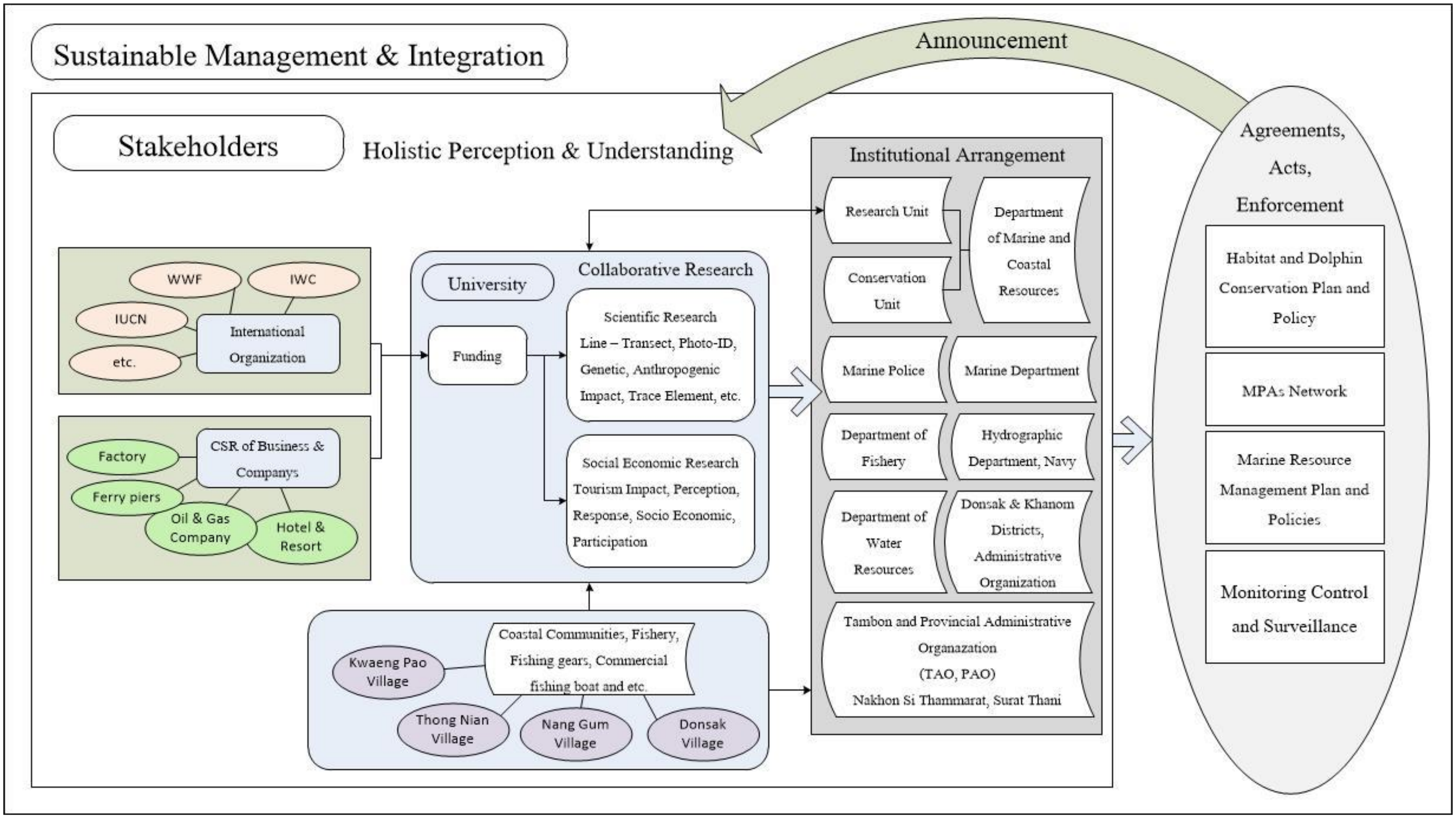

Figure 64 Conceptual framework of sustainable management and integration for marine resources, habitat and dolphin conservation plan & policies

5.2 Suggestions

In terms of abundance, distribution tendency and habitat characteristics, the conservation policies should include dolphin conservation awareness from the surrounding fishing communities. Firstly, the habitat and marine ecosystem should be maintained for sustainable management. Secondly, fishing gear investigation should be monitored by the government and fishermen frequently. This monitoring will decrease by-catch mortality from fishnet entanglement. Thirdly, the regulation enforcement should be announced for the fishing communities in the study area. Dolphin-watching tours should be conducted by the rules of wildlife watching tour guidance. Finally, the motivation and education in dolphin ecosystem should be conducted continuously. The schools in adjacent areas should include dolphin issues into the curriculum so students are educated about conservation awareness in the long term. The suggestions that follow are needed for the study area in the future:

1. Line-transect method should be conducted in the study area to define the core habitat area for marine protected area and Indo-Pacific humpback dolphin conservation.
2. The relevant government agency should investigate dolphin-watching tourism activities
3. Biopsy and genetic analysis should be conducted to investigate the species
4. Any information regarding dolphins in the study area should be announced with social media, which is a successful tool for sharing dolphin news with the public, such as Instagram and Facebook. In more remote areas, fishing villages may need focus group meetings.
5. Ecosystem-based management should be conducted in the dolphin habitat area along the study area.
6. A wildlife dolphin-monitoring network should be broadcasted for the marine protected area with cooperation between the stakeholders, such as the coastal communities, government units, NGOs, companies, hotels, resorts, research unit in the university, and international organizations.

7. Some of the activities of dolphin-watching tourism should be abandoned, such as feeding (Figure 65a-b), swimming close to dolphins (Figure 65c), and the large number of tour boats. (Figure 65d)

(a)
(b)
(c)
(d)

Figure 65 (a) Tourist guide threw fish to attract dolphins (b) Fish feeding (c) Tourists swam in the water near the dolphins (d) Large number of tour boats

8. Wooden structures for fishnet throwing and stationary fishing between the Donsak estuary and Somserm ferry should be forbidden (Figure 66).
9. Coastal-based dolphin watching should be promoted for dolphin watching activities in Raja and Som Serm Ferries. Coastal-based watching can decrease the impact of disturbance in the dolphin habitat impact from overcrowding of tour boats in the study area (Figure 67).

Figure 66 Fishnet throwing structures and surface nets between Donsak Estuary and Som Serm Ferry

(a)  (b) 

Figure 67 Coastal-based dolphin watching at (a) Raja Ferry (b) Som Serm Ferry

5.3 Future Work

1. Mobile application to record dolphin encounters in dolphin-watching tourism
2. % Dorsal fins injuries analysis
3. Remote sensing (RS) with niche modelling for the Indo-Pacific humpback dolphin, and collaborative research with Dr.Shiang-Lin Huang, Hong Kong University.
4. Collaborative research with Assoc.Pro.Dr.Wang Xianyi from Xiamen University with a proposal submitted to the Chinese government (Under consideration)
5. Collaborative research with Prof.Zhu Qian, Shandong University, China
6. Apply for funding of long term study on line-transect method in the study area for at least 5 years

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Appendix I

ชื่อ ผู้สัมภาษณ์ : ____________________วันที่:_________แบบสอบถามเลขที่:___________

หมู่บ้าน: ____________ตำบล______________อำเภอ______________จังหวัด________

ข้อมูลทั่วไป (ของผู้ให้สัมภาษณ์)

1. ชื่อนามสกุล_____________________อายุ __________ปี เพศ: ☐ชาย ☐หญิง

2. ก่อนหน้านี้คุณเคยให้ข้อมูล หรือให้สัมภาษณ์ ในประเด็นที่เกี่ยวข้อง ดังต่อไปนี้หรือไม่

☐การทำประมง ☐โลมา ปลาวาฬ และโลมาหลังโหนก

☐การกำหนดเขตอนุรักษ์ทางทะเล ☐การท่องเที่ยวเชิงนิเวศ

☐เต่าทะเล ☐ไม่เคยให้ข้อมูลหรือให้สัมภาษณ์ในประเด็นเหล่านี้

☐อื่นๆ ได้แก่ ______________________

3.ให้ข้อมูล หรือให้สัมภาษณ์ ในประเด็นข้างต้น เมื่อไหร่

☐ ไม่เกิน 1 ปี ☐1-2 ปี ☐ มากกว่า 2 ปี

4. รายละเอียดของข้อมูลที่ให้สัมภาษณ์: ____

5. ทำอาชีพประมงมานานกี่ปี_____________________________ปี

6. การประกอบอาชีพประมงในครอบครัว

6.1) พ่อ แม่ (ครอบครัว) ทำอาชีพประมงหรือไม่ ☐ทำ ☐ไม่ได้ทำ

6.2) ปู่ ย่า ตา ยาย ทำอาชีพประมงด้วยหรือไม่ ☐ทำ ☐ไม่ได้ทำ

7. ประมงเป็นอาชีพหลักที่สร้างรายได้ให้กับคุณใช่หรือไม่ ☐ใช่ ☐ไม่ใช่

8. รายได้จากการประกอบอาชีพประมง

8.1) รายได้สำหรับการหาเลี้ยงชีพของคุณมาจากการทำประมงเพียงอย่างเดียวใช่หรือไม่

☐ใช่ ☐ ไม่ใช่

8.2) *(ถ้าตอบว่าไม่ใช่)* อาชีพอื่นๆ นอกเหนือจากการทำประมง คือ อะไร___________

9.โดยปกติคุณทำประมงในช่วงเดือนไหน *(หากตอบเป็นช่วงฤดูกาล ให้ระบุลงไปว่า เริ่มต้นและสิ้นสุดในช่วงเดือนใด)* ระบุเหตุผลข้างเคียง เช่นบางพื้นที่มีการกำหนดพื้นที่ห้ามจับปลาในฤดูวางไข่____

10.ช่วงเวลาในฤดูทำการประมง

11.ช่วงเวลาในฤดูทำการประมง

10.1) ปกติในหนึ่งช่วงฤดูมรสุมทำประมง กี่วัน__________วัน/เดือน วันละ________รอบ

10.2) ในช่วงนอกฤดูมรสุมทำประมงกี่วัน________วัน/เดือน

12.ท่านเคยเห็นโลมาหลังโหนกหรือไม่ ☐ใช่ ☐ไม่ใช่

13.ในท้องถิ่นของท่าน โลมาหลังโหนกมีชื่อเรียกอย่างอื่นหรือไม่

☐มี ชื่อ________________ ☐ไม่มี

14.ปกติถ้าท่านพบเห็นโลมาหลังโหนก จะเป็นช่วงเวลาใดต่อไปนี้ (ตอบได้มากกว่า 1 ข้อ)

☐ ขณะที่กำลังจับปลา ☐ระหว่างทางที่ขับเรือไปยังจุดที่จะทำการประมง

☐เจอโดยบังเอิญ เพราะโลมาหลังโหนกติดเครื่องมือประมงขึ้นมา

(ช่วยระบุชนิดเครื่องมือประมง)

☐การล่า ☐พบขณะที่โลมาหลังโหนกขึ้นมาเกยตื้น

☐เจอระหว่างเริ่มทำการประมง ☐เจอระหว่างเก็บเครื่องมือประมง

15.ท่านพบเห็นโลมาหลังโหนกบ่อยครั้งแค่ไหน

15.1) ในช่วงชีวิตของท่าน

☐ไม่เคยเห็น ☐ครั้งเดียวในชีวิต ☐2-3ครั้ง ในชีวิต

☐พบบ่อยแต่ไม่ทุกปี ☐พบทุกปี (ในช่วง 5 ปีที่ผ่านมา) ☐พบเกือบทุกสัปดาห์

☐พบเกือบทุกวัน ☐พบทุกวัน ☐ไม่ทราบ

15.2) ปีที่ผ่านมาจนถึงปัจจุบันพบกี่ครั้ง

☐ไม่พบเลย ☐พบ 1 ครั้ง ☐พบมากกว่า 1 ครั้ง

☐พบเกือบทุกเดือน ☐พบเกือบทุกสัปดาห์ ☐พบเกือบทุกวัน

15.3) ช่วงเวลาที่พบเห็นโลมา

☐ 01.01-03.00 ☐ 03.01-06.00 ☐ 06.01-09.00 ☐ 09.01-12.00

☐ 12.01-15.00 ☐ 15.01-18.00 ☐ 18.01-21.00 ☐ 21.01-24.00

16.ตำแหน่งที่พบเห็นโลมาหลังโหนก

*16.1) ท่านทราบหรือไม่ว่าบริเวณใดที่สามารถพบเห็นโลมาหลังโหนกได้เป็นประจำ

☐ไม่ทราบ

☐ทราบระบุสถานที่ที่พบ______________***(ผู้สัมภาษณ์ ต้องระบุลงในแผนที่ด้วย)***

17.ท่านพบโลมาหลังโหนกว่ายน้ำวนเวียนบริเวณเครื่องมือประมงของท่านหรือไม่

☐ ไม่พบ ☐พบบ่อยเพียงใด ☐ทุกครั้งที่ทำการประมง

☐ทุกวัน ☐ อาทิตย์ละครั้ง ☐เดือนละครั้ง

☐ 3 เดือนครั้ง ☐6 เดือนครั้ง ☐ปีละครั้ง

18. จำนวนโลมาหลังโหนกที่จับได้นั้น ถือว่าเป็นจำนวนที่สูงกว่า ต่ำกว่า หรือเป็นจำนวนปกติที่จับได้

19.ความสำคัญของโลมาหลังโหนก

ปฏิสัมพันธ์ระหว่างการทำประมง

20. เมื่อพบโลมาหลังโหนกในบริเวณที่ท่านจะทำประมงท่านคิดว่า

☐ทำการประมงบริเวณนั้นต่อไป ☐ไปทำประมงที่อื่น

☐ทำประมงแต่เฝ้าอวนเอาไว้ ☐อื่นๆ

21. ขณะทำการประมงท่านเคยพบโลมาระหว่างการทำประมงหรือไม่

☐ไม่เคยพบ ☐เคยพบ และ ☐กำลังต้อนปลาเข้าไปในอวน ☐ว่ายวนรอบเครื่องมือประมง ชนิด_____________ บริเวณใด_____________

22. ท่านปฏิบัติอย่างไรเมื่อพบโลมาว่ายวนบริเวณเครื่องมือประมงของท่าน

☐เอาไม้เคาะเพื่อไล่โลมาออกไป ☐ทำการประมงตามปกติ

☐ปลดปลาบางส่วนให้โลมา ☐อื่นๆ____________

23. สัตว์น้ำที่ได้มีปริมาณมากหรือน้อยกว่าเมื่อไม่พบโลมา

☐ มากกว่า ☐ น้อยกว่า ☐ ไม่แตกต่างกัน

24. เหตุใดท่านจึงปล่อยสัตว์น้ำที่หาได้ให้แก่โลมา

☐ สัตว์น้ำขนาดเล็กเกินไป ☐ สัตว์ที่ได้ขายไม่ได้ราคา

☐ สงสาร เมตตา ☐ แบ่งให้โดยคิดว่าสวยดีได้ดูโลมา

☐ เห็นประจำ ☐ ได้สัตว์น้ำมาเยอะจึงแบ่งให้โลมา

☐ อื่นๆ________

*25. บริเวณที่ท่านพบว่ามักมีโลมามาอยู่ใกล้เครื่องมือประมงกับท่านเป็นประจำคือ

บริเวณ________________________________***(ผู้สัมภาษณ์ ต้องระบุลงในแผนที่ด้วย)***

26. ท่านคิดว่าพบโลมาขณะทำการประมงมีผลต่อจำนวนสัตว์น้ำที่ได้หรือไม่

☐ มีผลได้สัตว์น้ำมากขึ้น ☐ มีผลได้สัตว์น้ำน้อยลง

☐ไม่มีผลต่อจำนวนสัตว์น้ำ ☐ อื่นๆ_______________________

27. ท่านคิดว่าการพบโลมามีส่วนในการทำประมงของท่านอย่างไร

☐โลมาช่วยต้อนปลามาติดอวน ☐ โลมามากินปลาที่อวนของตน

☐โลมามาขอส่วนแบ่งของปลาจากอวน ☐ อื่นๆ_______________________

28. ก่อนที่จะพบว่ามีโลมามาว่ายวนบริเวณเครื่องมือประมงของท่าน ท่านทิ้งอวนไว้____________ชม.

29. ช่วงเวลาที่ท่านพบโลมาระหว่างทำการประมงอยู่เสมอ

☐01.01-03.00 ☐03.01-06.00 ☐06.01-09.00 ☐09.01-12.00

☐12.01-15.00 ☐15.01-18.00 ☐18.01-21.00 ☐ 21.01-24.00

ปฏิสัมพันธ์ระหว่างการนำเที่ยวชมโลมา

30. ช่วงเวลาโดยส่วนใหญ่ที่ท่านนำนักท่องเที่ยวไปเที่ยวชมโลมาคือเวลาใด

☐06.00-08.00 ☐08.01-10.00 ☐10.01-12.00

☐12.01-14.00 ☐14.00-16.00 ☐16.00-18.00

31.โดยปกติเวลาท่านวางเครื่องมือประมง ท่านจะคอยเฝ้าเครื่องมือเหล่านั้นหรือไม่

☐ คอย จนกว่าจะกู้ขึ้นมา ☐ไม่คอย ปล่อยเครื่องมือทิ้งไว้ แล้วค่อยกู้ขึ้นมาภายหลัง

32.ใช้เวลานานแค่ไหนในการวางเครื่องมือประมงแต่ละครั้ง ก่อนที่จะมีการกู้ขึ้นจากน้ำ

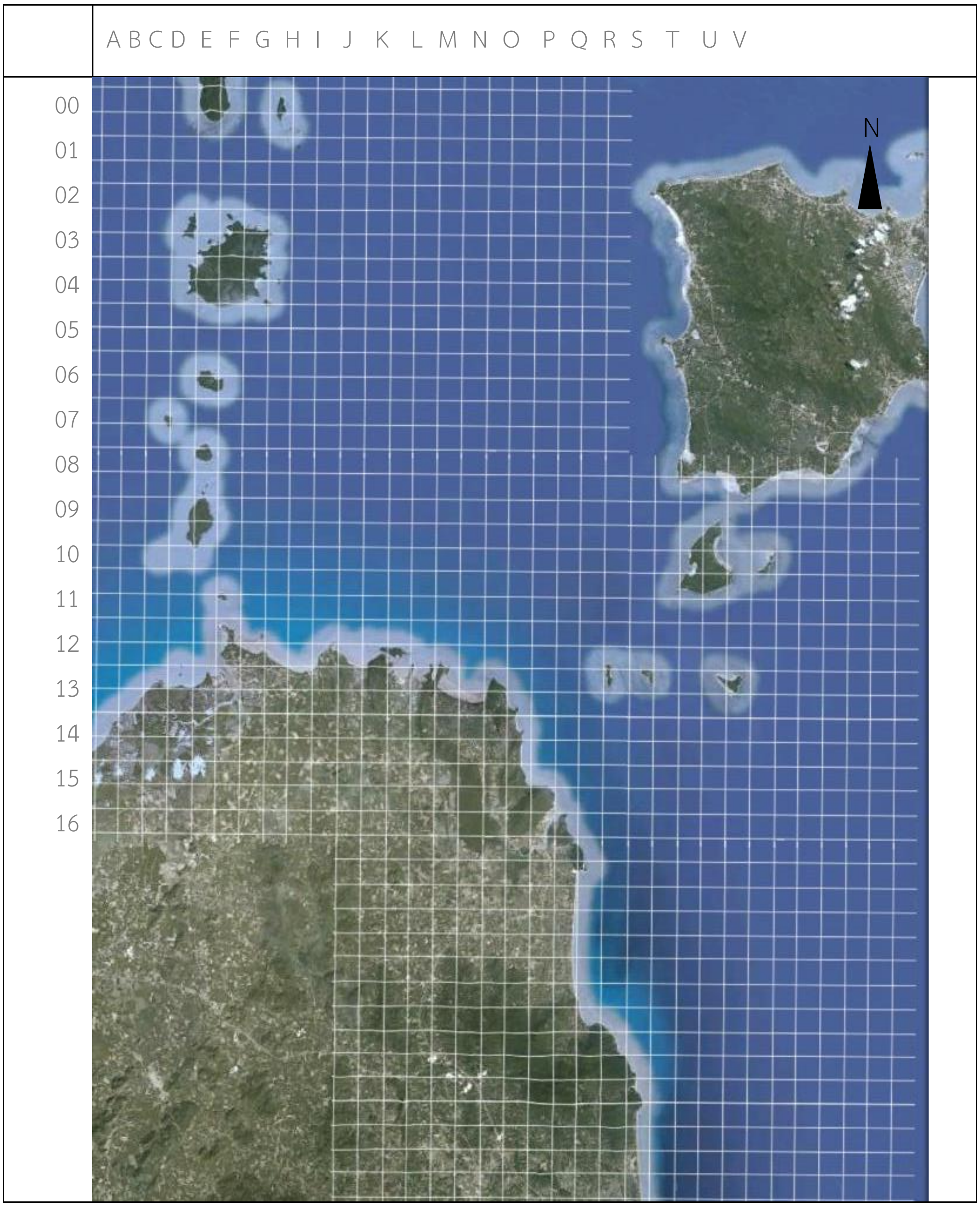
☐< 2 ชั่วโมง ☐2-6 ชั่วโมง ☐7-12 ชั่วโมง

☐13-24 ชั่วโมง ☐>24 ชั่วโมง

33.ท่านหาปลาในช่วงเวลาใด

☐กลางวัน (เช้า กลางวัน เย็น) ☐ตอนกลางคืน ☐ทั้งกลางวัน และกลางคืน

อ้างอิงจุดที่พบโลมาและการใช้เครื่องมือประมง



Appendix II

Photo – Identification with Age classes

Age classe : Unspotted Calves (UC)

Left side

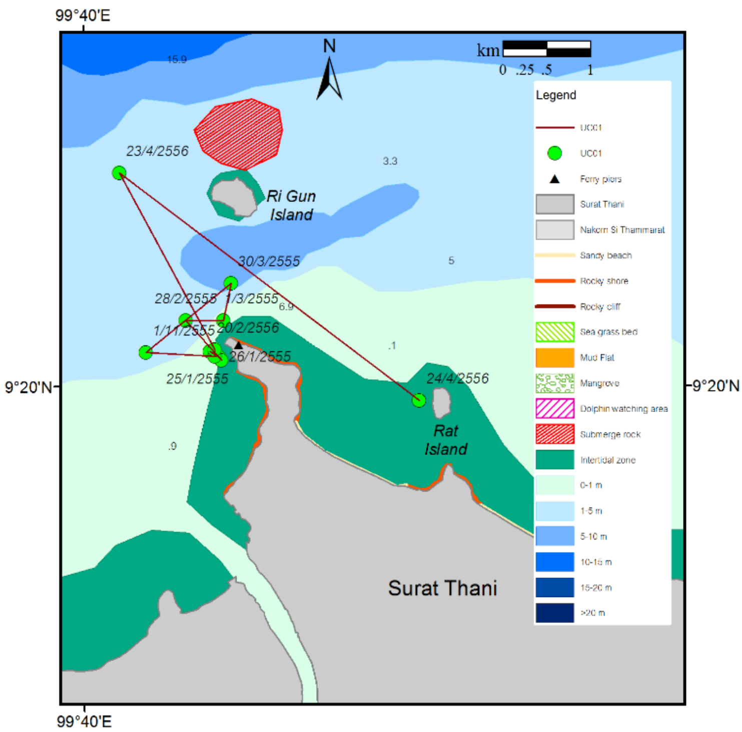
Right side

Number: 01

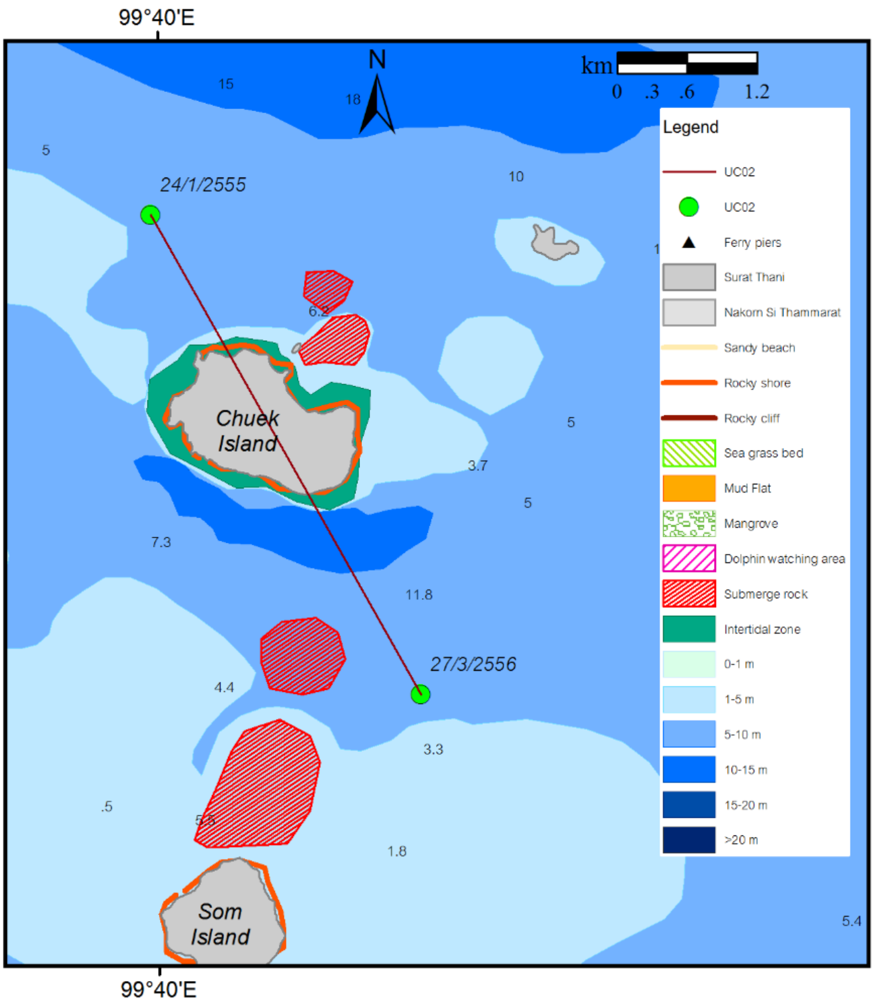
Code: UA01

Encountered history

No.	Date/Time	Lat, Long
1	24/1/12, 13.32	N09°20.172',E099°40.781'
2	25/1/12, 15.03	N09°20.133',E099°40.842'
3	26/1/12, 08.33	N09°20.120',E099°40.856'
4	28/2/12, 11.51	N09°20.365',E099°40.629'
5	1/3/12, 07.37	N09°20.361',E099°40.867'
6	30/3/12, 09.39	N09°20.589',E099°40.913'
7	1/11/12, 09.19	N09°37931',E099.°77214'
8	30/11/12,09.38	N09°20.139',E099°40.813'
9	20/02/13,11.40	N09°20.182',E099°40.812'
10	23/04/13,13.11	N09°21.275',E099°40.218'
11	24/04/13,13.33	N09°19.867',E099°42.090'



Left side	Number: 02		
	Code: UC02		
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	24/1/12 09.46	N09°29.022′, E099°39.957′
	2	27/03/1311.02	N09°26.782′, E099°41.228′



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<tr><td rowspan="3">
</td><td colspan="3">Code: UC03</td></tr>
<tr><td colspan="3">Encountered history</td></tr>
<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td>Right side</td><td rowspan="2">1
2
3
4</td><td rowspan="2">25/1/12 13.28
20/2/13 10.03
27/3/13 11.02
23/4/13 11.41</td><td rowspan="2">N09°29.527′, E099°39.943′
N09°28.726′, E099°40.646′
N09°26.782′, E099°41.228′
N09°26.370′, E099°39.828′</td></tr>
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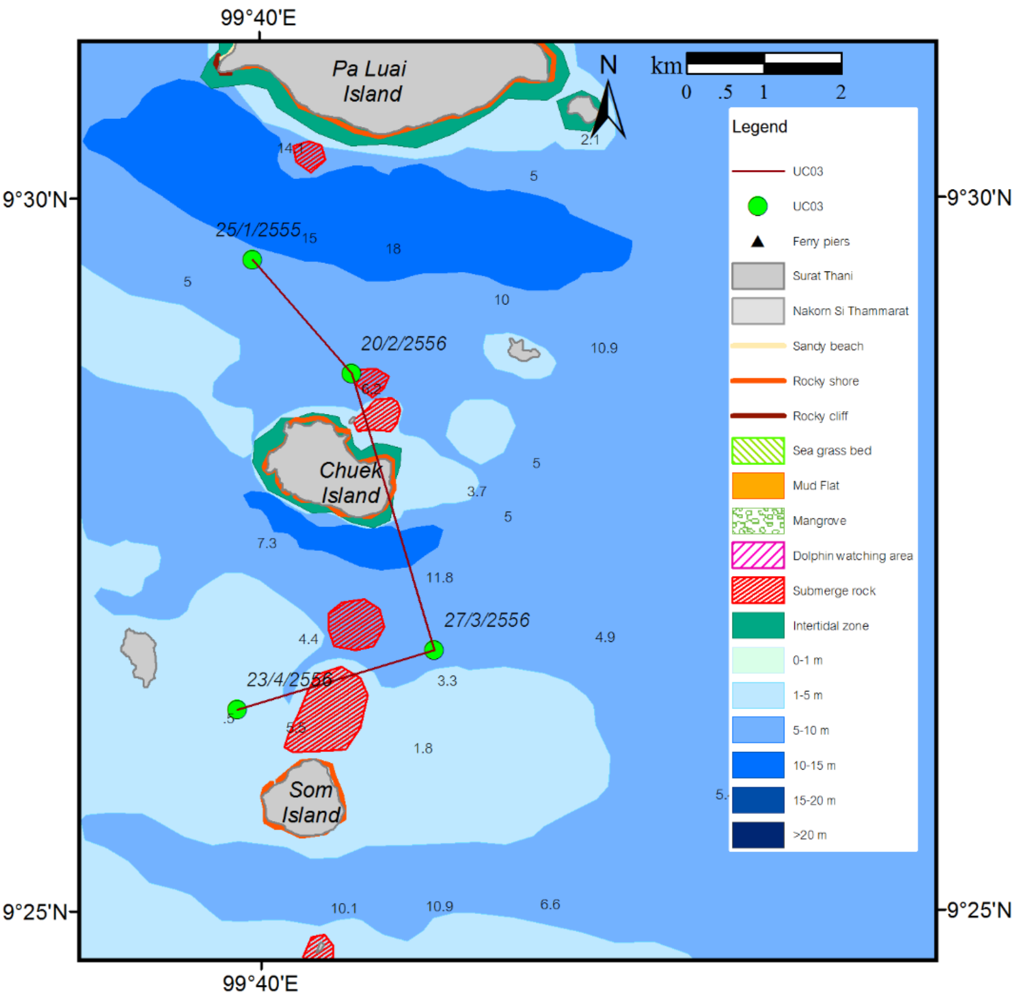
<tr><td colspan="4">
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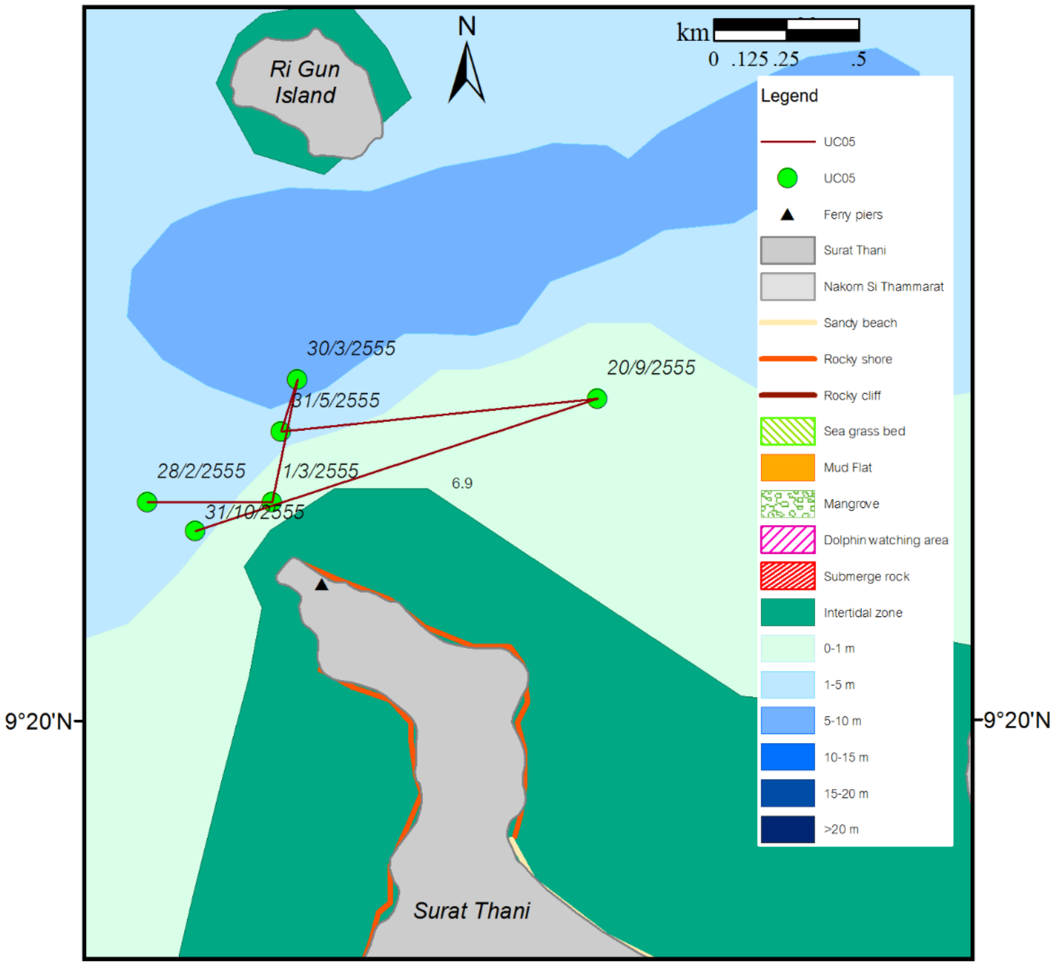
<tr><td colspan="3">Encountered history</td></tr>
<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td rowspan="3">1</td><td rowspan="3">25/1/12 13.28</td><td rowspan="3">N09°29.527′, E099°39.943′</td></tr>
<tr><td>Right side</td></tr>
<tr><td></td></tr>
</table>

Left side	Number: 05
	Code: UC05
Right side	Encountered history
	

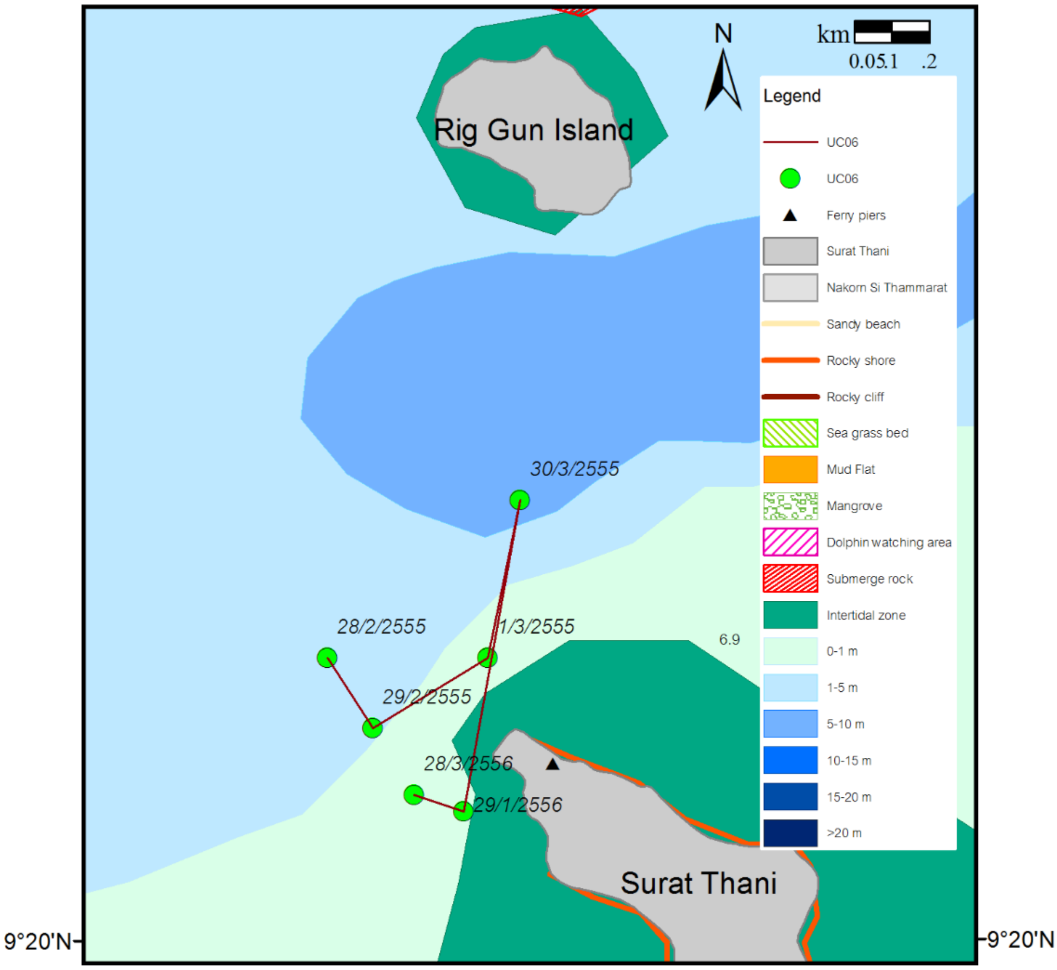
No.	Date/Time	Area Code
1	28/2/12 11.51	N09°20.365′, E099°40.629′
2	1/3/12 07.37	N09°20.361′, E099°40.867′
3	30/3/12 09.39	N09°20.589′, E099°40.913′
4	31/5/12 07.54	N09°20.498′, E099°40.886′
5	20/9/12 08.09	N09°20.554′, E099°41.478′
6	31/10/12 07.58	N09°20.309′, E099°40.722′



Left side	Number: 06
	Code: UC06
Right side	
	

Encountered history

No.	Date/Time	Area Code
1	28/2/1211.51.	N09°20.365′, E099°40.629′
2	29/2/12 14.30.	N09°20.260′, E099°40.699′
3	1/3/12 07.37 .	N09°20.361′, E099°40.867′
4	30/3/12 09.39.	N09°20.589′, E099°40.913′
5	29/1/13 10.41.	N09°20.143′, E099°40.832′
6	28/3/13 11.47.	N09°20.166′, E099°40.757′

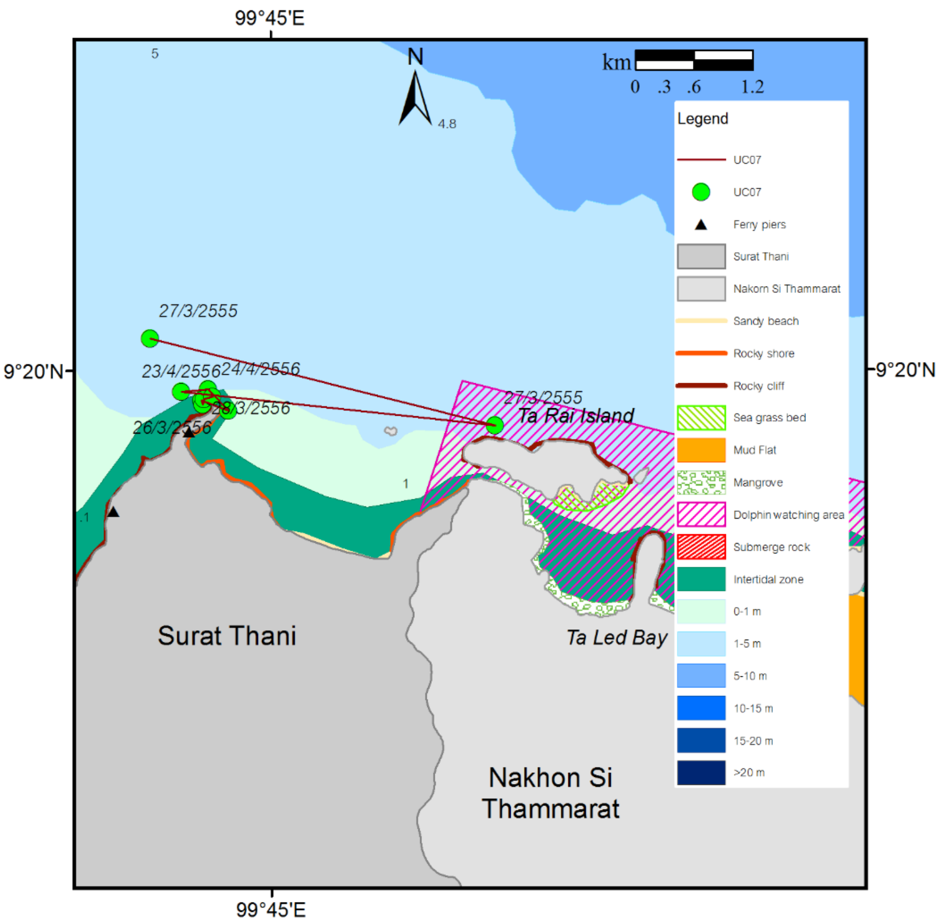


Left side	Number: 07
	Code: UC07

Right side

Encountered history

No.	Date/Time	Area Code
1	27/3/12 09.22	N09°20.135′, E099°44.318′
2	29/3/12 08.55	N09°19.648′, E099°46.246′
3	19/9/12 08.16	N09°19.842′, E099°44.490′
4	20/9/12 09.45	N09°19.856′, E099°44.642′
5	31/10/12 12.56	N09°19.732′, E099°44.752′
6	26/3/13 13.17	N09°19.796′, E099°44.602′
7	28/3/13 8.53	N09°19.768′, E099°44.608′
8	23/4/13 8.36	N09°19.800′, E099°44.615′
9	24/4/13 8.14	N09°19.814′, E099°44.661′



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<tr><td>Right side</td><td>1
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4
5</td><td>27/6/12 17.48
22/8/12 13.17
23/8/12 11.14
19/2/12 10.12</td><td>N09°19.510′,E099°44.279′
N09°19.478′,E099°44.209′
N09°20.039′,E099°44.980′
N09°19.292′,E099°44.002′</td></tr>
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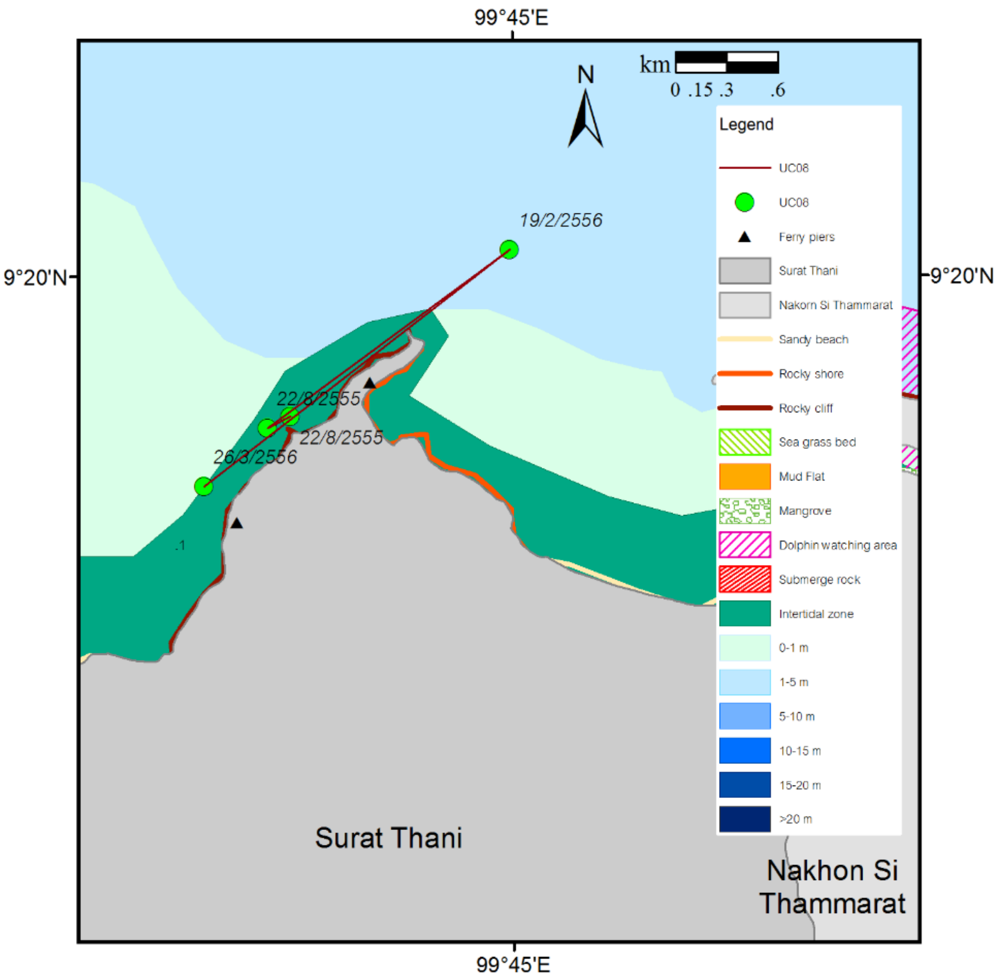

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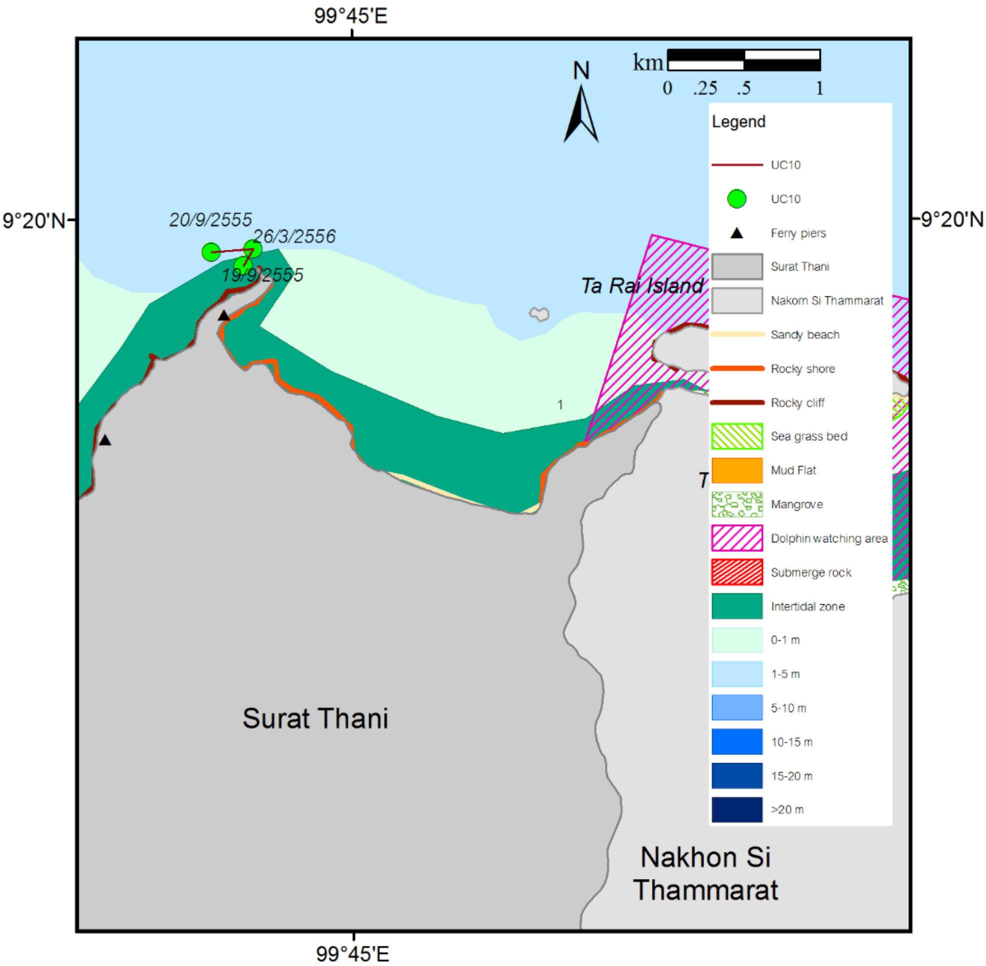
Left side	Number: 10		
	Code: UC10		
	Encountered history		
	No	Date/Time	Area Code
	1	19/9/12 08.16	N09°19.842′, E099°44.490′
Right side	2	20/9/12 09.45	N09°19.856′, E099°44.642′
	3	26/3/13 13.17	N09°19.796′, E099°44.602′
	4		



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<tr><td rowspan="3">1</td><td rowspan="3">18/9/12 12.33 .</td><td rowspan="3">N09°24.569′, E099°39.878′</td></tr>
<tr><td>Right side</td></tr>
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<tr><td>Right side</td></tr>
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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td>Right side</td><td rowspan="2">1</td><td rowspan="2">18/9/12 12.33</td><td rowspan="2">N09°24.569′, E099°39.878′</td></tr>
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<tr><td>Right side</td><td rowspan="2">1</td><td rowspan="2">18/9/12 12.33</td><td rowspan="2">N09°24.569′, E099°39.878′</td></tr>
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Left side	Number: 16		
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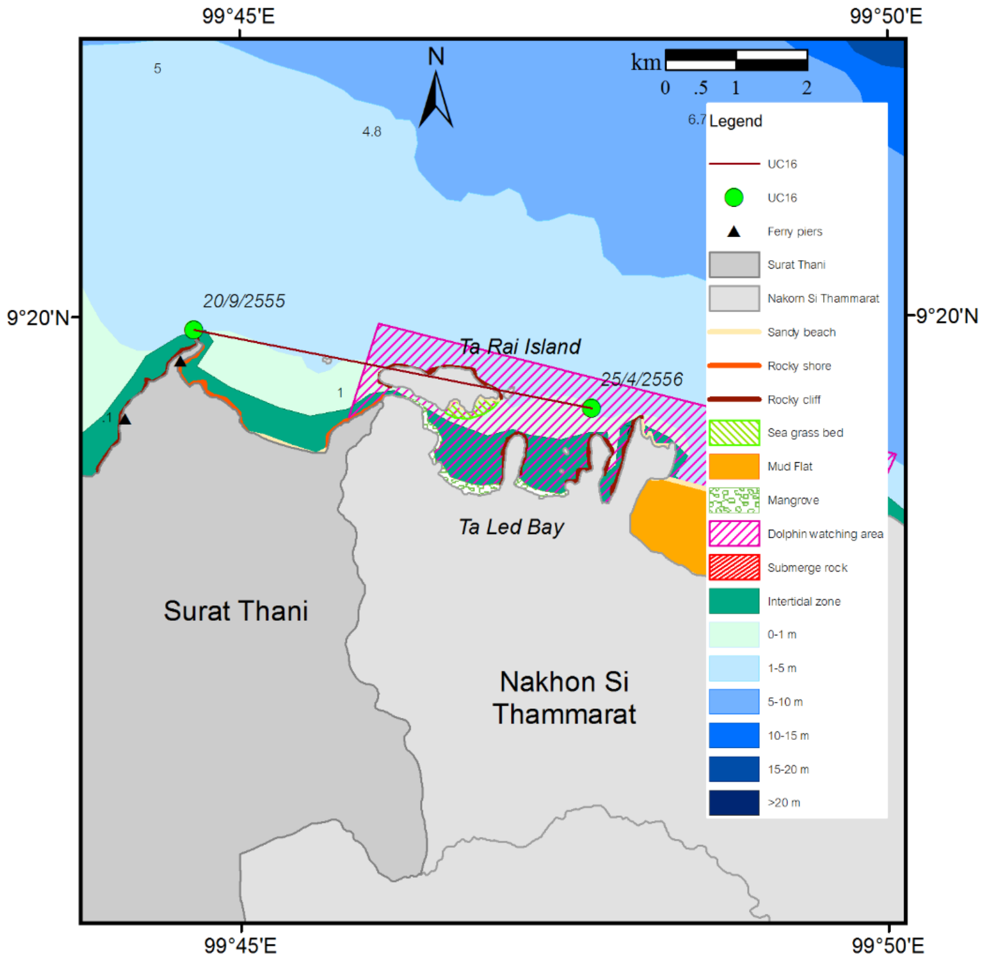
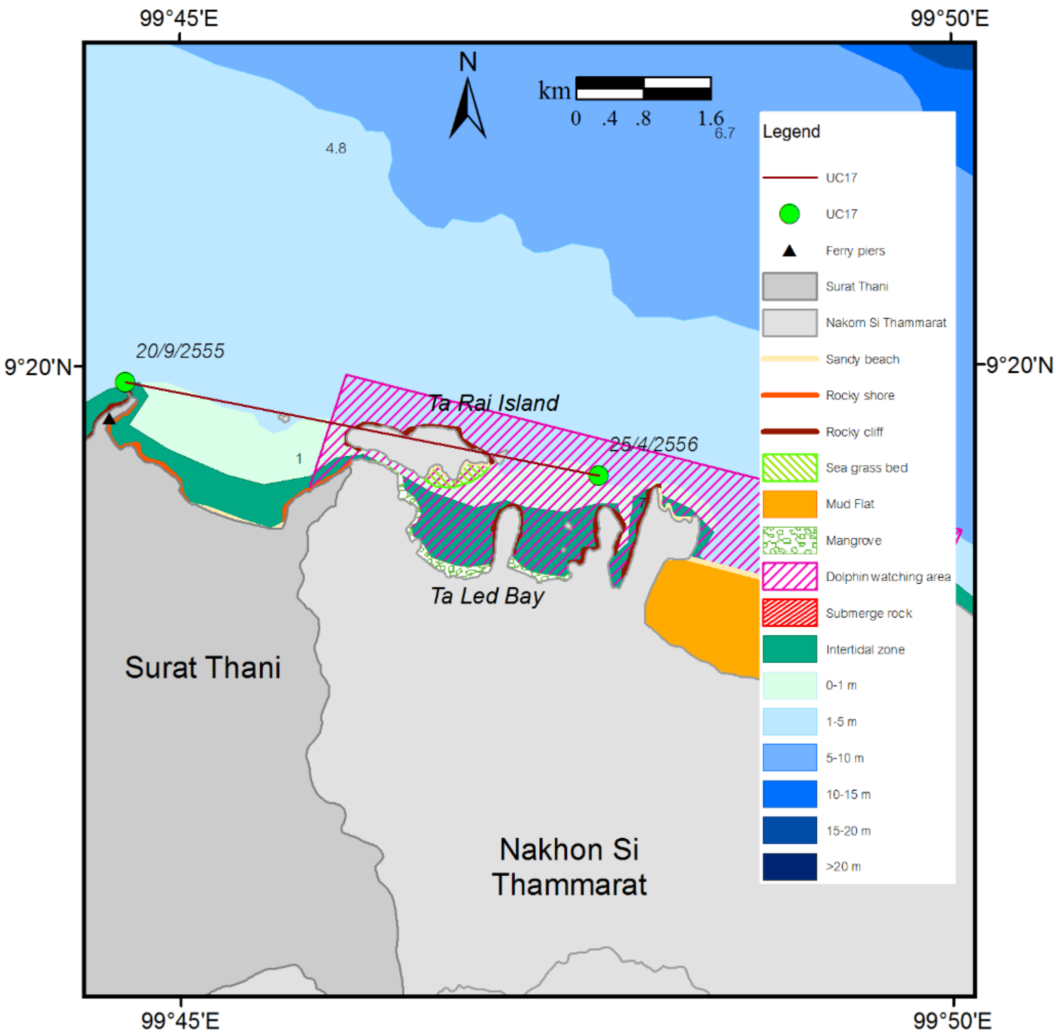
	Encountered history		
	No.	Date/Time	Area Code
	1 2	20/9/12 09.45 25/4/13 09.39	N09°19.856′, E099°44.642′ N09°19.246′, E099°47.704′
Right side			
			



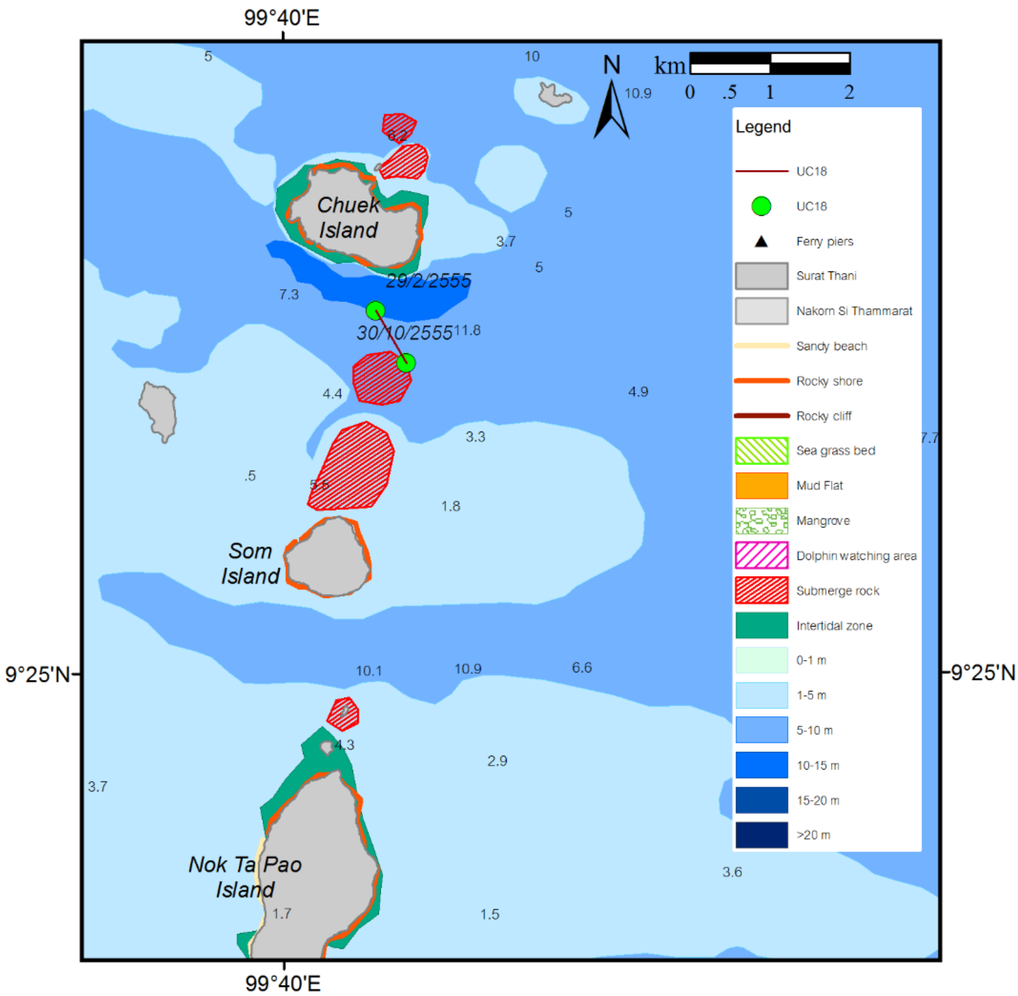
Left side	Number: 17
	Code: UC17
Right side	
	

Encountered history

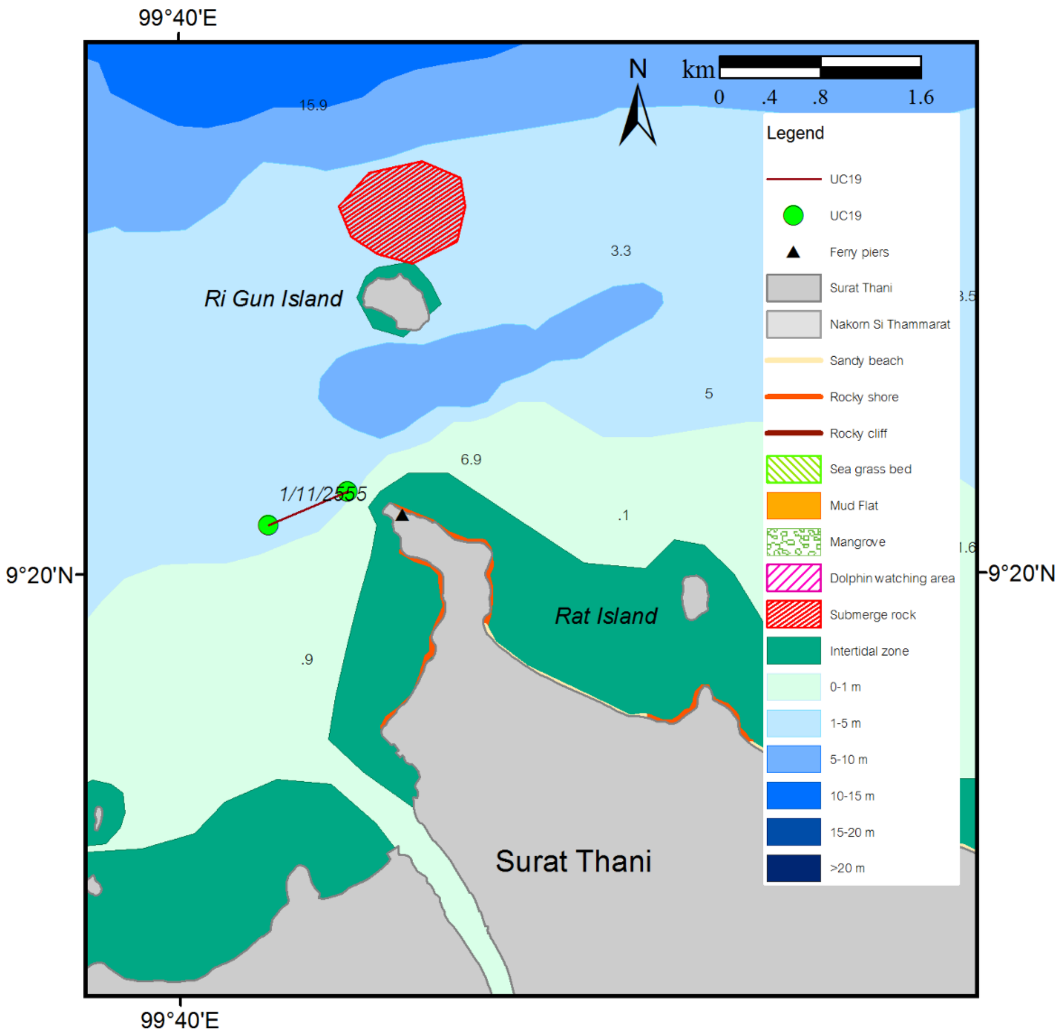
No.	Date/Time	Area Code
1	20/9/12 09.45	N09°19.856′, E099°44.642′
2	25/4/13 09.39	N09°19.246′, E099°47.704′
3		



Left side	Number: 18		
	Code: UC18		
	Encountered history		
	No.	Date/Time	Area Code
	1	29/2/12 11.00	N09°27.420′,E099°40.630′
	2	30/10/12 11.36	N09°27.067′,E099°40.838′
Right side			
			



Left side	Number: 19		
	Code: UC19		
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	31/10/55 07.58	N09°20.309′,E099°40.722′
	2	1/11/55 09.19	N09°20.166′,E099°40.379′



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<tr><td>1</td><td>1/11/55 09.19</td><td>N09°20.166′, E099°40.379′</td></tr>
<tr><td>Right side</td><td>2</td><td>29/11/55 11.00</td><td>N09°20.222′, E099°40.701′</td></tr>
<tr><td rowspan="7">
</td><td>3</td><td>30/11/55 09.38</td><td>N09°20.139′, E099°40.813′</td></tr>
<tr><td>4</td><td>29/1/56 10.41</td><td>N09°20.143′, E099°40.832′</td></tr>
<tr><td>5</td><td>30/1/56 11.17</td><td>N09°20.149′, E099°40.824′</td></tr>
<tr><td>6</td><td>21/2/56 12.17</td><td>N09°20.145′, E099°40.823′</td></tr>
<tr><td>7</td><td>27/3/56 12.25</td><td>N09°20.091′, E099°40.840′</td></tr>
<tr><td>8</td><td>28/3/56 11.47</td><td>N09°20.152′, E099°40.806′</td></tr>
<tr><td>9</td><td>25/4/5612.06</td><td>N09°20.183′, E099°40.783′</td></tr>
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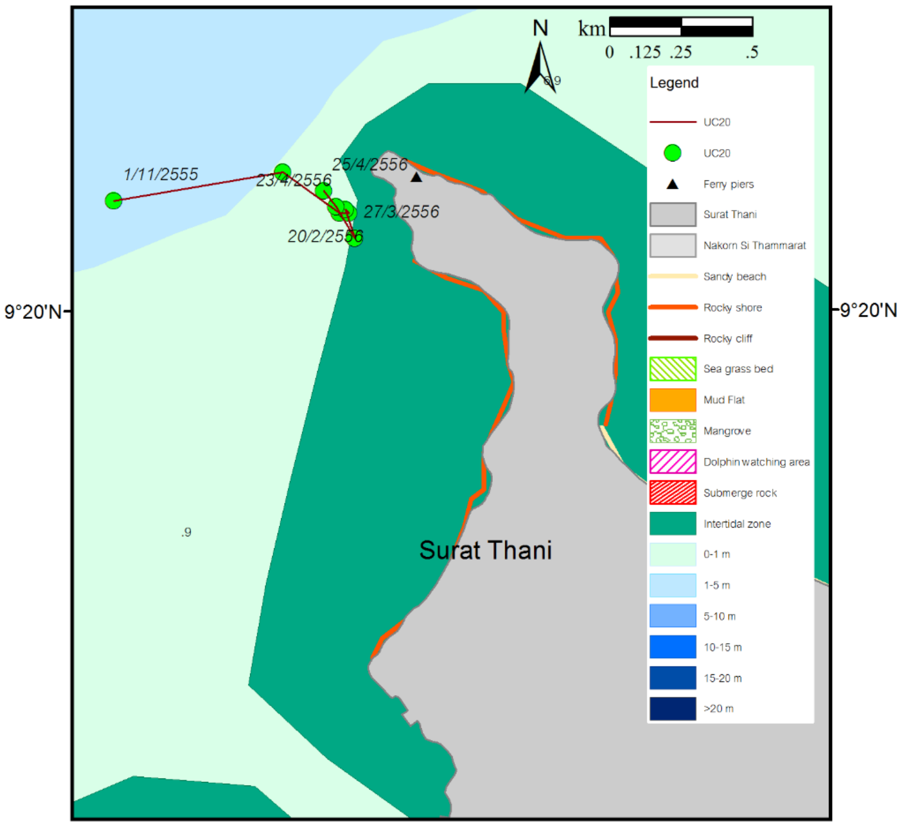
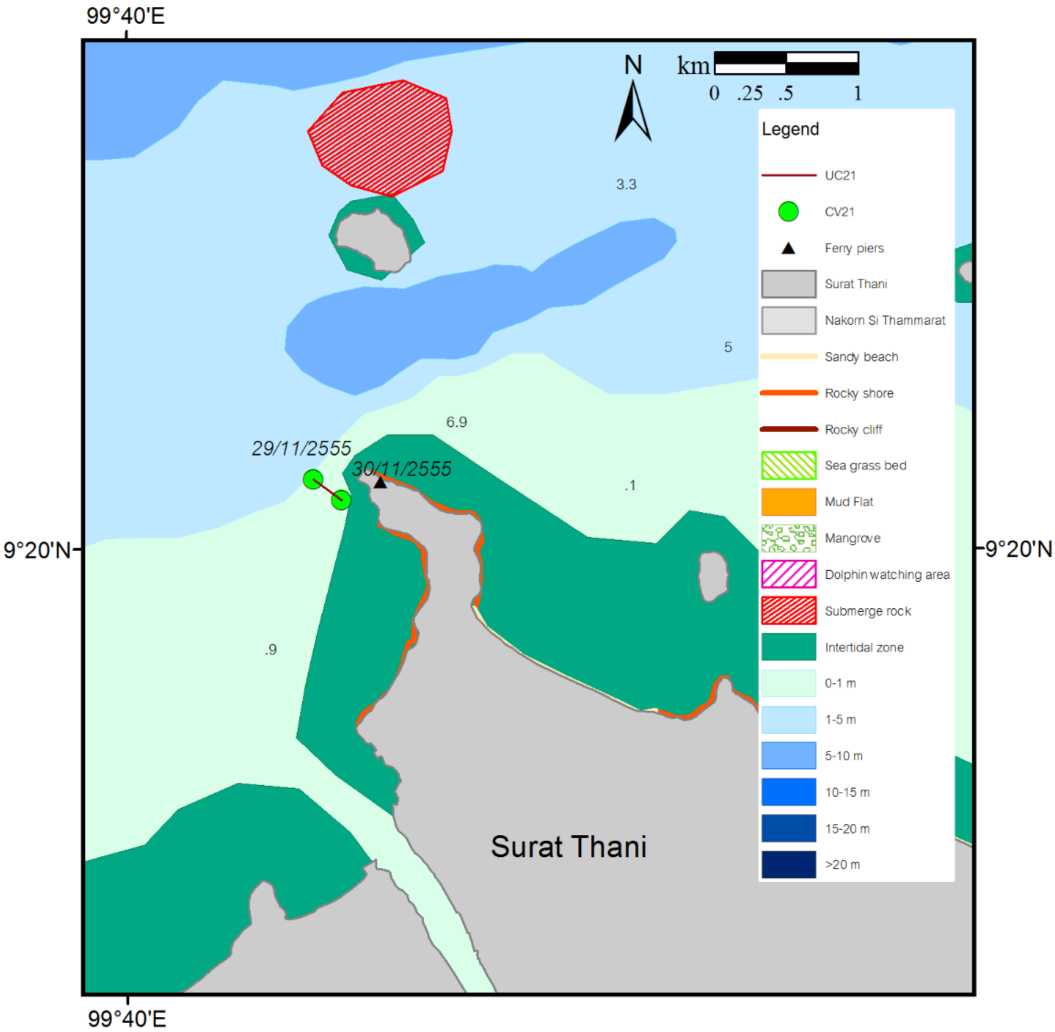


Left side	Number: 21		
	Code: UC21		
	Encountered history		
Right side	No.	Date/Time	Area Code
	1	29/11/12 11.00	N09°20.222′,E099°40.701′
	2	30/11/12 09.38	N09°20.139′,E099°40.813′



Left side	Number: 22		
	Code: UC22		
	Encountered history		
	No.	Date/Time	Area Code
	1	29/11/1211.00 .	N09°20.222′,E099°40.701′
Right side			

Left side	Number: 23		
	Code: UC23		
	Encountered history		
	No.	Date/Time	Area Code
	1	1/3/55 09.22	N09°23.730′,E099°39.719′
Right side			
			

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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td>Right side</td><td rowspan="2">1
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3</td><td rowspan="2">30/1/56 09.08
30/1/56 11.17
21/2/56 12.17</td><td rowspan="2">N09°23.730′, E099°39.719′
N09°20.149′, E099°40.824′
N09°20.145′, E099°40.823′</td></tr>
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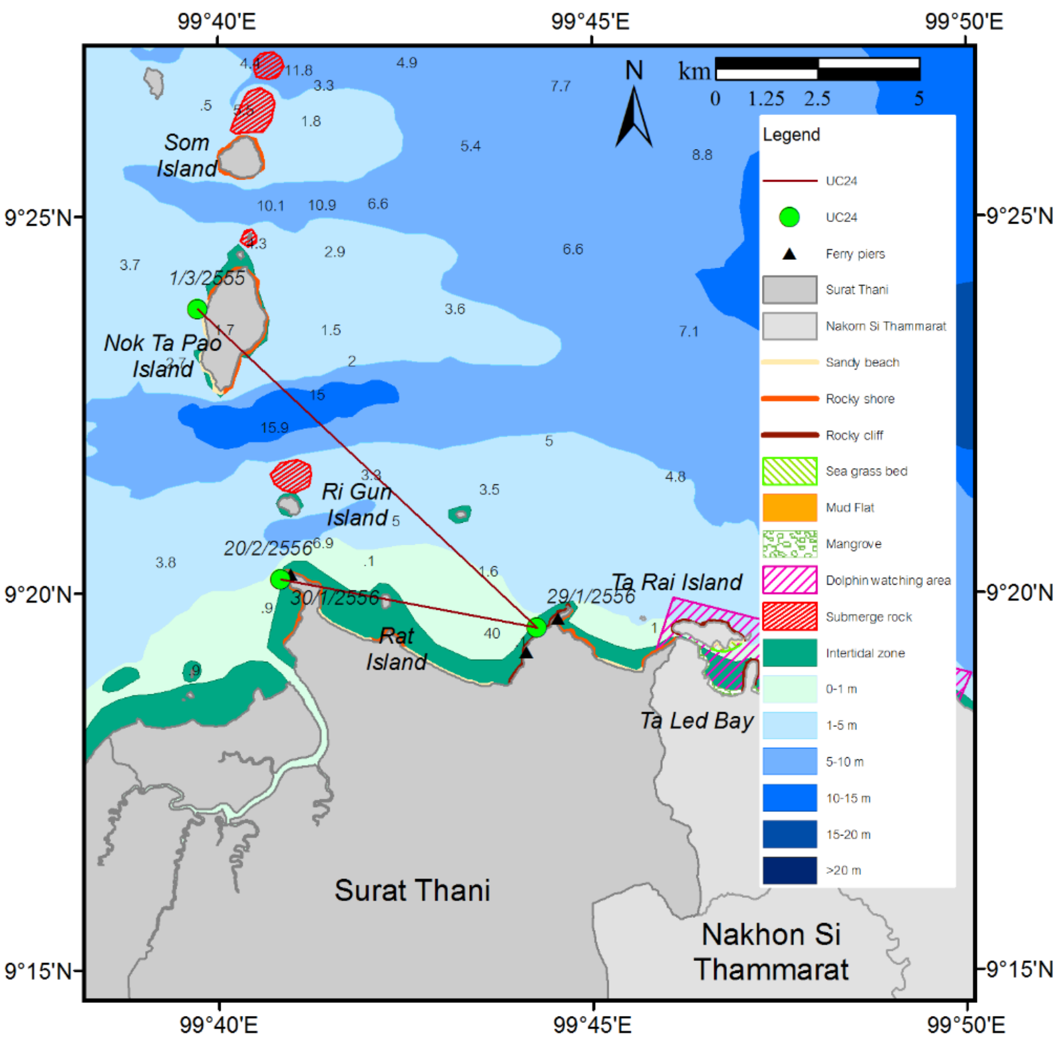

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<tr><td rowspan="3">1</td><td rowspan="3">30/1/13 11.14</td><td rowspan="3">N09°19.426′, E099°44.194′</td></tr>
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Left side

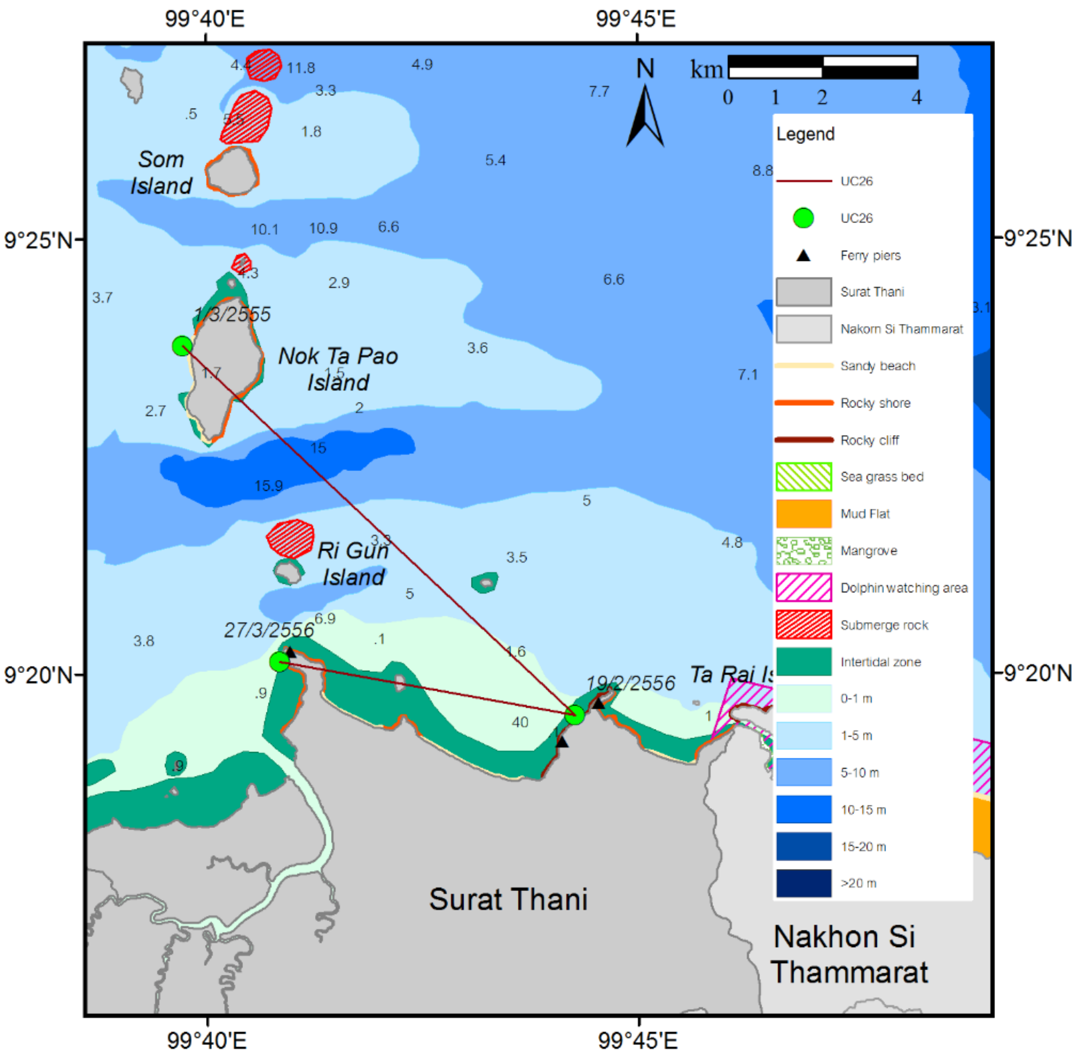
Right side

Number: 26

Code: UC26

Encountered history

No.	Date/Time	Area Code
1	19/2/13 8.52	N09°23.730′, E099°39.719′
2	26/3/13 8.43	N09°19.483′, E099°44.254′
3	27/3/13 12.25	N09°20.091′, E099°40.840′



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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td>Right side</td><td rowspan="2">1
2
3</td><td rowspan="2">1/3/12 9.18
19/2/13 9.30
25/4/13 9.39</td><td rowspan="2">N09°23.730′, E099°39.719′
N09°19.021′, E099°47.037′
N09°19.246′, E099°47.704′</td></tr>
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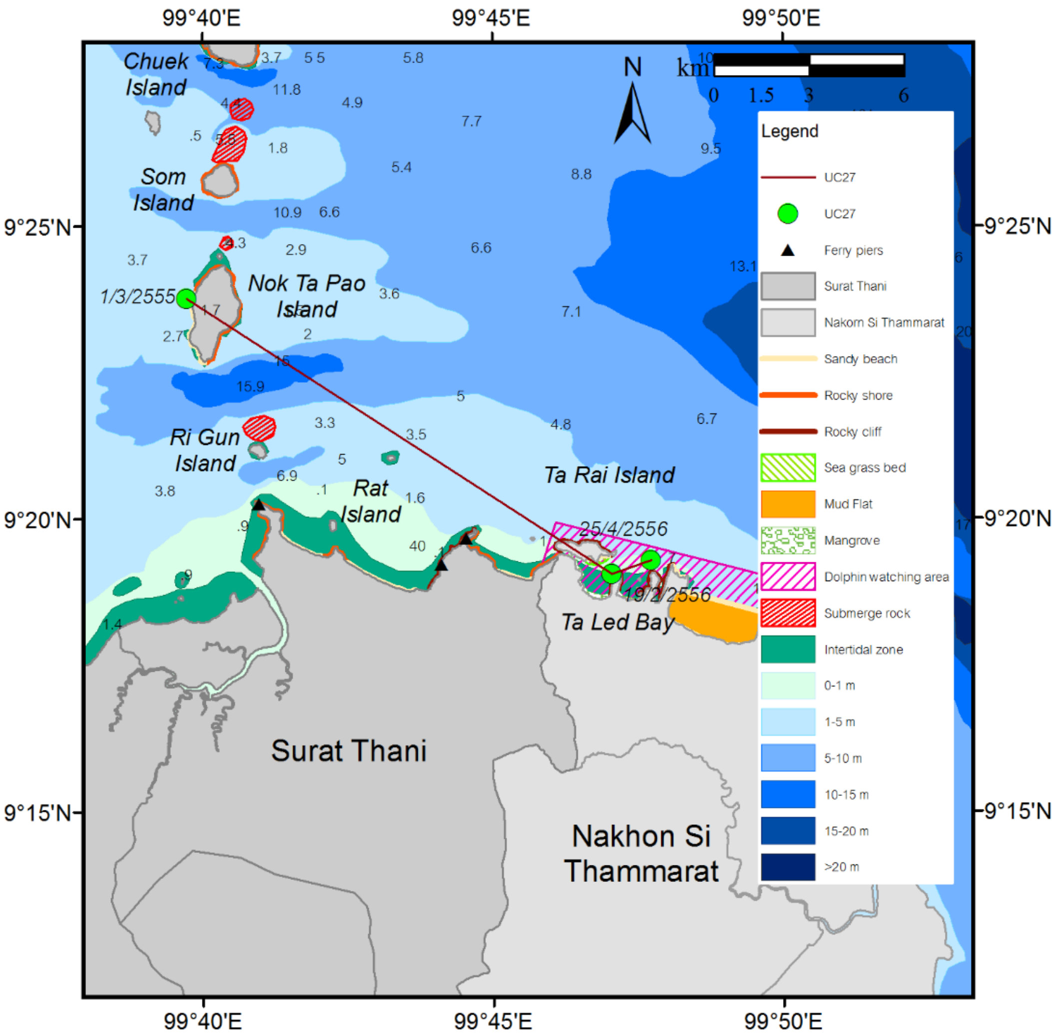
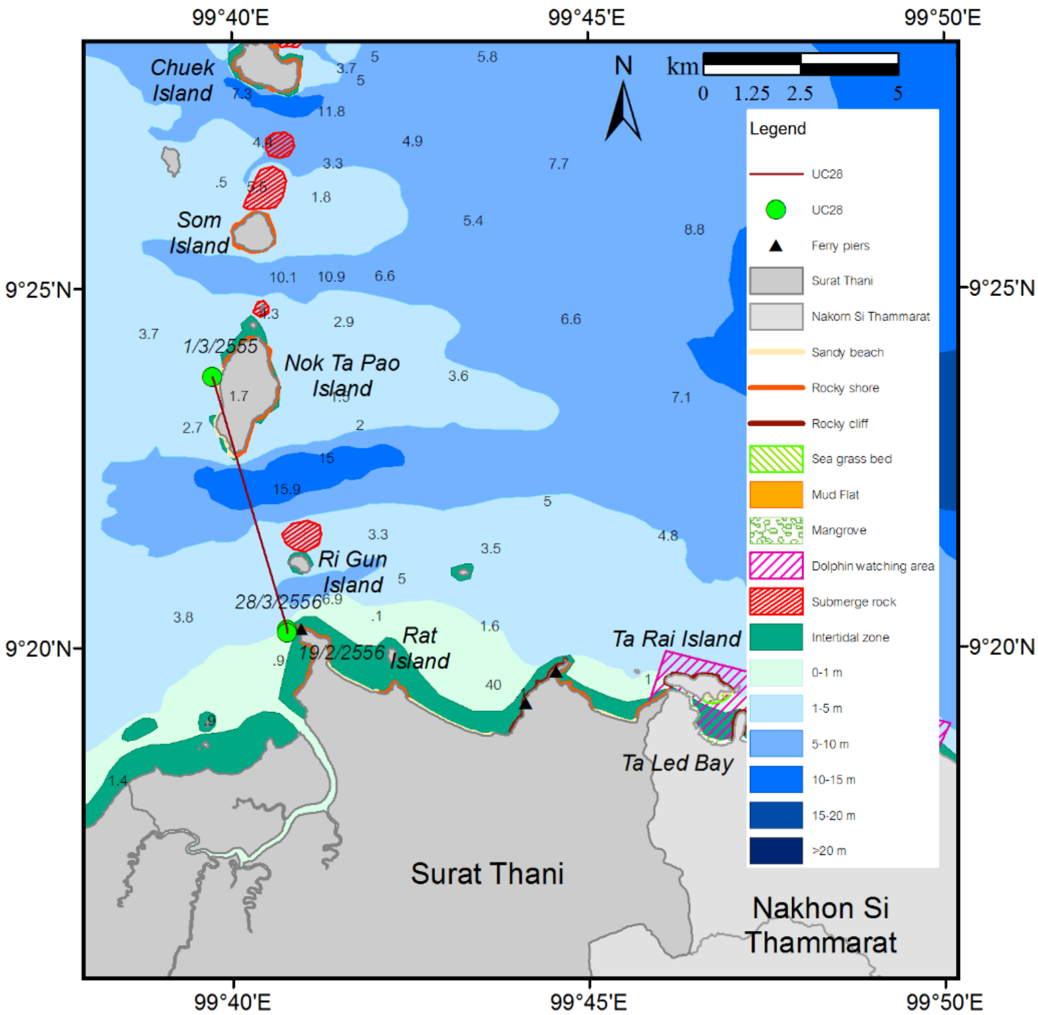


Left side	Number: 28		
	Code: UC28		
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	19/2/56 12.30	N09°20.203′, E099°40.763′
	2	28/3/56 11.47	N09°20.166′, E099°40.757′



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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td rowspan="3">1</td><td rowspan="3">26/3/56 8.43</td><td rowspan="3">N09°20.372′, E099°40.816′</td></tr>
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<tr><td rowspan="3">1</td><td rowspan="3">26/3/56 11.30</td><td rowspan="3">N09°28.315′, E099°41.437′</td></tr>
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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td>Right side</td><td rowspan="2">1</td><td rowspan="2">28/3/56 10.15</td><td rowspan="2">N09°22.205′, E099°42.420′</td></tr>
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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td>Right side</td><td>1</td><td>28/3/56 10.15</td><td>N09°22.205′, E099°42.420′</td></tr>
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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td>Right side</td><td>1</td><td>28/3/56 10.15</td><td>N09°22.205′, E099°42.420′</td></tr>
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Age classe : Spotted Juveniles (SJ)

Left side

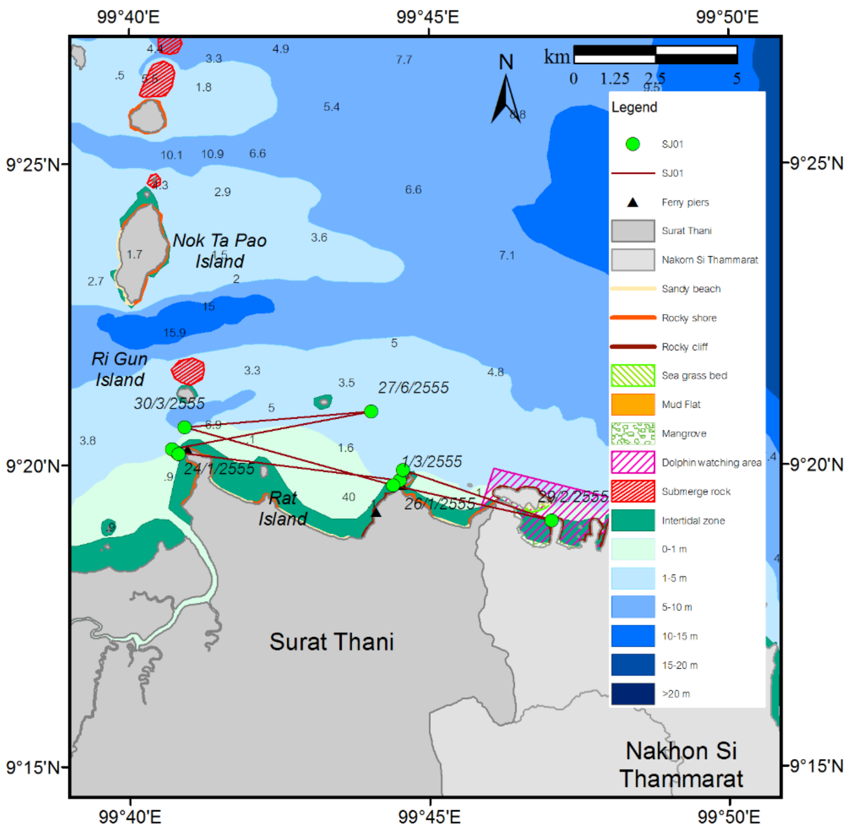
Right side

Number: 01

Code: SJ01

Encountered history

No.	Date/Time	Area Code
1	24/1/12 13.32	N09°20.172′, E099°40.781′
2	26/1/12 12.36	N09°19.700′, E099°44.496′
3	28/2/12 10.01	N09°19.870′, E099°44.554′
4	29/2/12 08.10	N09°19.023′, E099°47.034′
5	1/3/12 12.39	N09°19.617′, E099°44.394′
6	30/3/12 09.39	N09°20.589′, E099°40.913′
7	27/6/12 10.38	N09°20.843′, E099°44.024′
8	29/11/12 11.00.	N09°20.222′, E099°40.701′
9	30/11/12 09.38	N09°20.139′, E099°40.813′



Left side

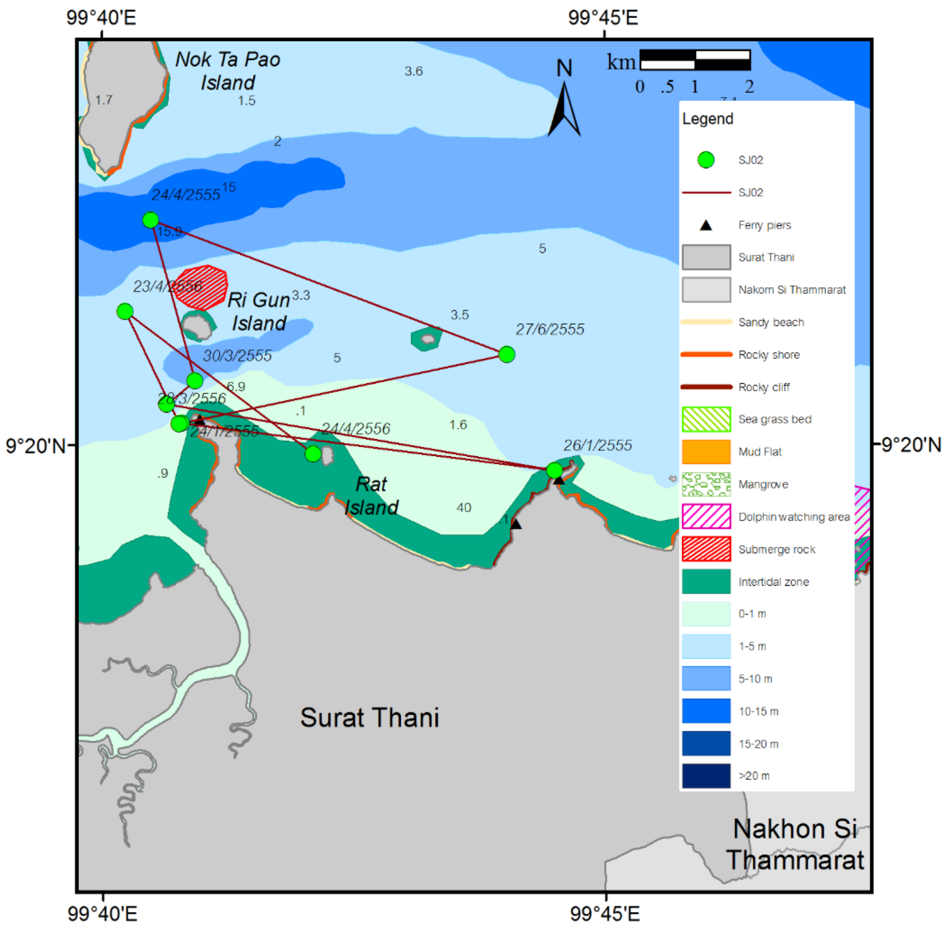
Right side

Number: 02

Code: SJ02

Encountered history

No.	Date/Time	Area Code
1	24/1/55 13.32	N09°20.172′, E099°40.781′
2	26/1/55 12.36	N09°19.700′, E099°44.496′
3	28/2/55 11.51	N09°20.365′, E099°40.629′
4	30/3/55 09.39	N09°20.589′, E099°40.913′
5	24/4/55 08.47	N09°22.183′, E099°40.475′
6	27/6/55 10.38	N09°20.843′, E099°44.024′
7	28/3/56 11.47	N09°20.166′, E099°40.757′
8	23/4/56 13.11	N09°21.275′, E099°40.218′
9	24/4/56 13.33	N09°19.867′, E099°42.090′



Left side

Right side

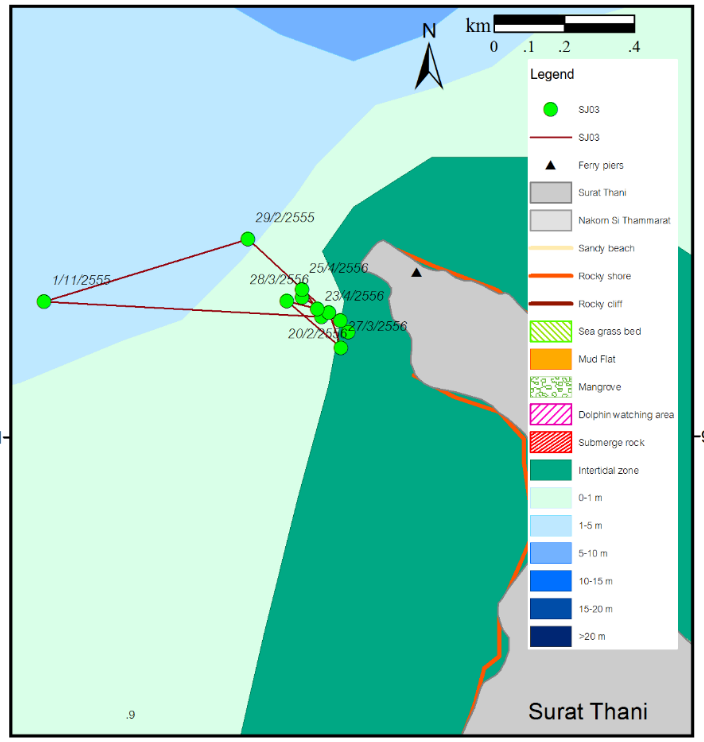
Number: 03

Code: SJ03

Encountered history

No.	Date/Time	Area Code
1	24/1/1213.32	N09°20.172′, E099°40.781′
2	25/1/12 15.03	N09°20.133′, E099°40.842′
3	26/1/12 08.33	N09°20.120′, E099°40.856′
4	29/2/2 14.30	N09°20.260′, E099°40.699′
5	1/11/12 09.19	N09°20.166′, E099°40.379′
6	30/11/12 09.38	N09°20.139′, E099°40.813′
7	30/1/13 11.17	N09°20.149′, E099°40.824′
8	21/2/13 12.17	N09°20.145′, E099°40.823′
9	27/3/13 12.25	N09°20.091′, E099°40.840′
10	28/3/13 11.47	N09°20.166′, E099°40.757′
11	23/4/1314.23	N09°20.152′, E099°40.806′
12	25/4/1312.06	N09°20.183′, E099°40.783′

9°20'N



9°20'N

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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
<tr><td>Right side</td><td rowspan="2">1</td><td rowspan="2">29/2/1211.00</td><td rowspan="2">N09°27.420′,E099°40.630′</td></tr>
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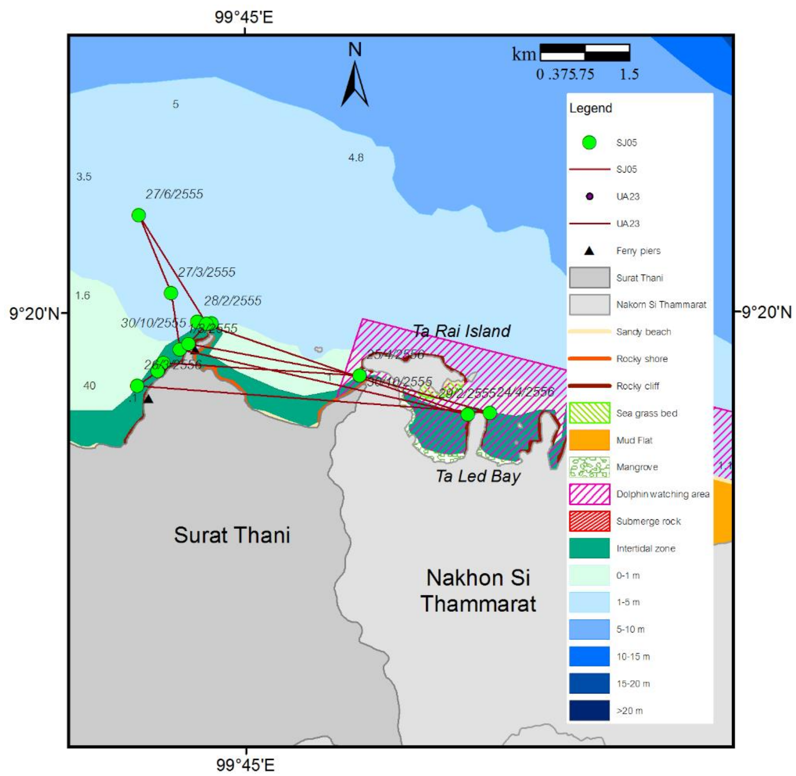
Left side	Number: 05
	Code: SJ05
Right side	
	

Encountered history

No.	Date/Time	Area Code
1	25/1/12 08.28	N09°19.858′, E099°44.690′
2	28/2/12 10.01	N09°19.870′, E099°44.554′
3	29/2/12 08.10	N09°19.023′, E099°47.034′
4	1/3/12 12.39	N09°19.617′, E099°44.394′
5	27/3/12 09.22	N09°20.135′, E099°44.318′
6	27/6/1210.38	N09°20.843′, E099°44.024′
7	20/9/12 09.45	N09°19.856′, E099°44.642′
8	30/10/12 08.31	N09°19.676′, E099°44.478′
9	30/10/12 09.37	N09°19.378′, E099°46.041′
10	29/1/13 8.28	N09°19.497′, E099°44.245′
11	30/1/13 9.08	N09°19.426′, E099°44.194′
12	26/3/1313.47	N09°19.292′, E099°44.002′
13	25/4/13 08.39	N09°19.038′, E099°47.233′
14	24/4/13 8.44	N09°19.382′, E099°46.042′



Left side

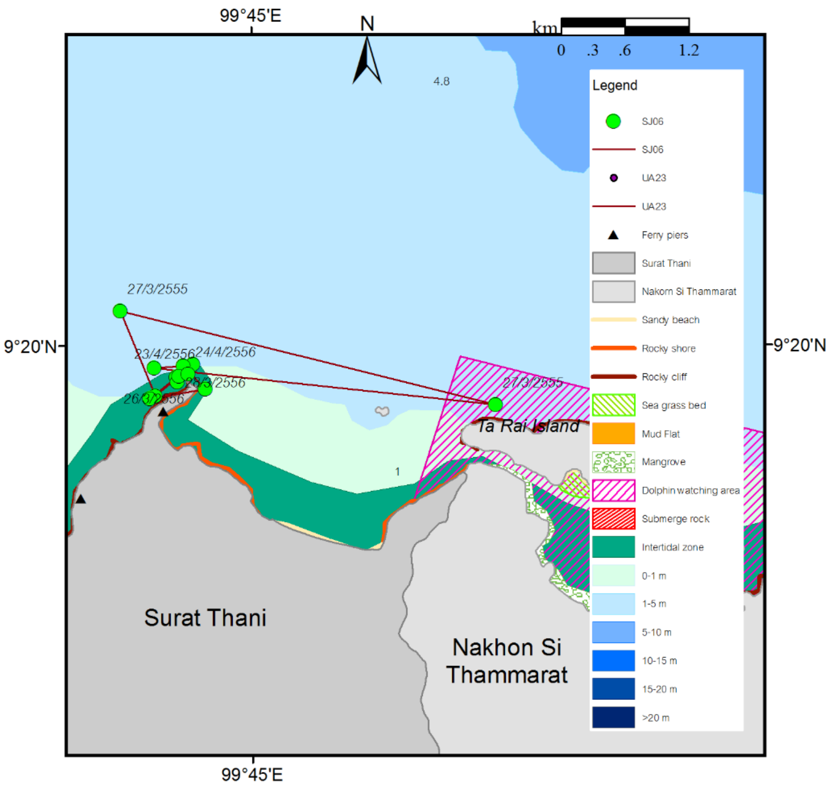
Right side

Number: 06

Code: SJ06

Encountered history

No.	Date/Time	Area Code
1	25/1/12 08.28	N09°19.858′, E099°44.690′
2	26/1/12 12.36	N09°19.700′, E099°44.496′
3	27/3/12 09.22	N09°20.135′, E099°44.318′
4	29/3/12 08.55	N09°19.648′, E099°46.246′
5	19/9/12 08.16	N09°19.842′, E099°44.490′
6	20/9/12 09.45	N09°19.856′, E099°44.642′
7	31/10/12 12.56	N09°19.732′, E099°44.752′
8	20/2/13 13.51	N09°19.688′, E099°44.463′
9	26/3/13 13.17	N09°19.796′, E099°44.602′
10	28/3/13 08.53	N09°19.768′, E099°44.608′
11	23/4/13 08.36	N09°19.800′, E099°44.615′
12	24/4/13 08.14	N09°19.814′, E099°44.661′



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28/2/12 11.51
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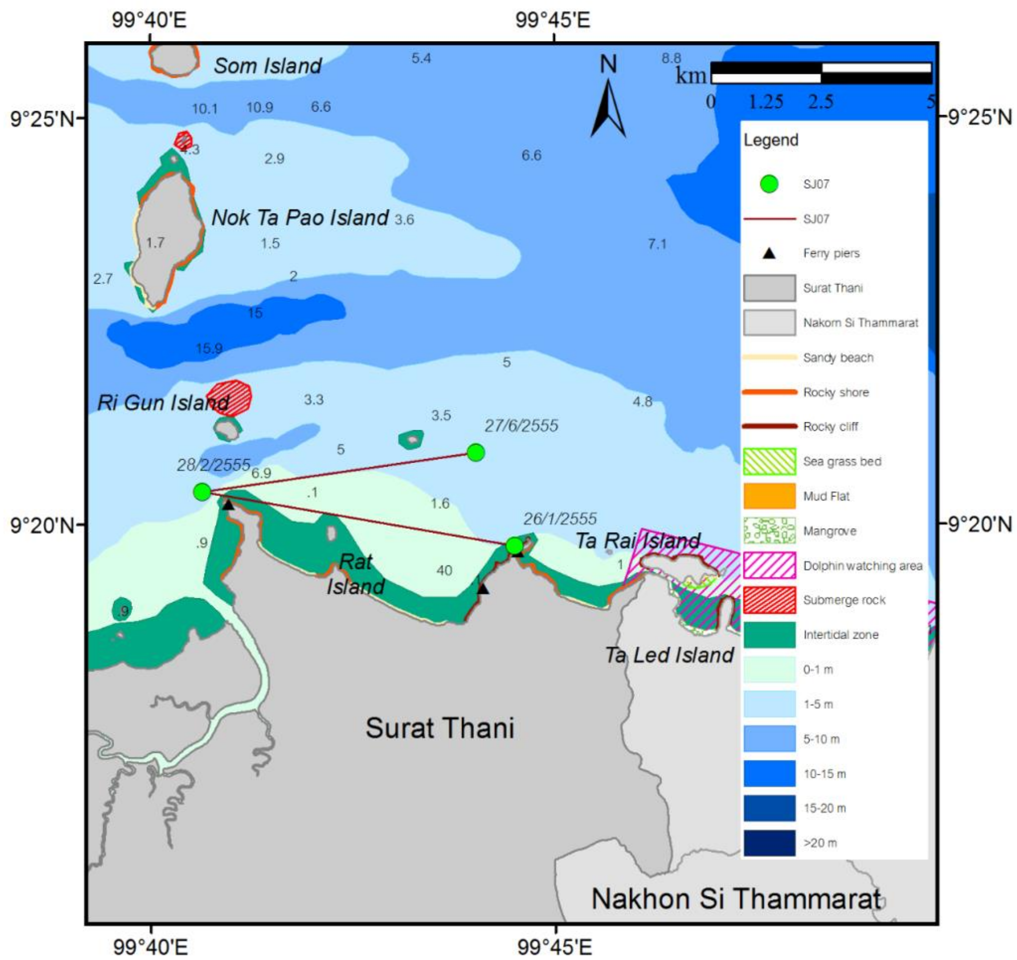

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	1	28/2/12 10.01	N09°19.870′, E099°44.554′
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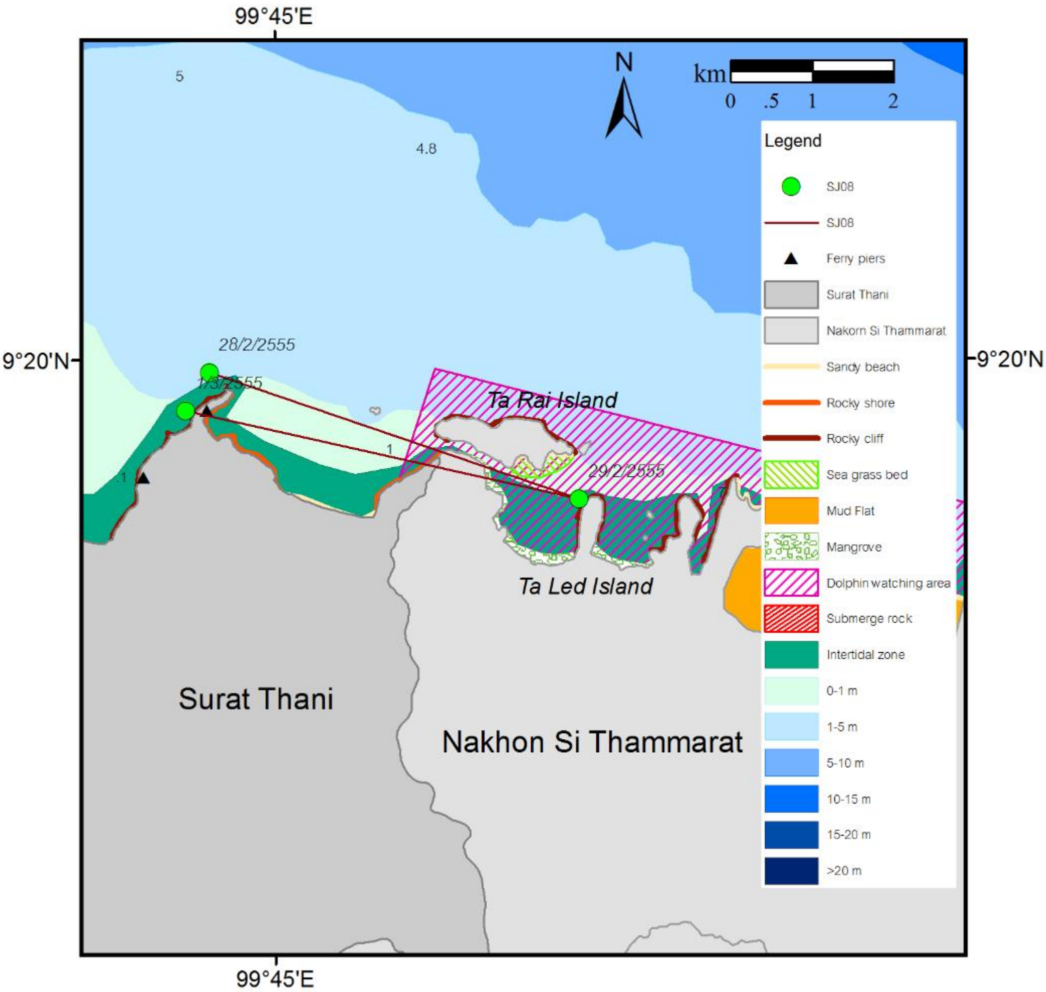
	3	1/3/12 12.39	N09°19.617′, E099°44.394′



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	Encountered history		
	No.	Date/Time	Area Code
Right side	1	29/3/12 12.20	N09°33.287′,E099°41.320′
			

Left side	Number: 12		
	Code: SJ12		
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	27/6/12 10.38	N09°20.843′, E099°44.024′
			

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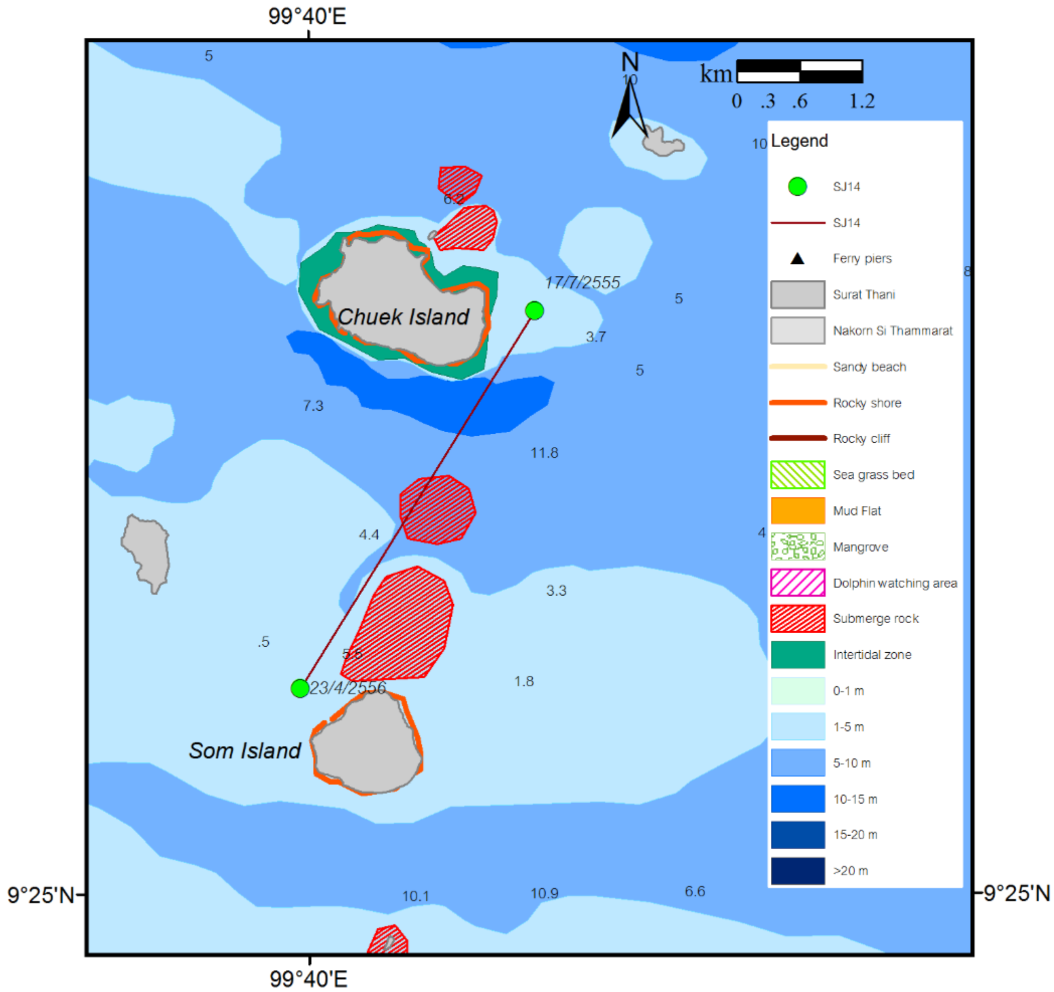

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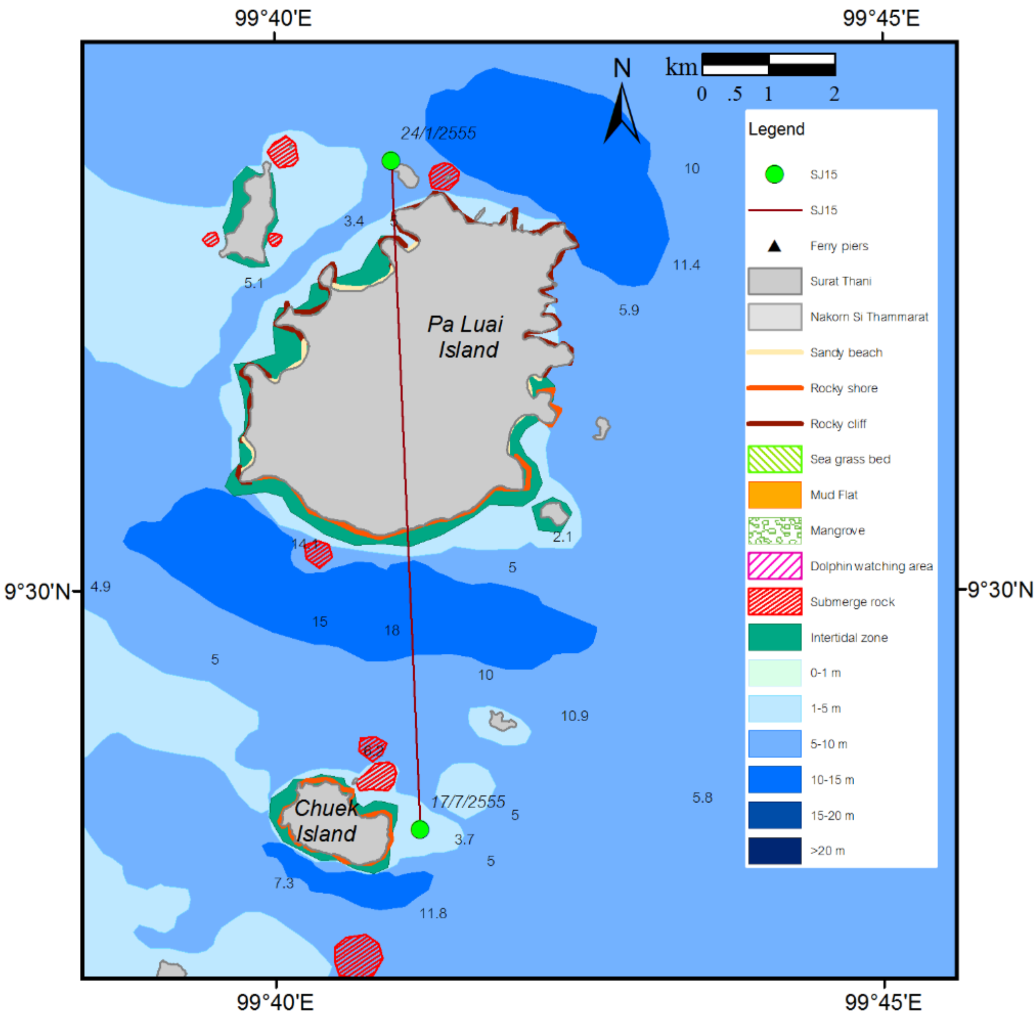
	2	17/7/55 10.11	N09°28.003′, E099°41.186′



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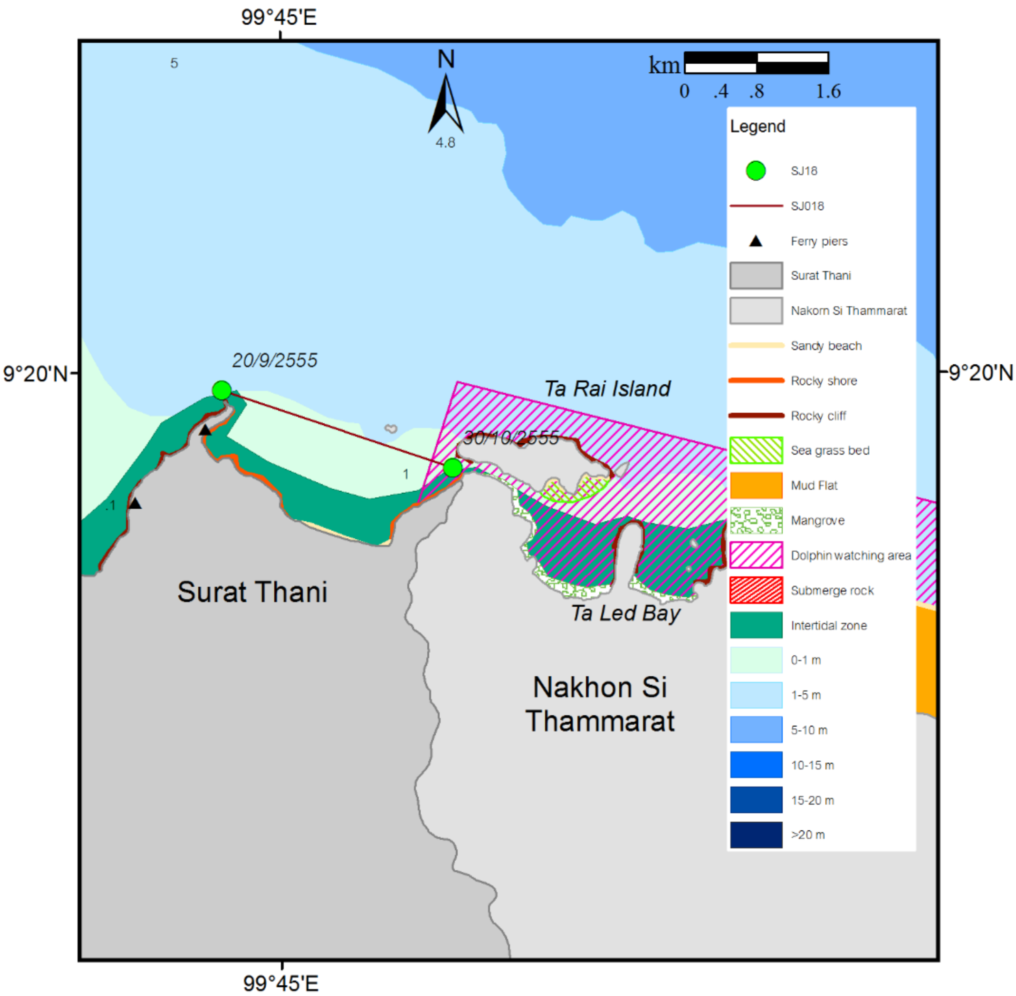

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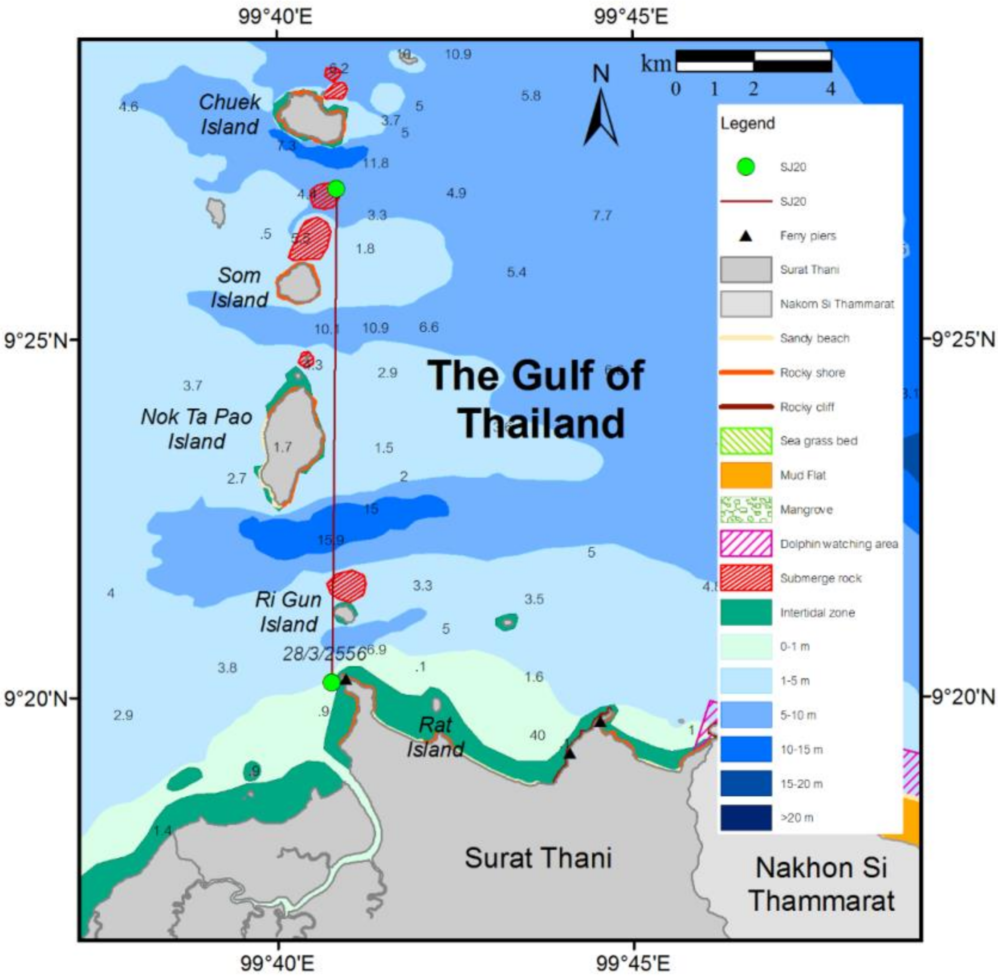
<tr><td colspan="4">
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28/03/13 11.47</td><td rowspan="2">N09°27.067′, E099°40.838′
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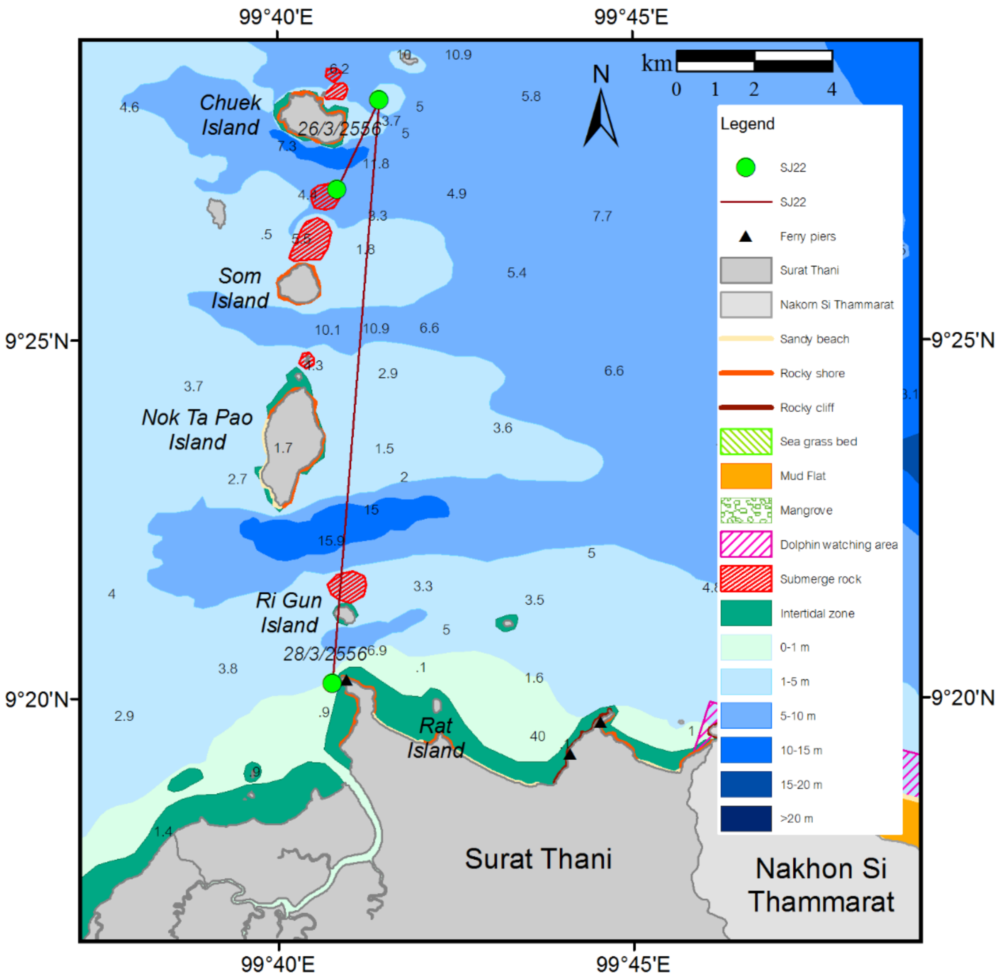

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<tr><td>2</td><td>20/02/13 13.51</td><td>N09°19.688′, E099°44.463′</td></tr>
<tr><td>3</td><td>27/03/13 8.59</td><td>N09°19.812′, E099°44.583′</td></tr>
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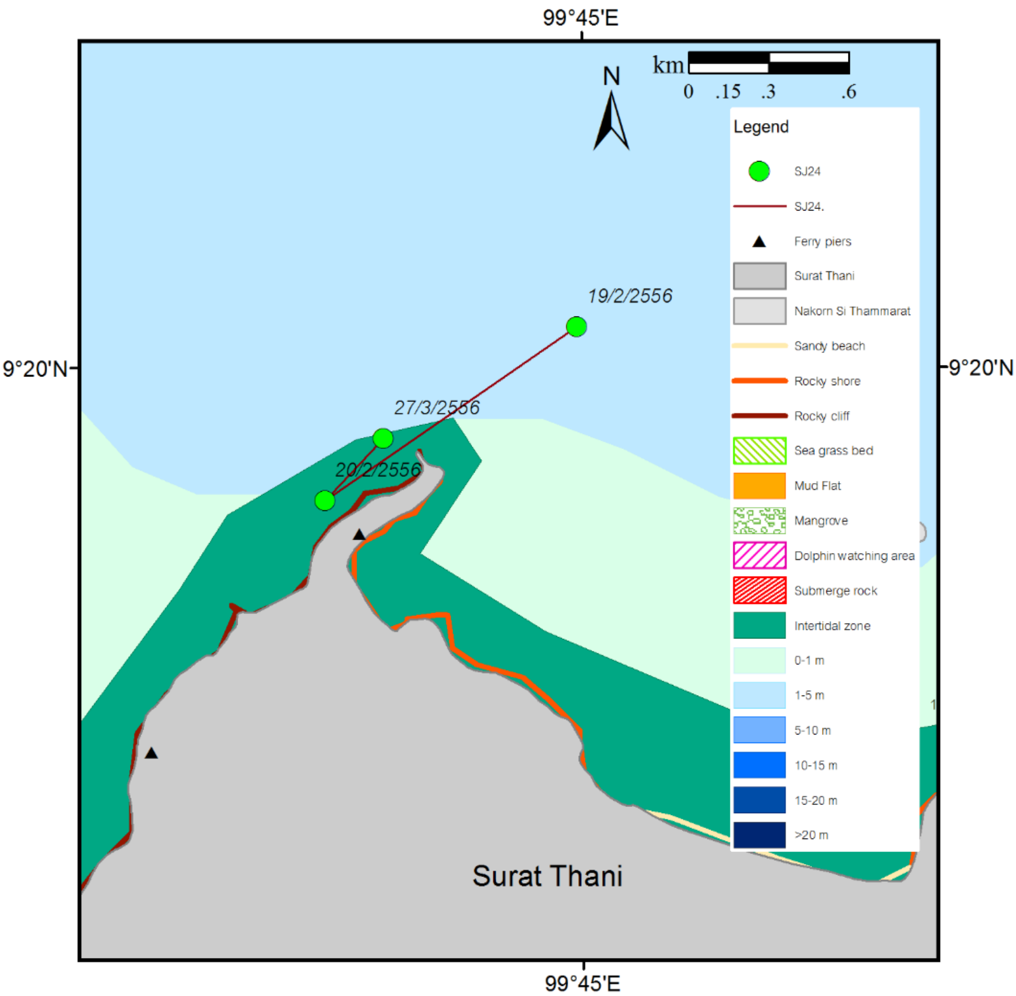

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Left side	Number: 27		
	Code: SJ27		
	Encountered history		
	No.	Date/Time	Area Code
	1	19/02/13 10.12	N09°20.039′, E099°44.980′
Right side	2		
	3		

Left side

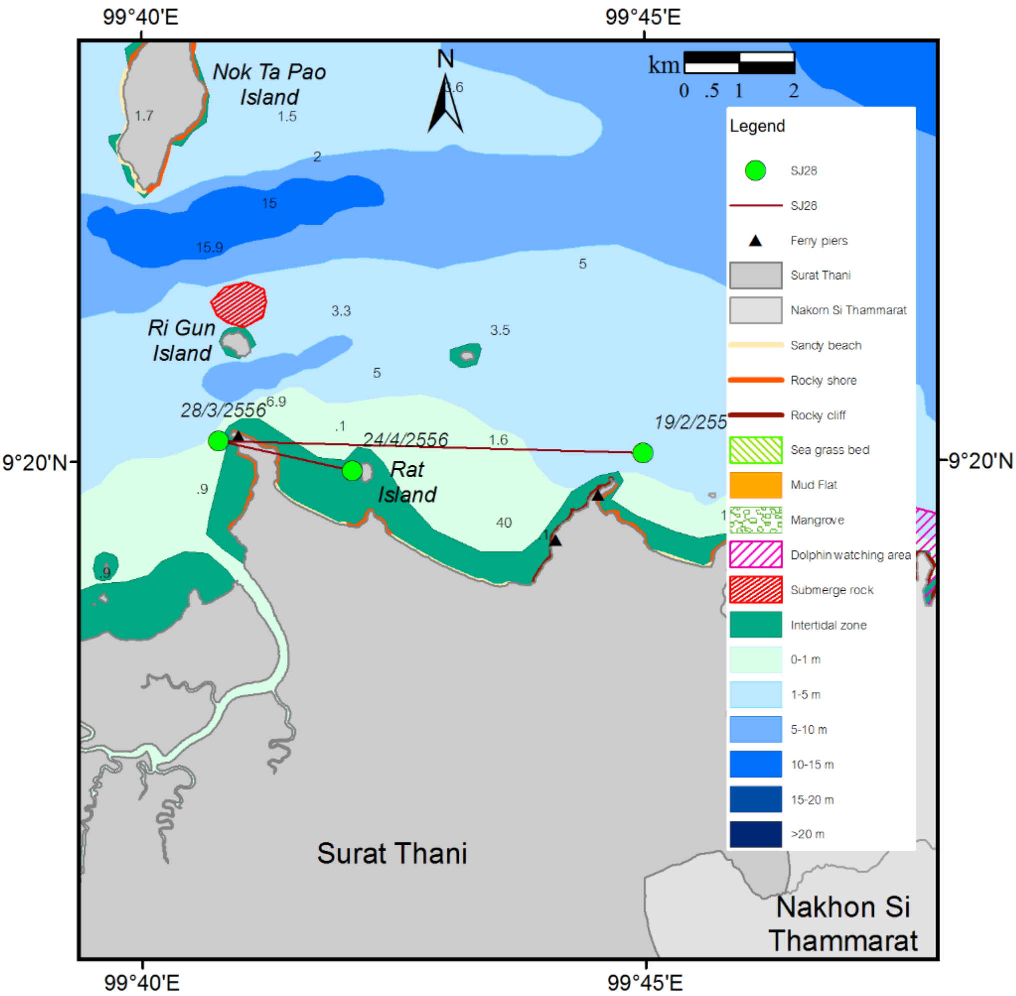
Right side

Number: 28

Code: SJ28

Encountered history

No.	Date/Time	Area Code
1	19/02/13 10.12	N09°20.039′, E099°44.980′
2	28/03/13 11.47	N09°20.166′, E099°40.757′
3	24/04/13 12.48	N09°19.867′, E099°42.090′



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24/04/13 8.44</td><td rowspan="2">N09°21.275′, E099°40.218′
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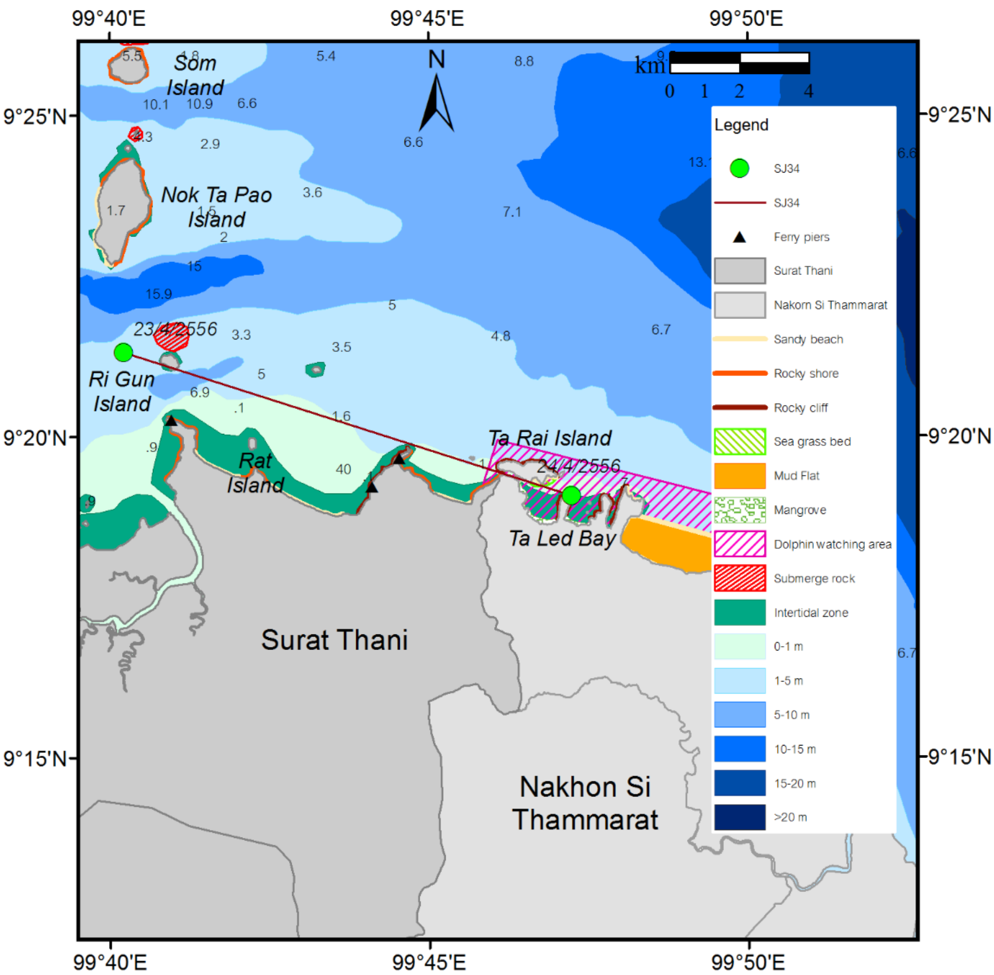

Left side	Number: 35		
	Code: SJ35		
	Encountered history		
	No.	Date/Time	Area Code
	1	24/04/13 8.44	N09°19.038′, E099°47.233′
Right side			
			

Left side	Number: 36		
	Code: SJ36		
	Encountered history		
	No.	Date/Time	Area Code
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Right side			
			

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Age classe : Spotted Adults (SA)

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<tr><td>4</td><td>19/02/13 9.30</td><td>N09°19.021′, E099°47.037′</td></tr>
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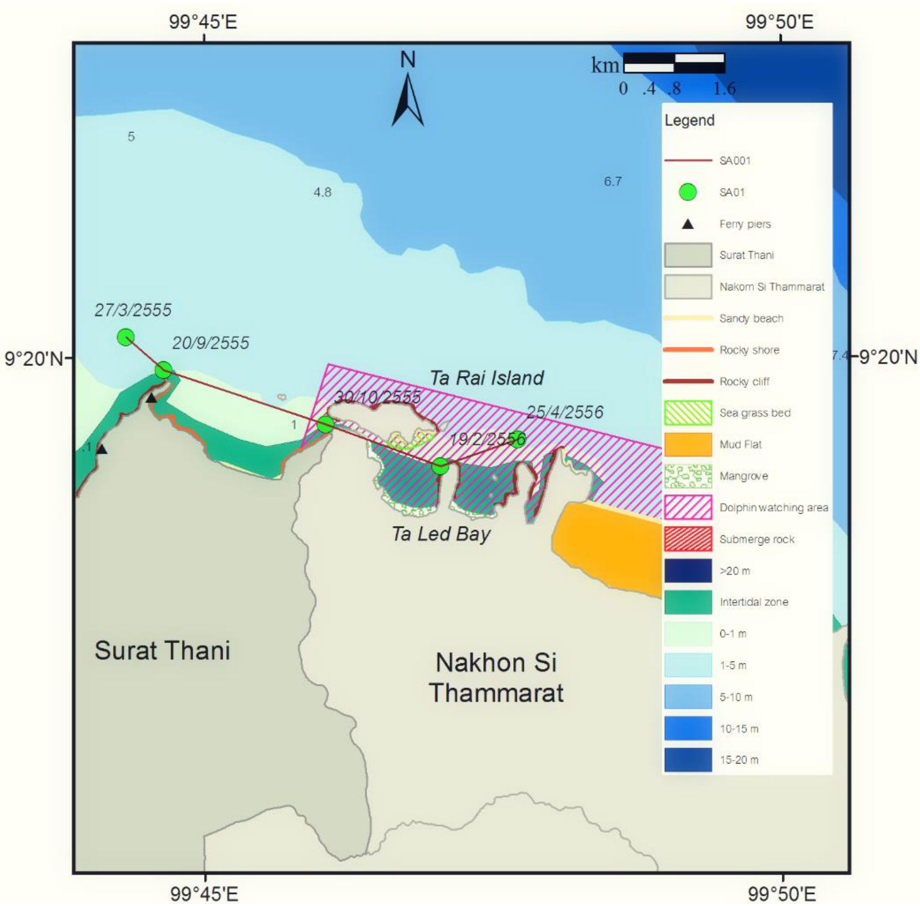


Left side

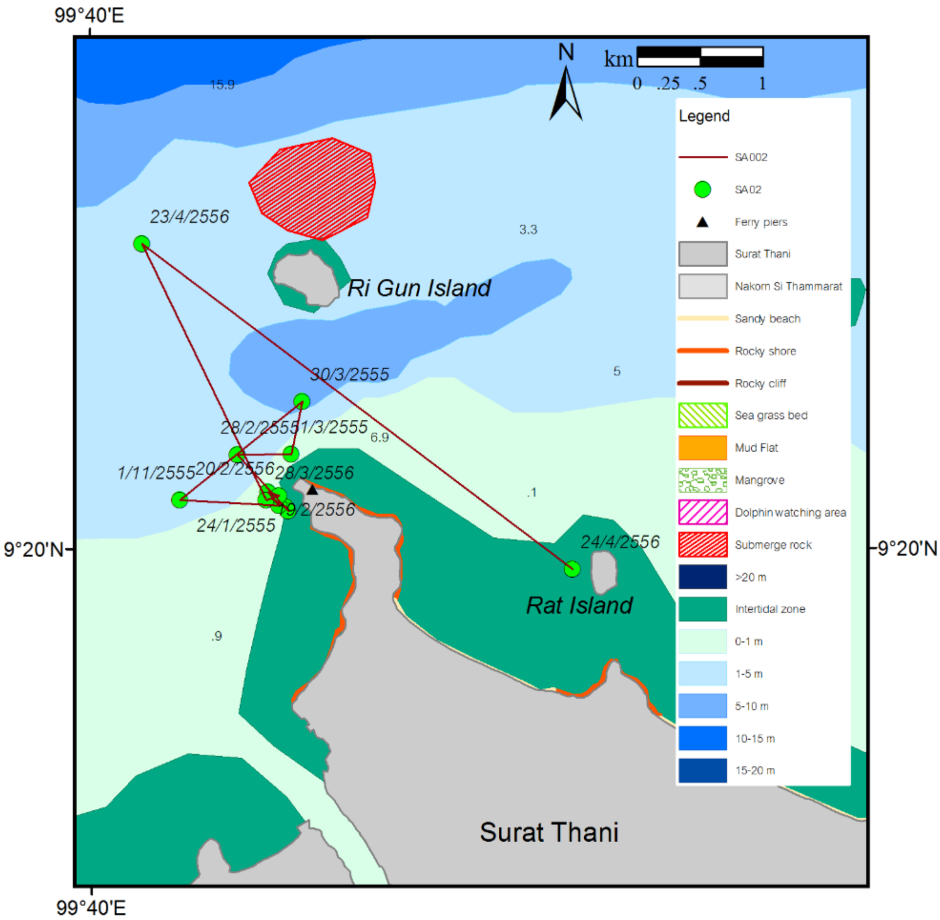
Right side

Number: 02

Code: SA02

Encountered history

No.	Date/Time	Area Code
1	24/1/12 13.32	N09°20.172′, E099°40.781′
2	25/1/12 15.03	N09°20.133′, E099°40.842′
3	26/1/12 08.33	N09°20.120′, E099°40.856′
4	28/2/12 11.51	N09°20.365′, E099°40.629′
5	1/3/12 07.37	N09°20.361′, E099°40.867′
6	30/3/12 09.39	N09°20.589′, E099°40.913′
7	1/11/12 09.19	N09°20.166′, E099°40.379′
8	30/11/12 09.38	N09°20.139′, E099°40.813′
9	19/02/13 12.30	N09°20.203′, E099°40.763′
10	20/02/13 11.40	N09°20.182′, E099°40.812′
11	28/03/13 11.47	N09°20.166′, E099°40.757′
12	23/04/13 13.11	N09°21.275′, E099°40.218′
13	24/04/13 13.33	N09°19.867′, E099°42.090′



Left side

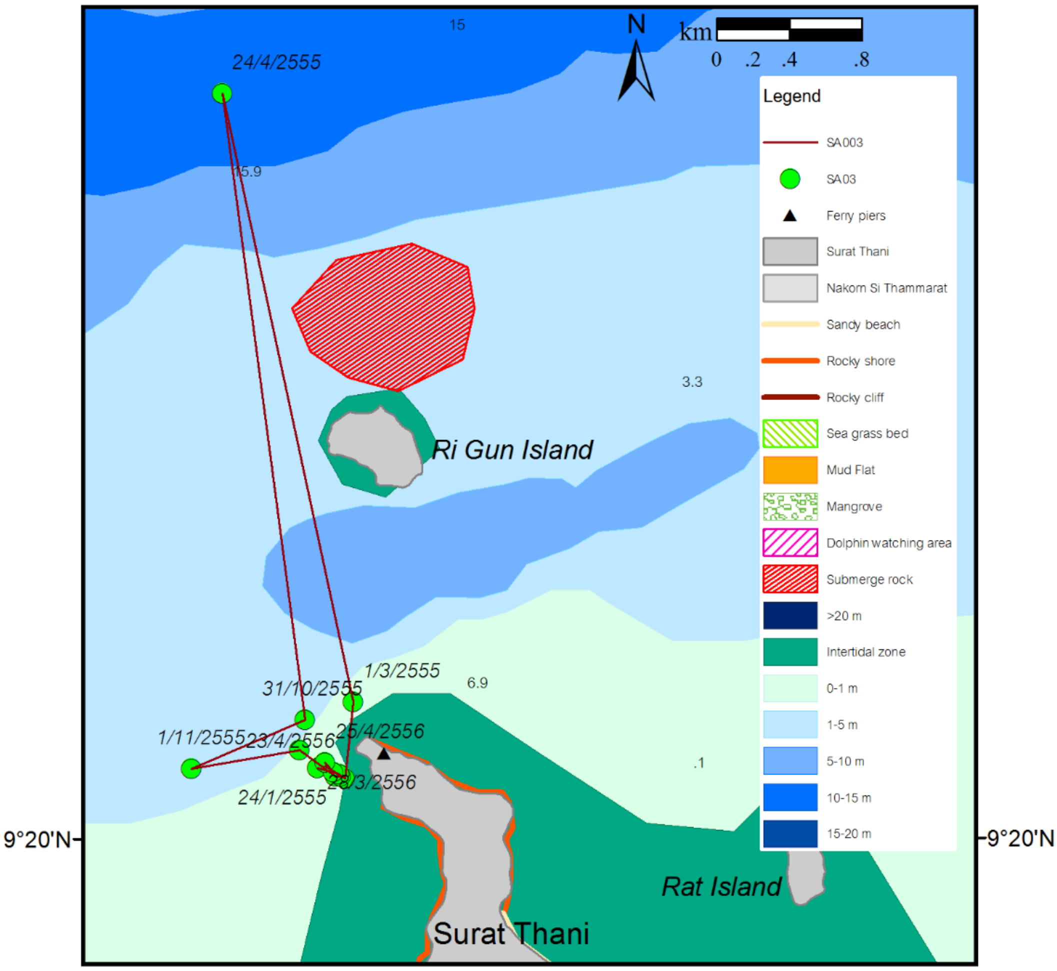
Right side

Number: 03

Code: SA03

Encountered history

No.	Date/Time	Area Code
1	24/1/12 13.32	N09°20.172′, E099°40.781′
2	25/1/12 15.03	N09°20.133′, E099°40.842′
3	1/3/12 07.37	N09°20.361′, E099°40.867′
4	24/4/1208.47	N09°22.183′, E099°40.475′
5	31/10/12 07.58	N09°20.309′, E099°40.722′
6	1/11/12 09.19	N09°20.166′, E099°40.379′
7	29/11/12 11.00	N09°20.222′, E099°40.701′
8	30/11/12 09.38	N09°20.139′, E099°40.813′
9	29/01/13 10.41	N09°20.143′, E099°40.832′
10	30/01/13 11.17	N09°20.149′, E099°40.824′
11	21/02/13 12.17	N09°20.145′, E099°40.823′
12	28/03/13 11.47	N09°20.166′, E099°40.757′
13	23/04/1314.23	N09°20.152′, E099°40.806′
14	25/04/1312.06	N09°20.183′, E099°40.783′



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Left side	Number: 05
	Code: SA05
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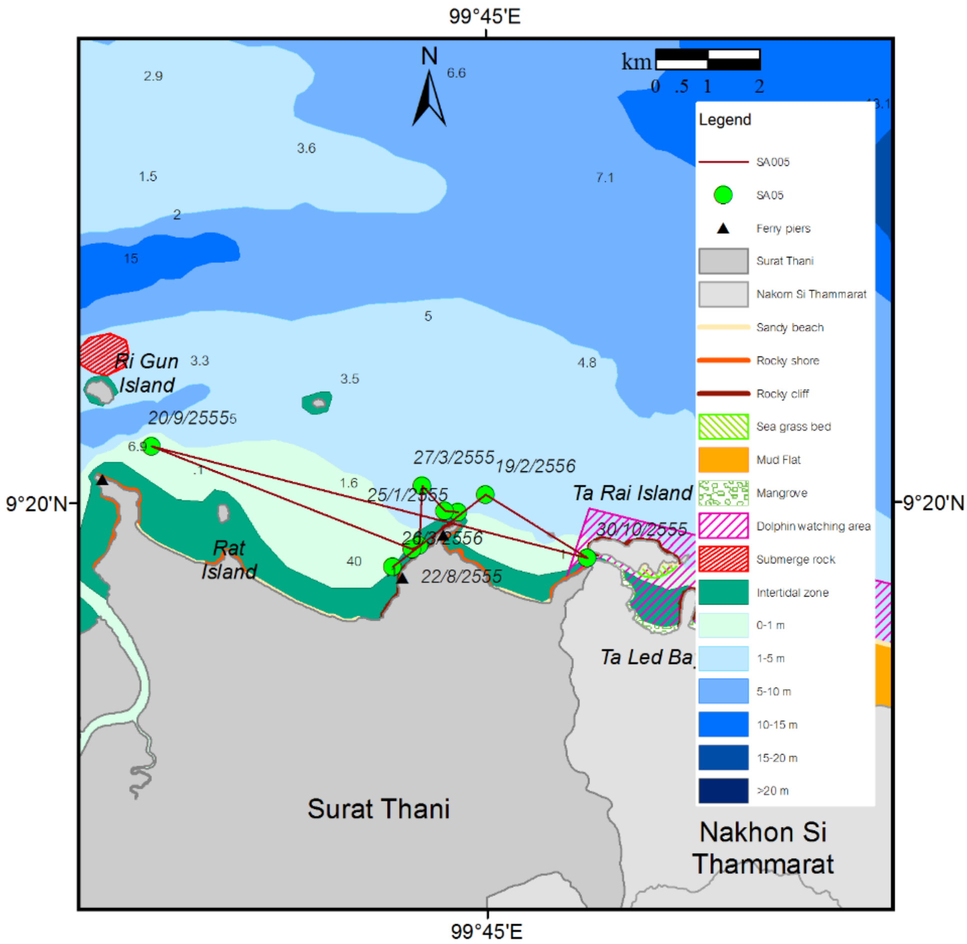
Encountered history

No.	Date/Time	Area Code
1	25/1/12 08.28	N09°19.858′, E099°44.690′
2	28/2/1210.01	N09°19.870′, E099°44.554′
3	27/3/12 09.22	N09°20.135′, E099°44.318′
4	22/8/12 13.17	N09°19.510′, E099°44.279′
5	23/8/12 11.14	N09°19.478′, E099°44.209′
6	20/9/12 8.09	N09°20.554′, E099°41.478′
7	30/10/12 9.37	N09°19.378′, E099°46.041′
8	19/02/13 10.12	N09°20.039′, E099°44.980′
9	26/03/1313.47	N09°19.292′, E099°44.002′
10		



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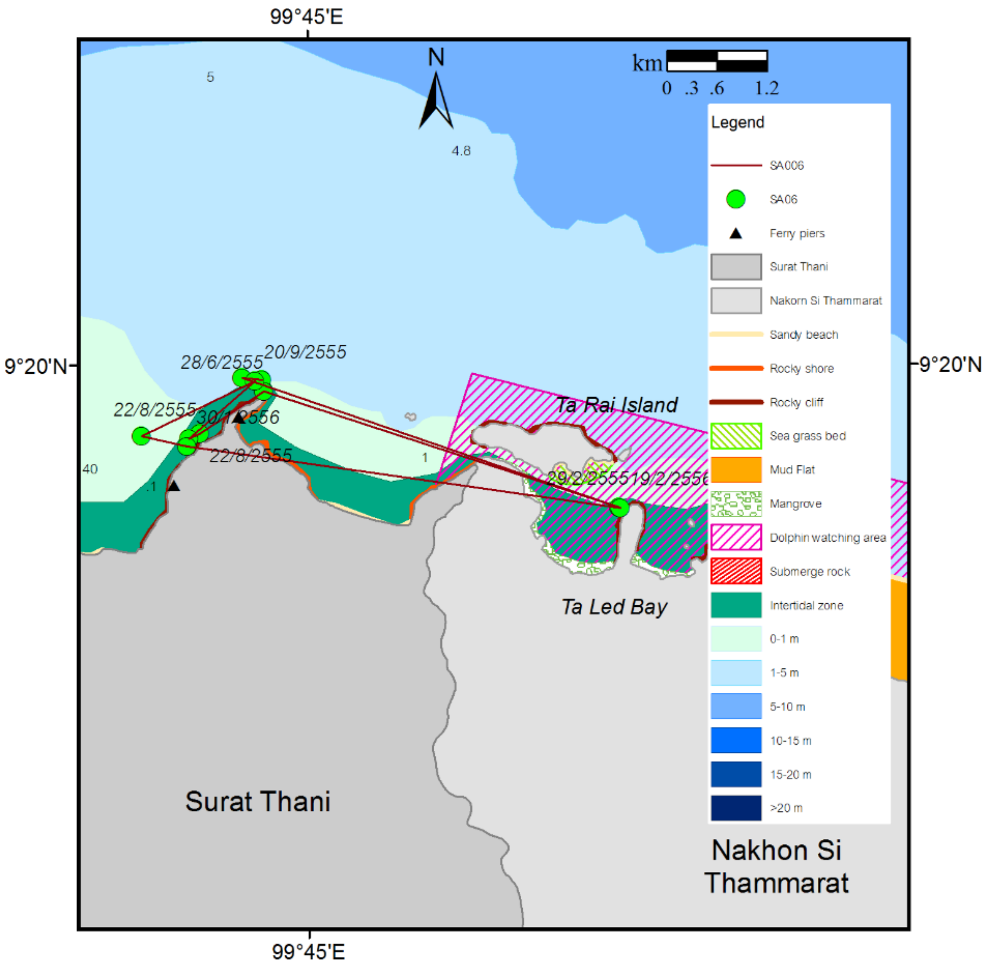
	Code: SA06

Right side

Encountered history

No.	Date/Time	Area Code
1	25/1/12 08.28	N09°19.858′, E099°44.690′
2	28/2/12 10.01	N09°19.870′, E099°44.554′
3	29/2/12 09.29	N09°19.023′, E099°47.034′
4	28/6/12 10.15	N09°19.790′, E099°44.697′
5	22/8/12 13.17	N09°19.510′, E099°44.279′
6	23/8/12 11.14	N09°19.478′, E099°44.209′
7	20/9/12 09.45	N09°19.856′, E099°44.642′
8	31/10/12 11.18	N09°19.496′, E099°43.896′
9	30/01/13 9.08	N09°19.426′, E099°44.194′
10	19/02/13 9.30	N09°19.021′, E099°47.037′



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20/2/13 10.03</td><td rowspan="2">N09°29.527′, E099°39.943′
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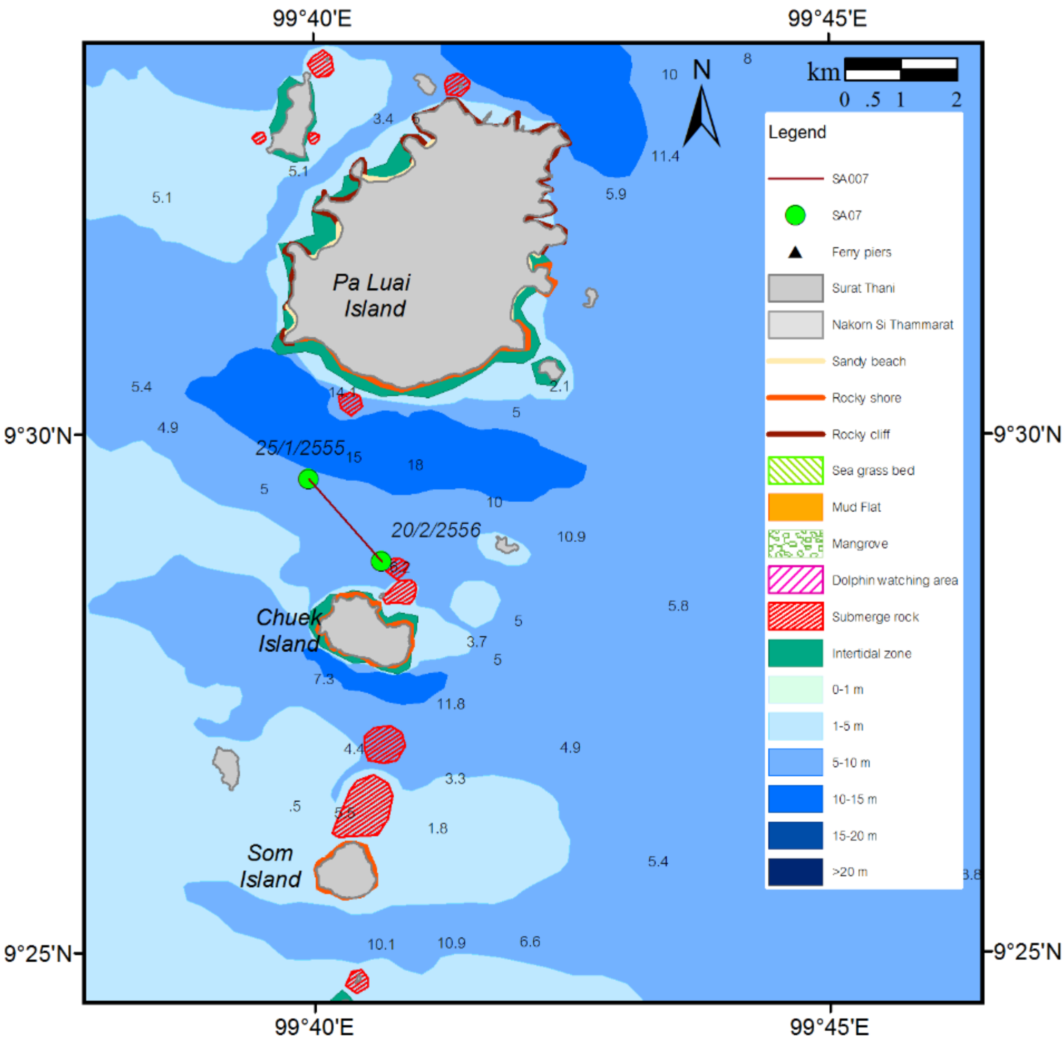

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	Code: SA08		
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	25/1/12 13.28.	N09°29.527′, E099°39.943′
			

Left side

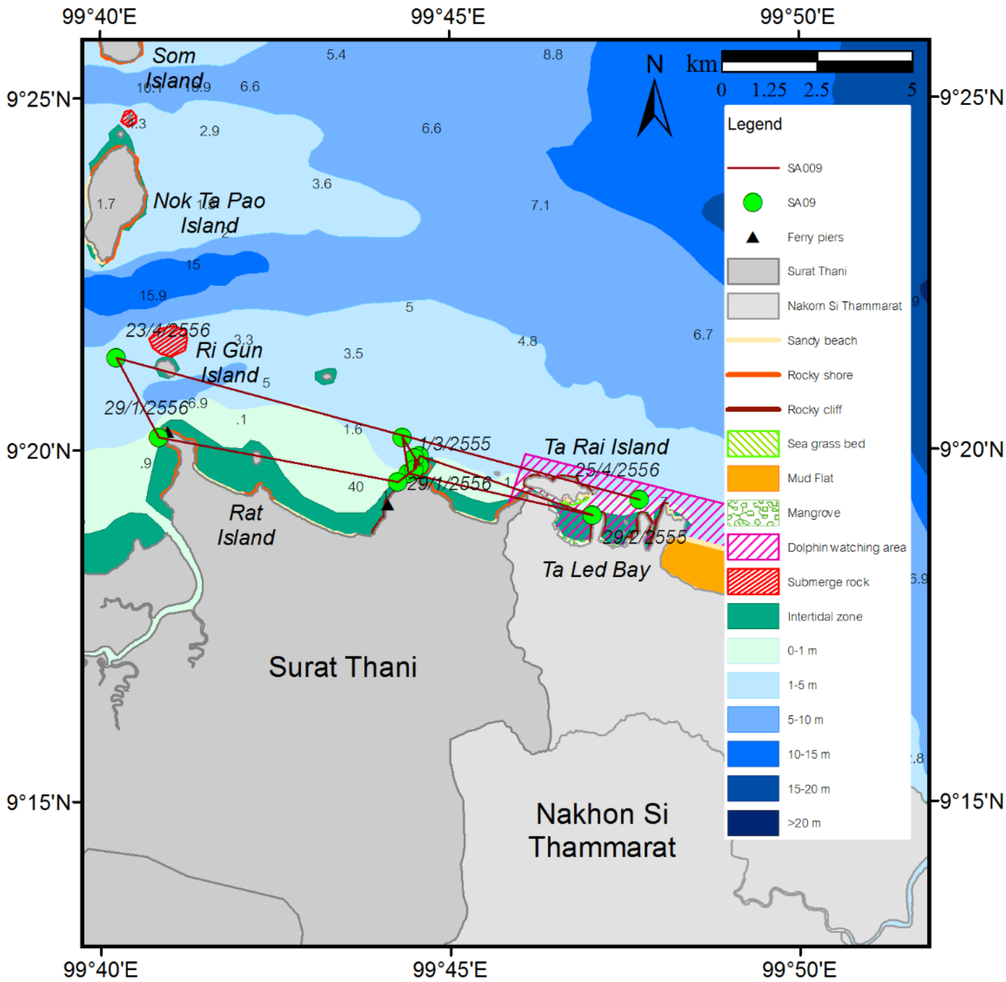
Right side

Number: 09

Code: SA09

Encountered history

No.	Date/Time	Area Code
1	26/1/12 12.36	N09°19.700′, E099°44.496′
2	28/2/12 10.01	N09°19.870′, E099°44.554′
3	29/2/2 08.10	N09°19.023′, E099°47.034′
4	1/3/12 12.39	N09°19.617′, E099°44.394′
5	27/3/12 09.22	N09°20.135′, E099°44.318′
6	18/9/12 08.18	N09°19.736′, E099°44.556′
7	19/9/12 08.16	N09°19.842′, E099°44.490′
8	30/10/1208.31	N09°19.676′, E099°44.478′
9	29/01/13 8.28	N09°19.497′, E099°44.245′
10	29/01/13 10.41	N09°20.143′, E099°40.832′
11	23/04/13 13.11	N09°21.275′, E099°40.218′
12	25/04/13 09.39	N09°19.246′, E099°47.704′



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28/2/12 11.51</td><td>N09°19.700′, E099°44.496′
N09°20.365′, E099°40.629′</td></tr>
<tr><td>Right side</td><td>3</td><td>30/3/12 09.39</td><td>N09°20.589′, E099°40.913′</td></tr>
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5</td><td>27/6/12 10.38
29/11/12 11.00</td><td>N09°20.843′, E099°44.024′
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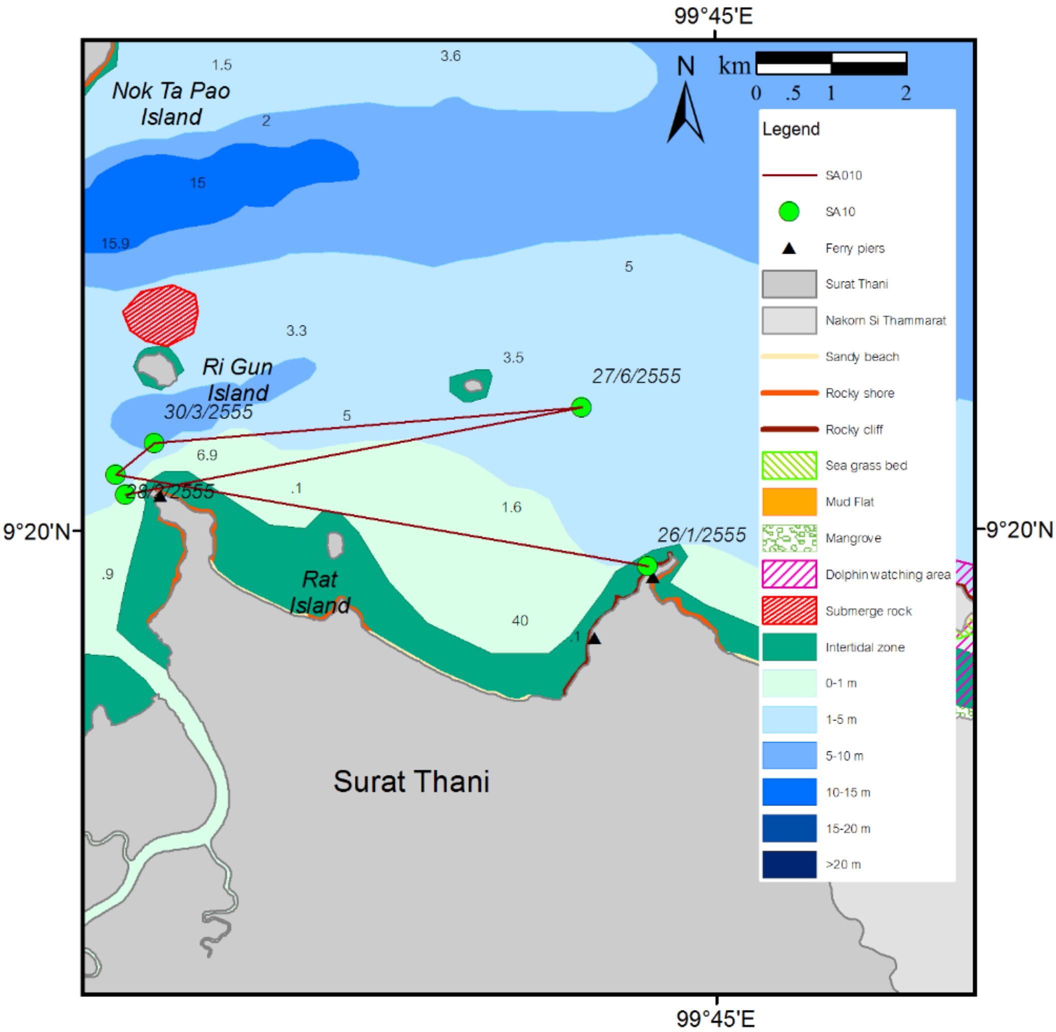

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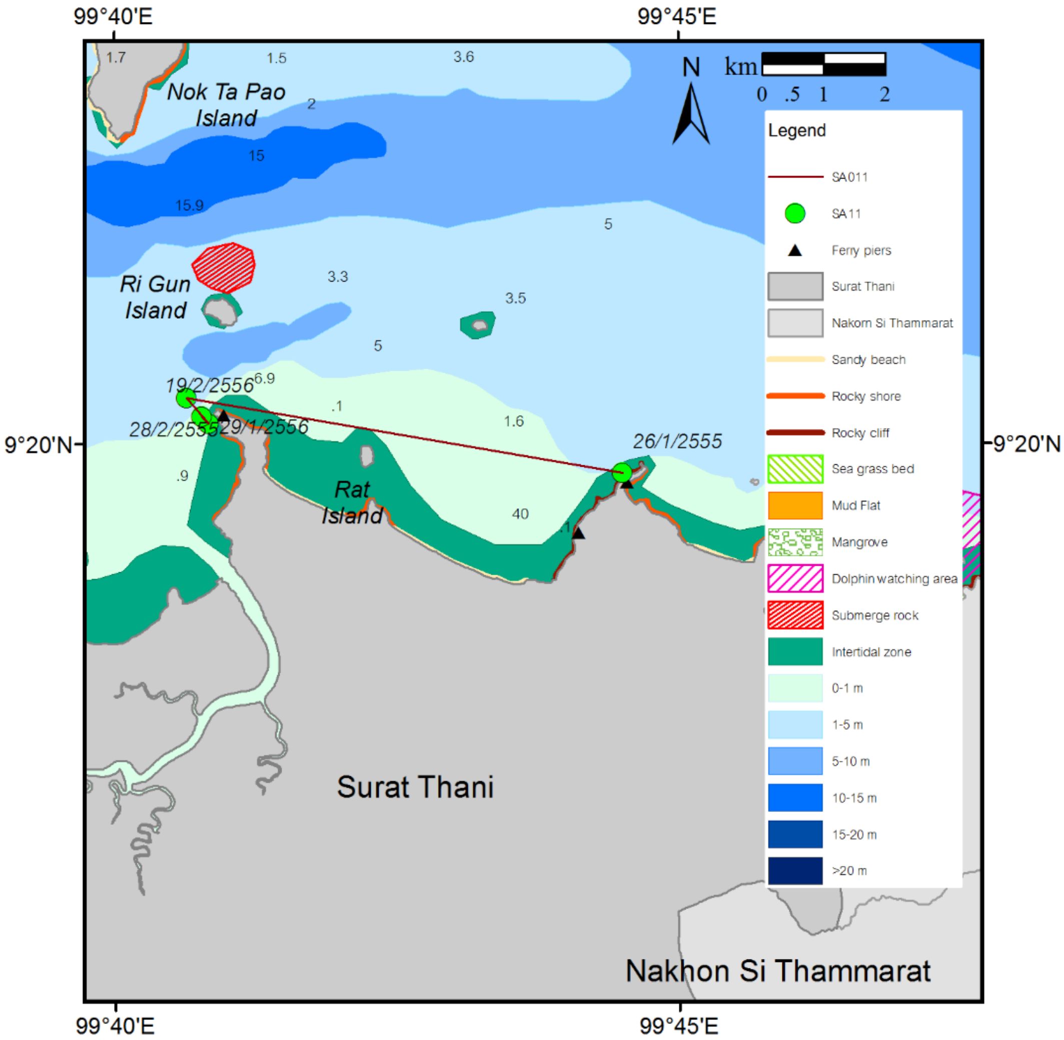
	Encountered history		
	No.	Date/Time	Area Code
	1	26/1/12 12.36	N09°19.700′, E099°44.496′
Right side	2	28/2/12 11.51	N09°20.365′, E099°40.629′
	3	29/01/13 10.41	N09°20.143′, E099°40.832′
	4	19/02/13 12.30	N09°20.203′, E099°40.763′



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<tr><td>2</td><td>29/2/55 14.30</td><td>N09°20.260′, E099°40.699′</td></tr>
<tr><td>3</td><td>1/3/12 07.37</td><td>N09°20.361′, E099°40.867′</td></tr>
<tr><td>4</td><td>30/3/12 09.39</td><td>N09°20.589′, E099°40.913′</td></tr>
<tr><td>5</td><td>20/9/12 08.09</td><td>N09°20.554′, E099°41.478′</td></tr>
<tr><td>6</td><td>31/10/12 07.58</td><td>N09°20.309′, E099°40.722′</td></tr>
<tr><td>7</td><td>1/11/12 09.19</td><td>N09°20.166′, E099°40.379′</td></tr>
<tr><td>8</td><td>30/01/13 11.17</td><td>N09°20.149′, E099°40.824′</td></tr>
<tr><td>9</td><td>20/2/138.41</td><td>N09°20.784′, E099°42.063′</td></tr>
<tr><td>10</td><td>20/02/13 11.40</td><td>N09°20.182′, E099°40.812′</td></tr>
<tr><td>11</td><td>28/03/13 11.47</td><td>N09°20.166′, E099°40.757′</td></tr>
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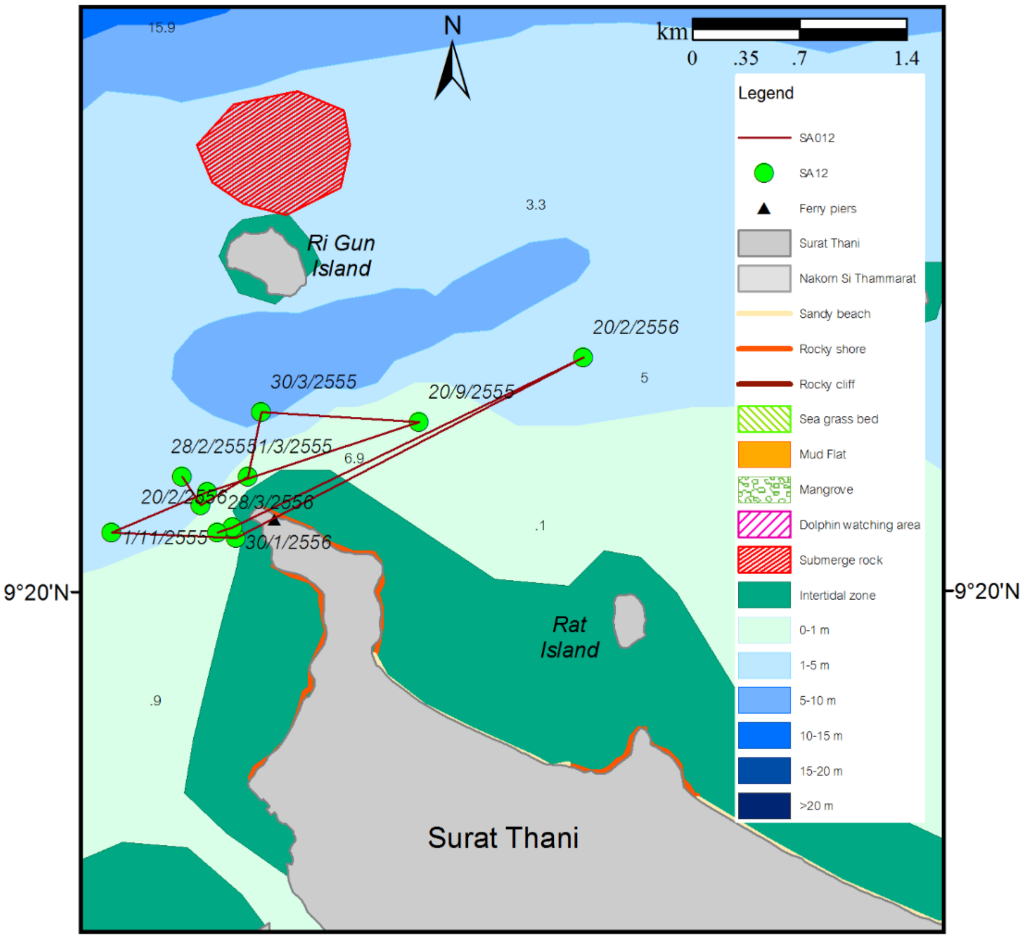

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5</td><td>28/2/12 11.51
24/4/1208.47
17/7/12 10.11
29/11/12 11.00
30/11/12 09.38</td><td>N09°20.365′, E099°40.629′
N09°22.183′, E099°40.475′
N09°28.003′, E099°41.186′
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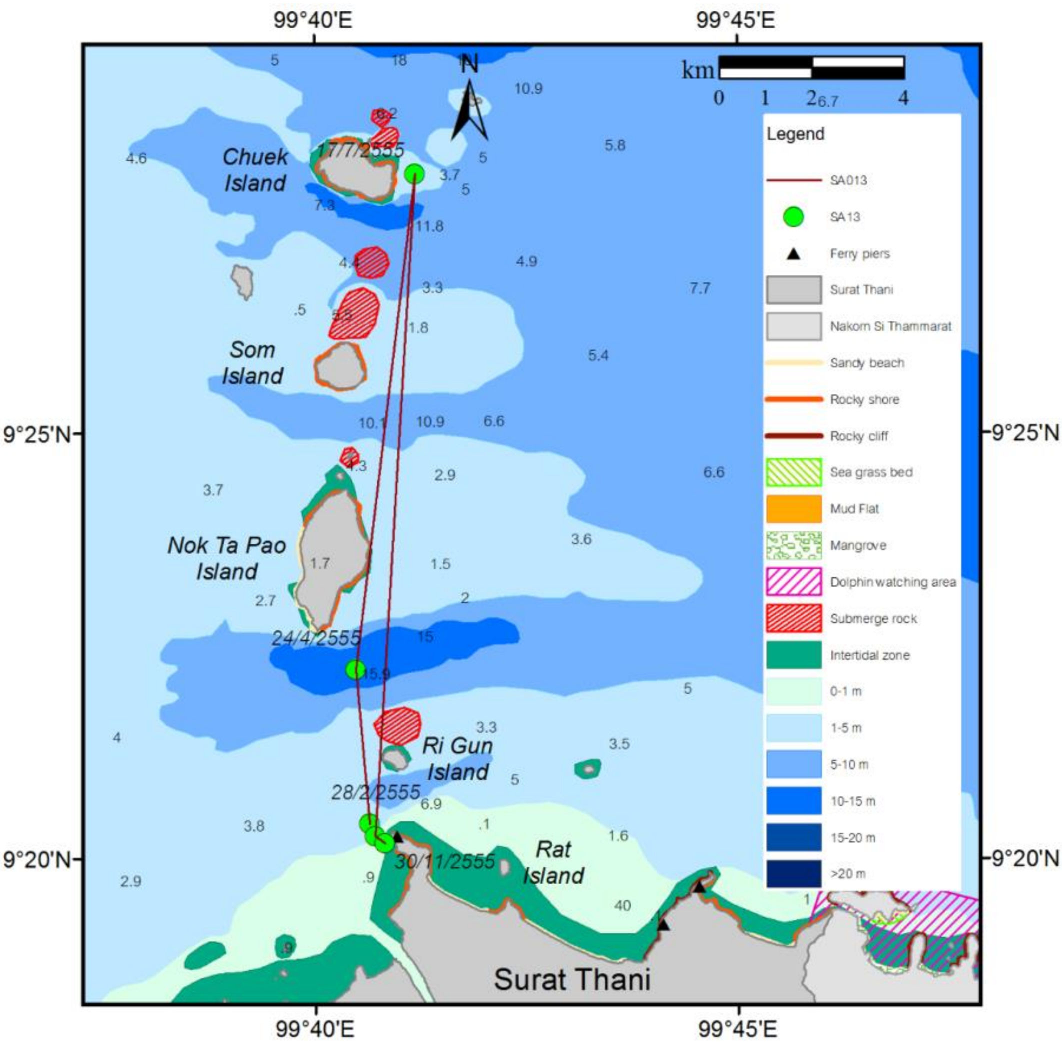

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Left side

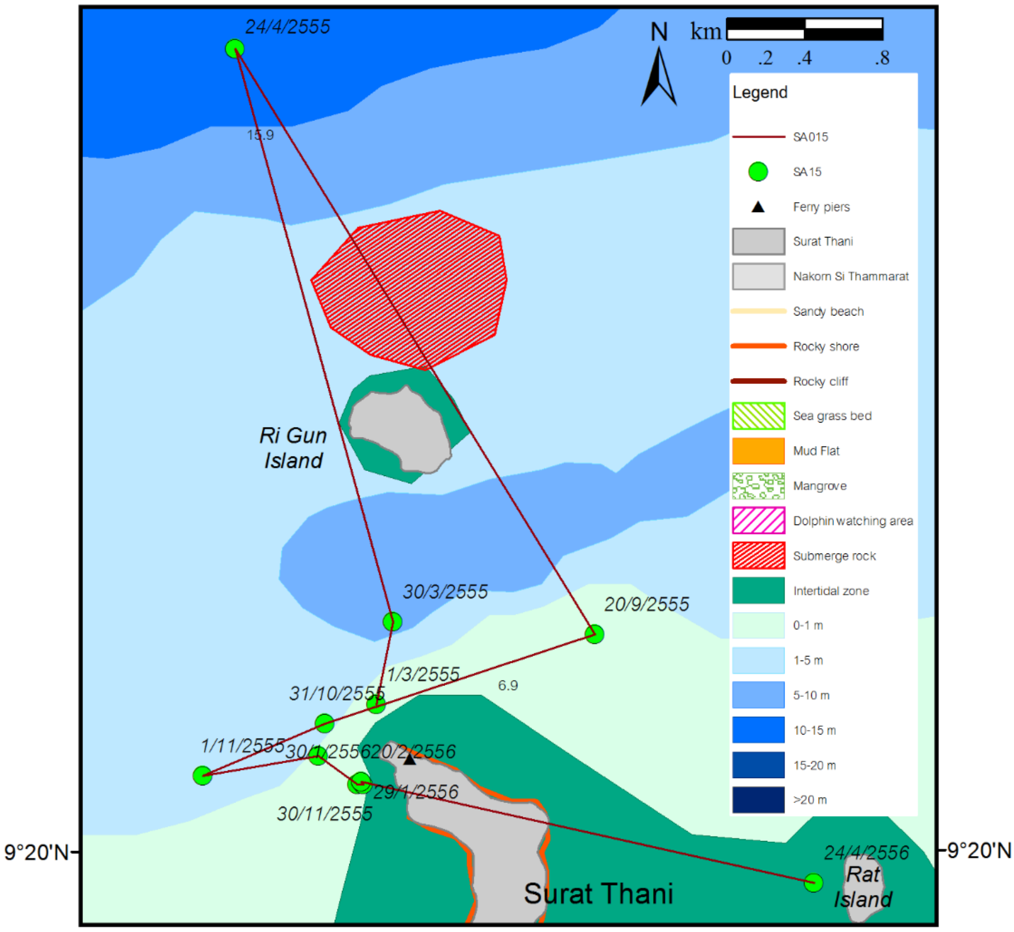
Right side

Number: 15

Code: SA15

Encountered history

No.	Date/Time	Area Code
1	1/3/12 07.37	N09°20.361′, E099°40.867′
2	30/3/12 09.39	N09°20.589′, E099°40.913′
3	24/4/12 08.47	N09°22.183′, E099°40.475′
4	20/9/12 08.09	N09°20.554′, E099°41.478′
5	31/10/12 07.58	N09°20.309′, E099°40.722′
6	1/11/12 09.19	N09°20.166′, E099°40.379′
7	29/11/12 11.00	N09°20.222′, E099°40.701′
8	30/11/12 09.38	N09°20.139′, E099°40.813′
9	29/01/13 10.41	N09°20.143′, E099°40.832′
10	30/01/13 11.17	N09°20.149′, E099°40.824′
11	21/02/13 12.17	N09°20.145′, E099°40.823′
12	24/04/13 13.33	N09°19.867′, E099°42.090′



Left side

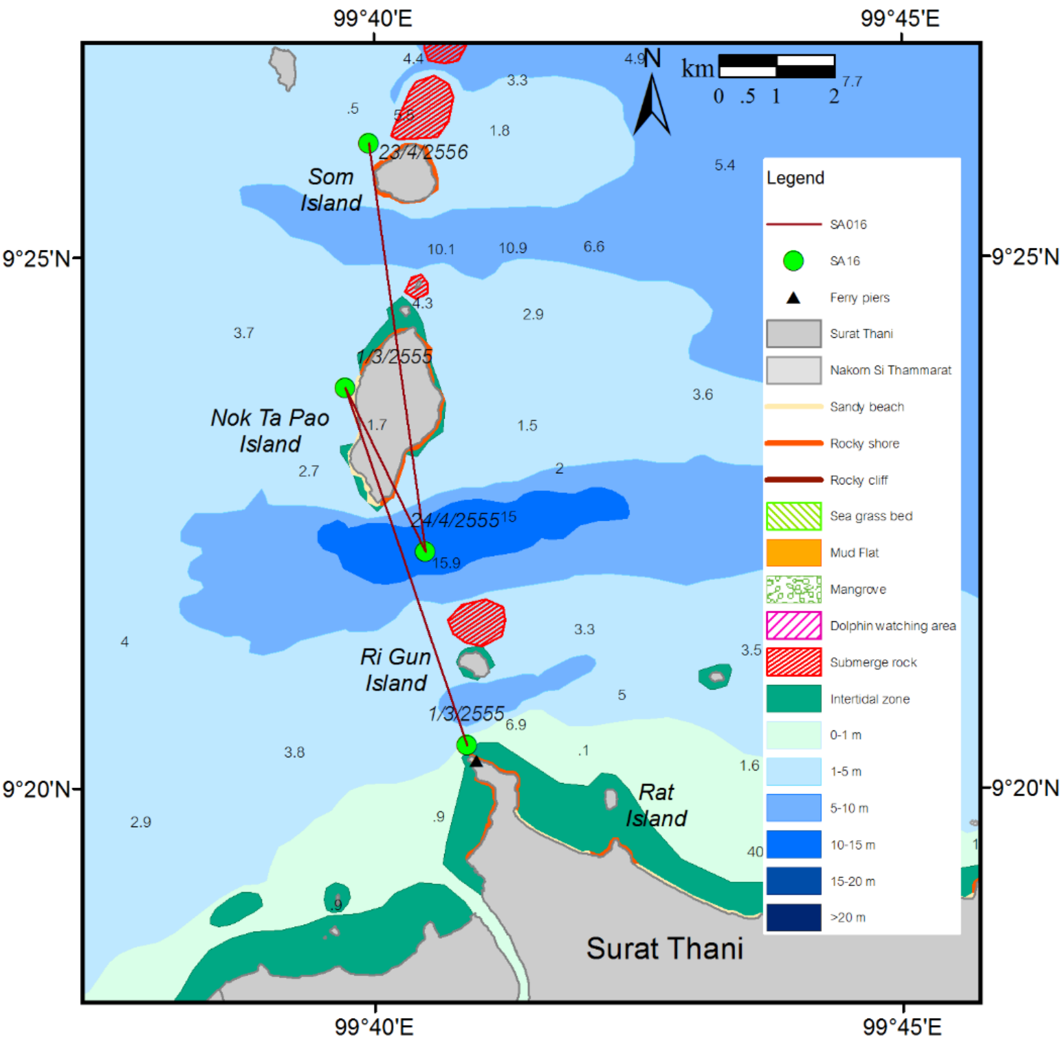
Right side

Number: 16

Code: SA16

Encountered history

No.	Date/Time	Area Code
1	1/3/12 07.37	N09°20.361′, E099°40.867′
2	1/3/12 09.22	N09°23.730′, E099°39.719′
3	24/4/12 08.47	N09°22.183′, E099°40.475′
4	23/4/13 12.22	N09°26.026′, E099°39.950′



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</td><td>2</td><td>30/10/12 09.37</td><td>N09°19.378′, E099°46.041′</td></tr>
<tr><td>3</td><td>31/10/12 11.18</td><td>N09°19.496′, E099°43.896′</td></tr>
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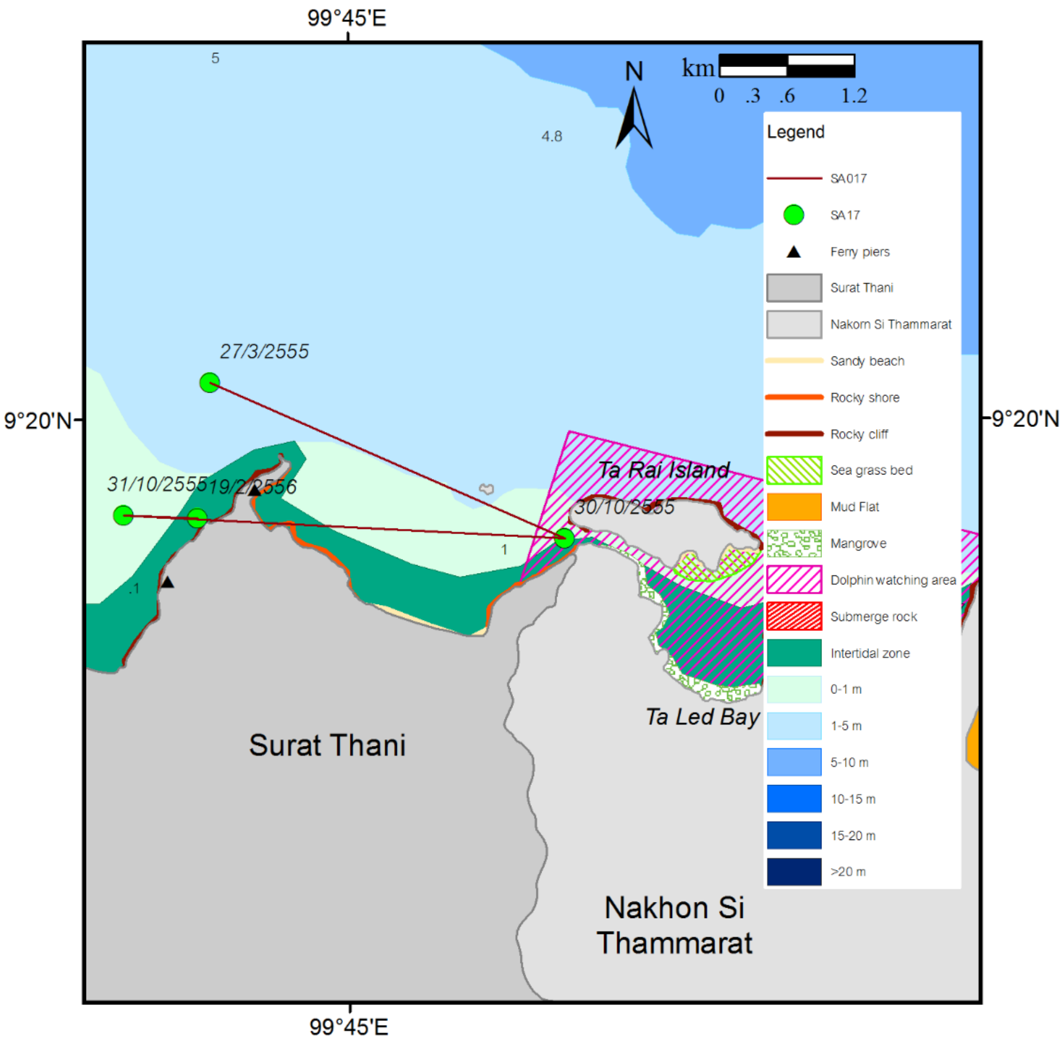

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	1	29/3/12 12.20	N09°33.287′, E099°41.320′
Right side			
			

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18/9/12 12.33
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N09°24.569′, E099°39.878′
N09°21.275′, E099°40.218′</td></tr>
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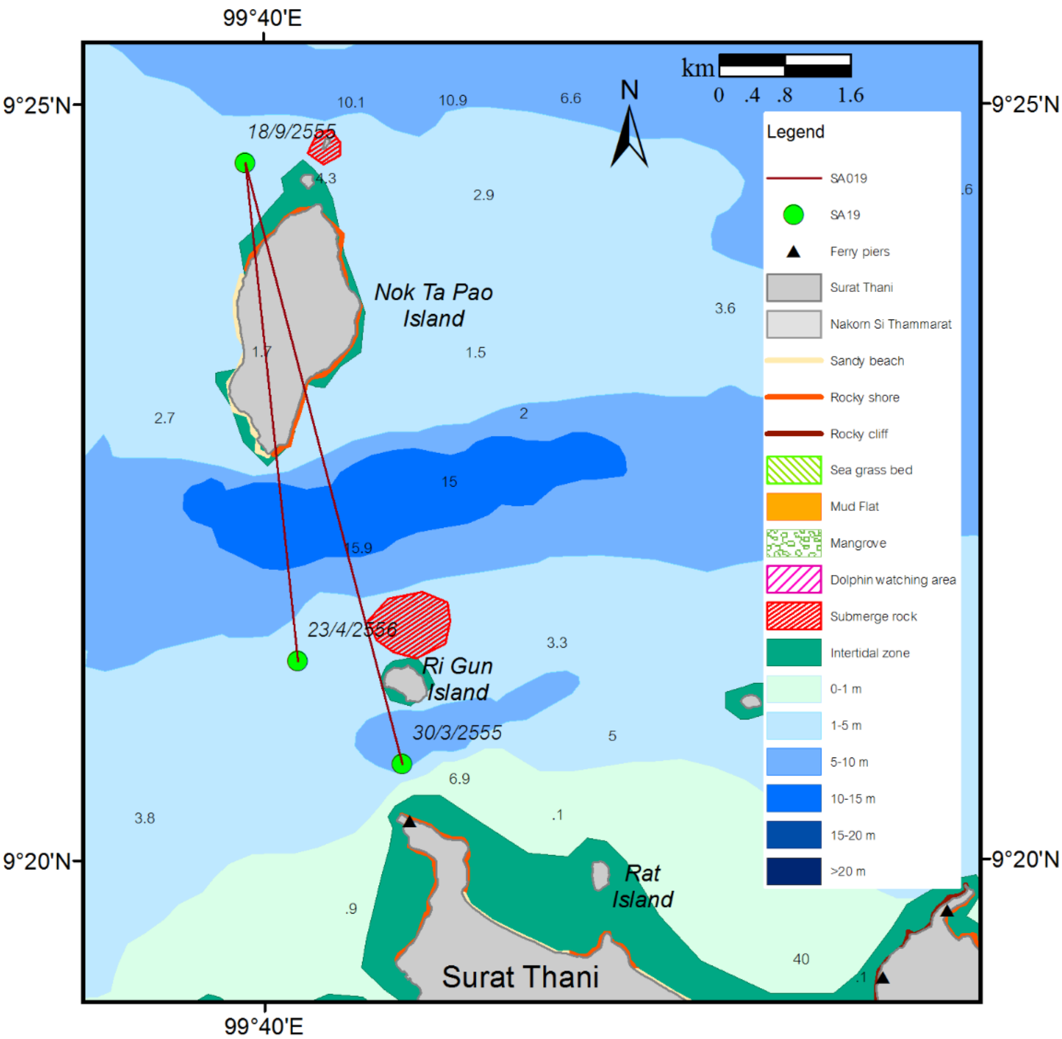

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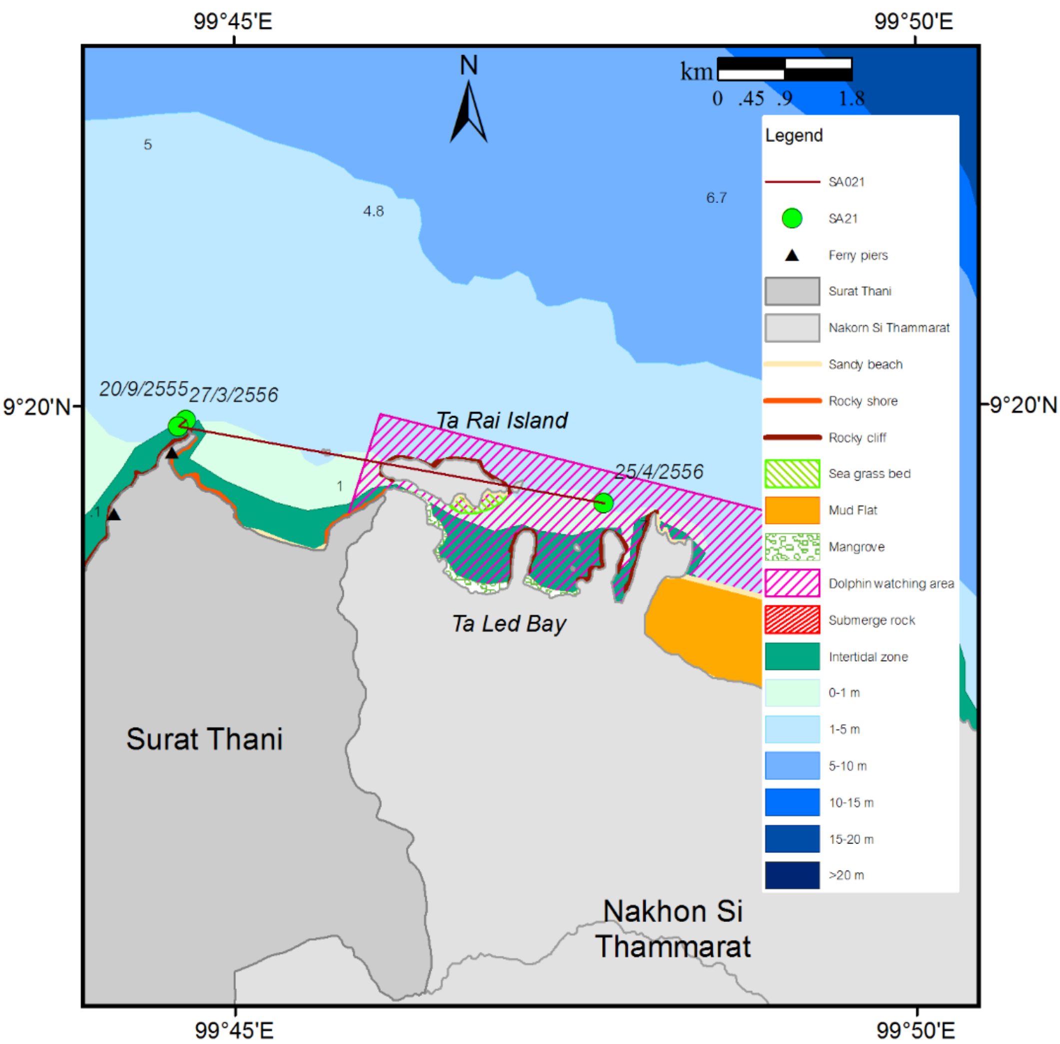
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	27/6/12 17.48	N09°21.275′, E099°40.218′
	2	20/9/12 09.45	N09°19.812′, E099°44.583′
	3	25/04/13 09.39	N09°19.246′, E099°47.704′



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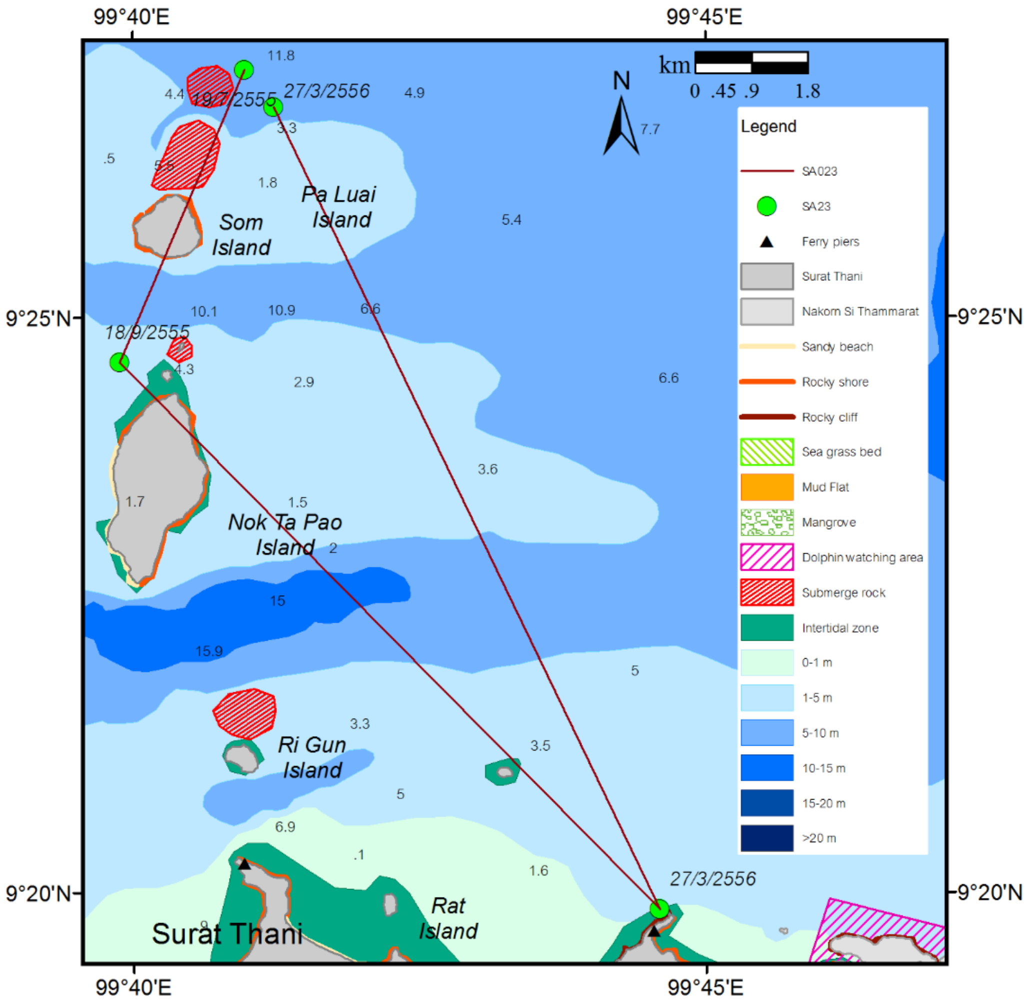
	Code: SA23

Right side

Encountered history

No.	Date/Time	Area Code
1	21/8/12 09.58	N09°27.110′, E099°40.966′
2	18/9/12 12.33	N09°24.569′, E099°39.878′
3	27/03/13 11.02	N09°26.782′, E099°41.228′



Left side

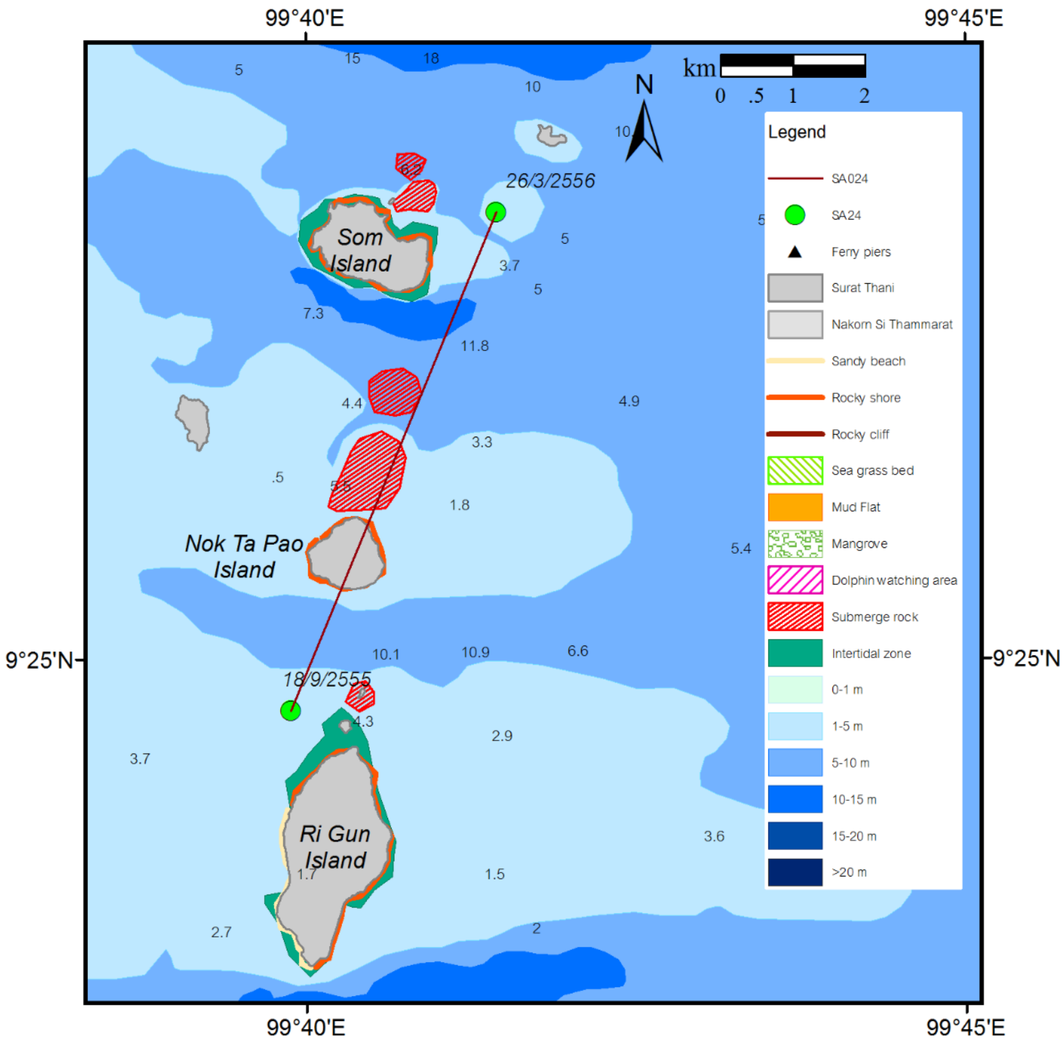
Right side

Number: 24

Code: SA24

Encountered history

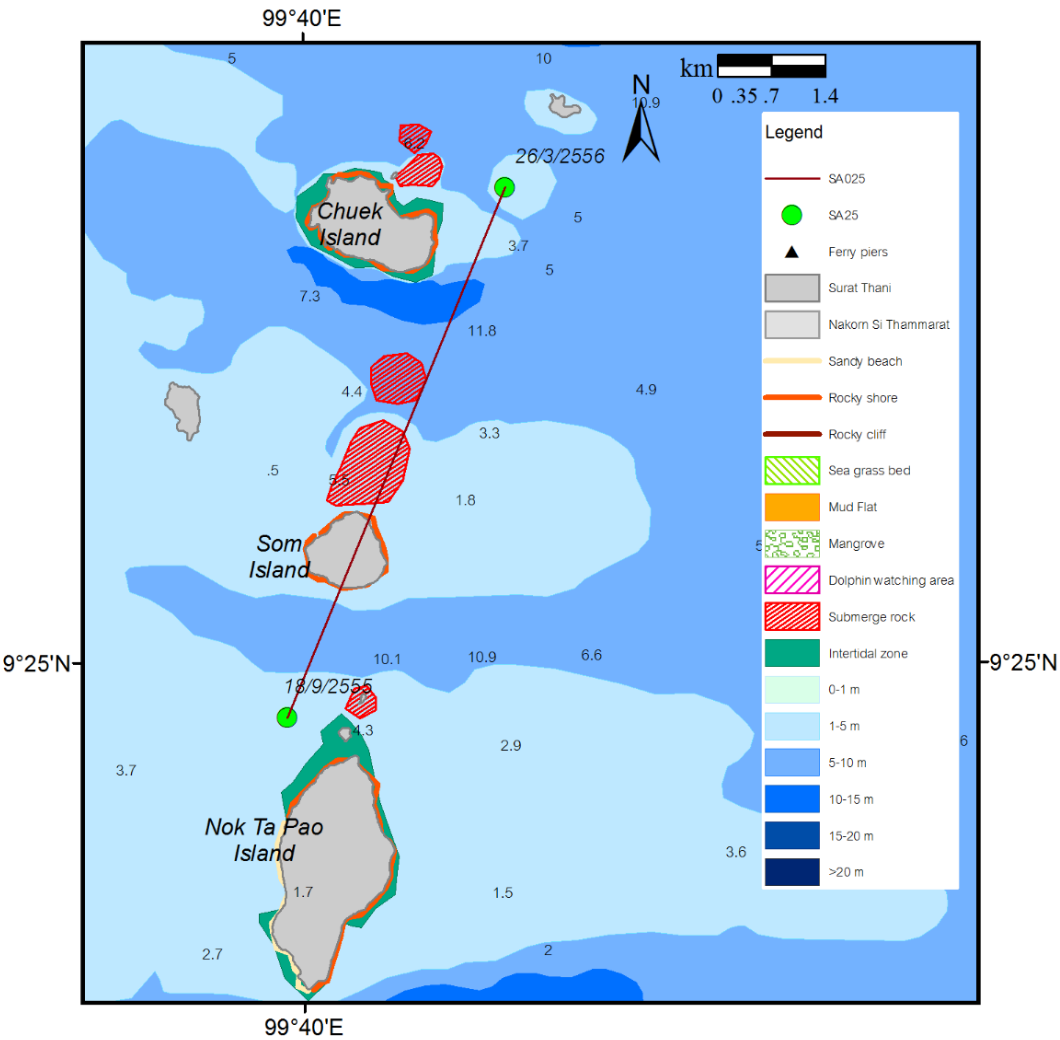
No.	Date/Time	Area Code
1	18/9/12 12.33	N09°24.569′, E099°39.878′
2	26/03/13 11.30	N09°28.315′, E099°41.437′



Left side

Right side

Number: 25		
Code: SA25		
Encountered history		
No.	Date/Time	Area Code
1	18/9/12 12.33	N09°24.569′, E099°39.878′
2	26/03/13 11.30	N09°28.315′, E099°41.437′



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<tr><td rowspan="3">1</td><td rowspan="3">24/4/13 8.44</td><td rowspan="3">N09°19.038′, E099°47.233′</td></tr>
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Age classe : UnspottedAdults (UA)

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<tr><td>2</td><td>26/1/12 08.33</td><td>N09°20.120′, E099°40.856′</td></tr>
<tr><td>Right side</td><td>3</td><td>1/3/12 07.37</td><td>N09°20.361′, E099°40.867′</td></tr>
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<tr><td>5</td><td>31/10/12 07.58</td><td>N09°20.309′, E099°40.722′</td></tr>
<tr><td>6</td><td>1/11/12 09.19</td><td>N09°20.166′, E099°40.379′</td></tr>
<tr><td>7</td><td>20/02/13 11.40</td><td>N09°20.182′, E099°40.812′</td></tr>
<tr><td>8</td><td>26/03/13 8.43</td><td>N09°20.372′, E099°40.816′</td></tr>
<tr><td>9</td><td>27/03/13 12.25</td><td>N09°20.091′, E099°40.840′</td></tr>
<tr><td>10</td><td>28/03/13 11.47</td><td>N09°20.166′, E099°40.757′</td></tr>
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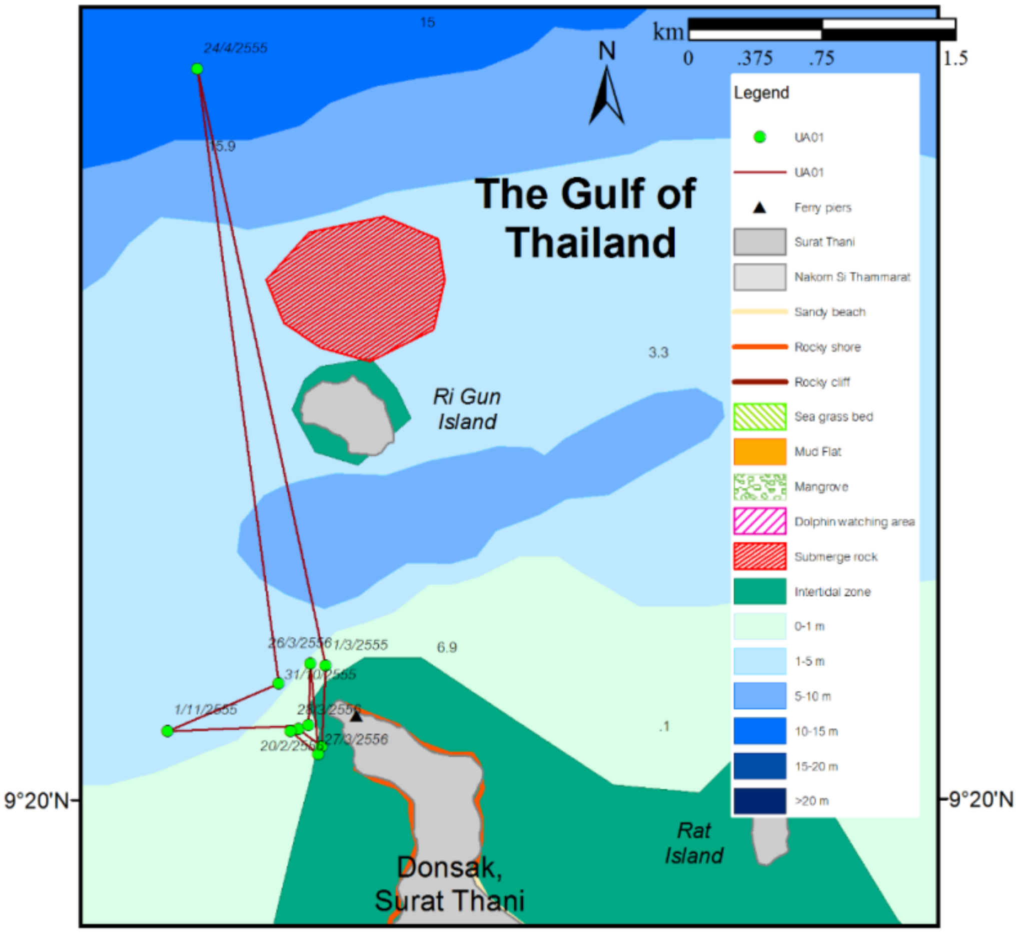

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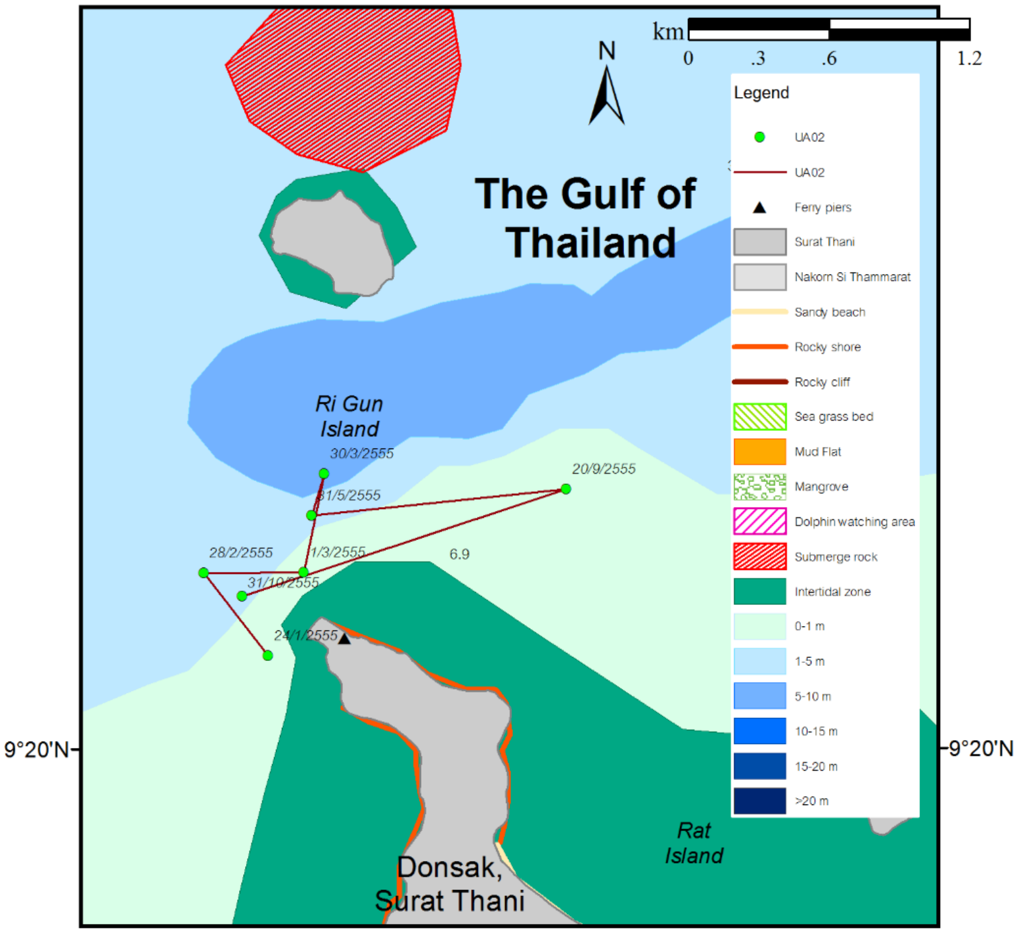

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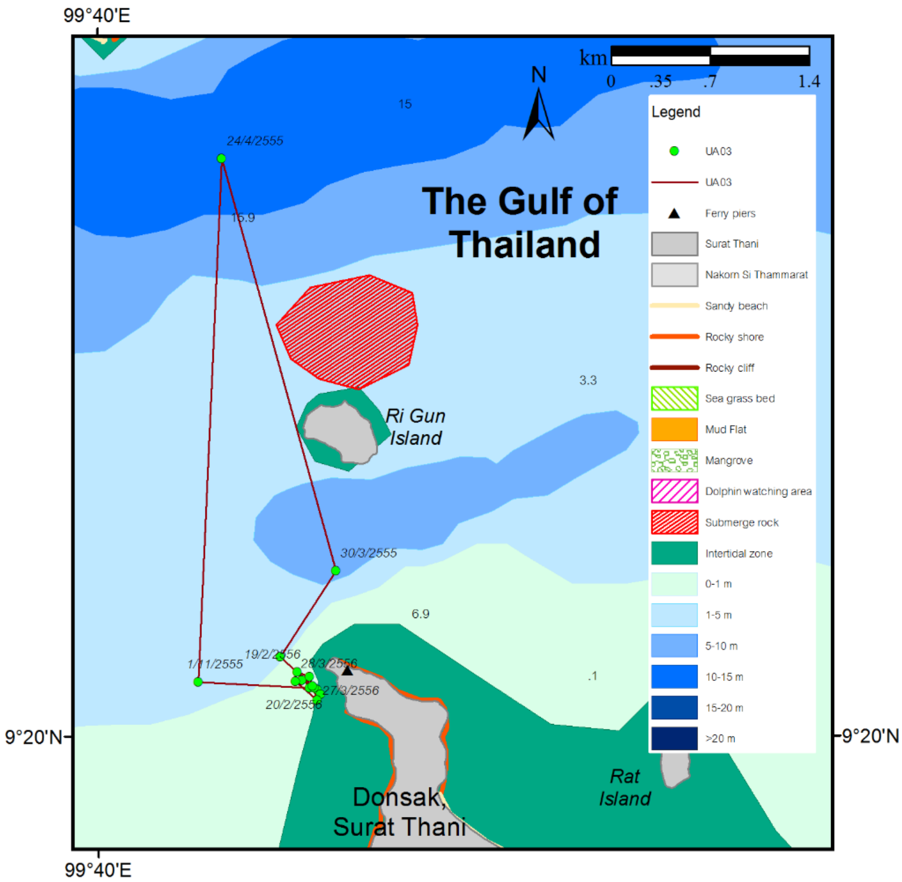
Right side	Encountered history
	

No.	Date/Time	Area Code
1	24/1/12 13.32	N09°20.172′, E099°40.781′
2	25/1/12 15.03	N09°20.133′, E099°40.842′
3	26/1/12 08.33	N09°20.120′, E099°40.856′
4	29/2/12 14.30	N09°20.260′, E099°40.699′
5	30/3/12 09.39	N09°20.589′, E099°40.913′
6	24/4/12 08.47	N09°22.183′, E099°40.475′
7	1/11/12 09.19	N09°20.166′, E099°40.379′
8	30/11/12 09.38	N09°20.139′, E099°40.813′
9	29/01/13 10.41	N09°20.143′, E099°40.832′
10	19/02/13 12.30	N09°20.203′, E099°40.763′
11	20/02/13 11.40	N09°20.182′, E099°40.812′
12	21/02/13 12.17	N09°20.145′, E099°40.823′
13	27/03/13 12.25	N09°20.091′, E099°40.840′
14	28/03/13 11.47	N09°20.166′, E099°40.757′



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24/4/12 08.47</td><td rowspan="2">N09°20.361′, E099°40.867′
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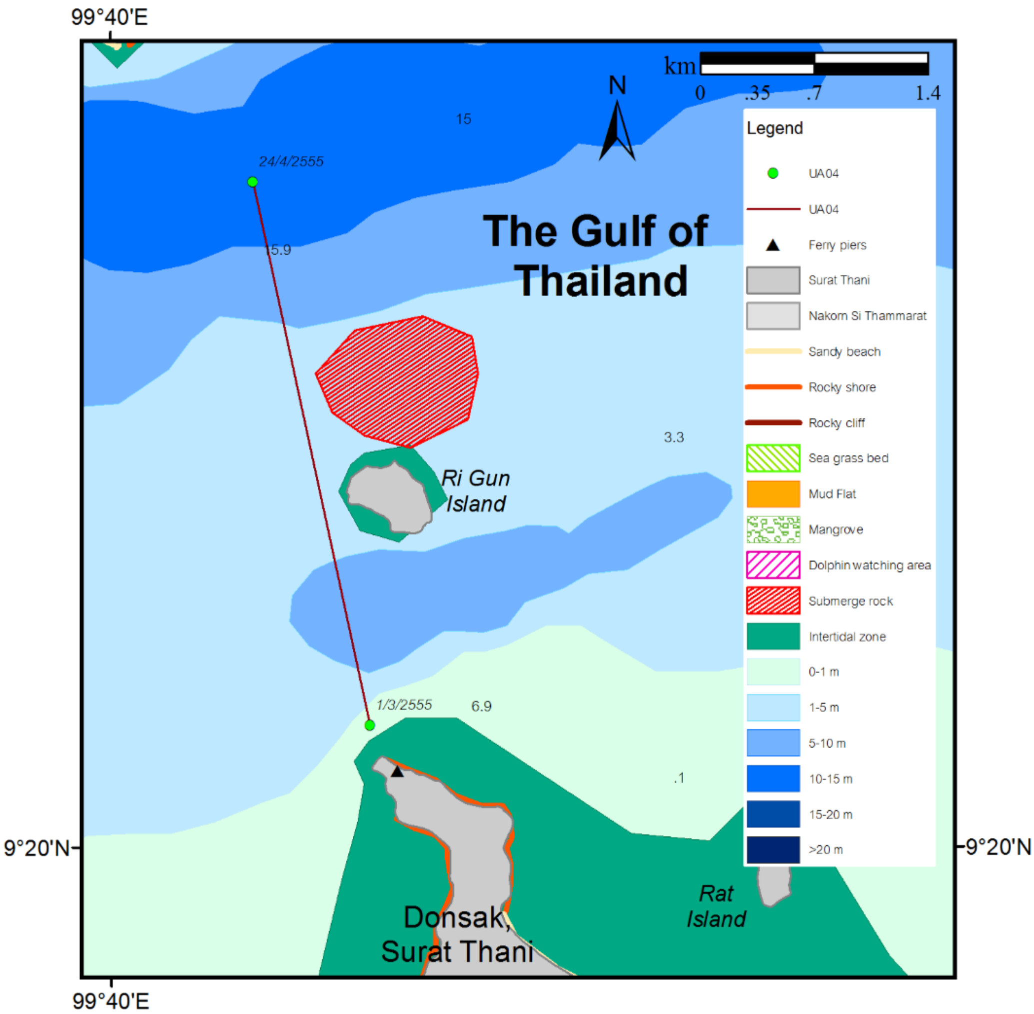

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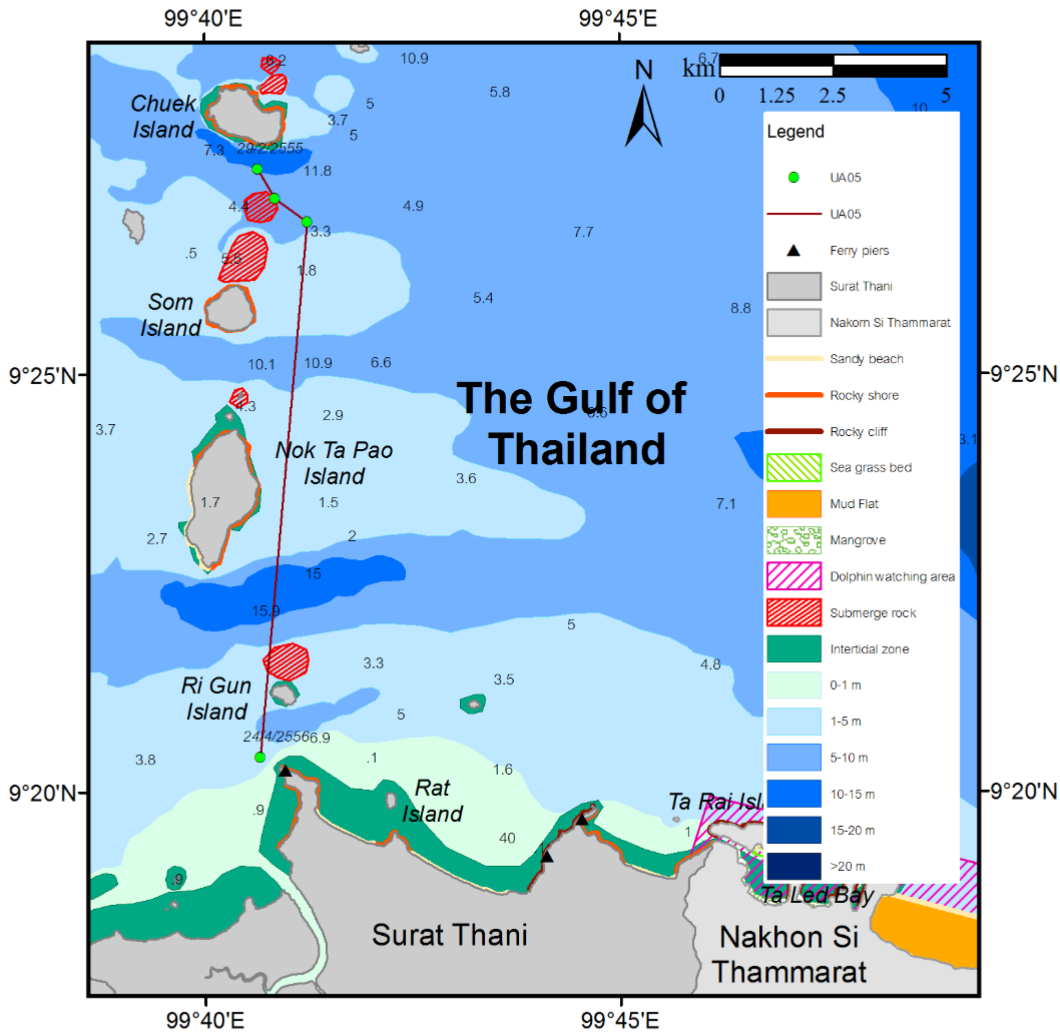
Right side

Number: 05

Code: UA05

Encountered history

No.	Date/Time	Area Code
1	29/2/12 11.00	N09°27.420′, E099°40.630′
2	30/10/12 11.36	N09°27.067′, E099°40.838′
3	27/03/13 11.02	N09°26.782′, E099°41.228′
4	24/04/13 11.16	N09°20.369′, E099°40.656′



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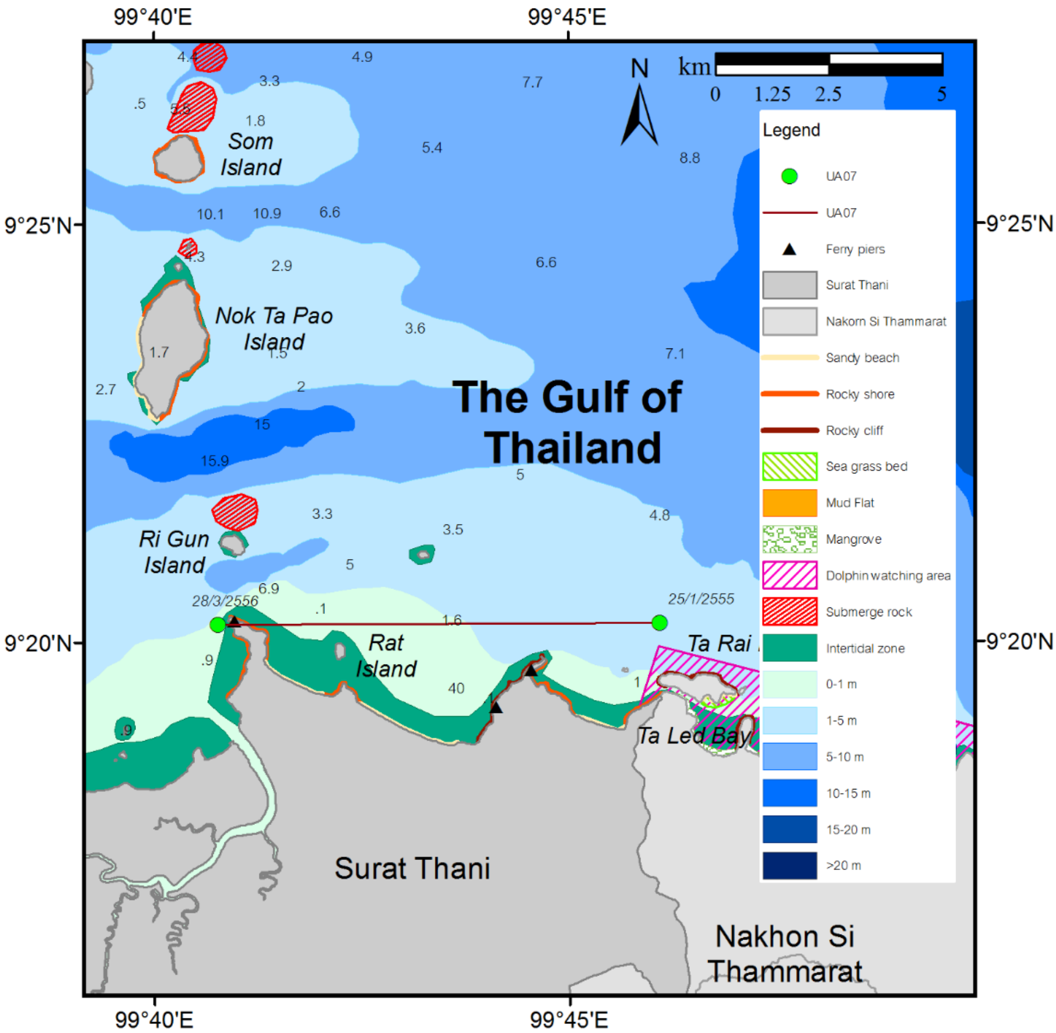
Right side

Number: 07

Code: UA07

Encountered history

No.	Date/Time	Area Code
1	25/1/12 09.59	N09°20.177′, E099°46.085′
2	28/03/13 11.47	N09°20.166′, E099°40.757′



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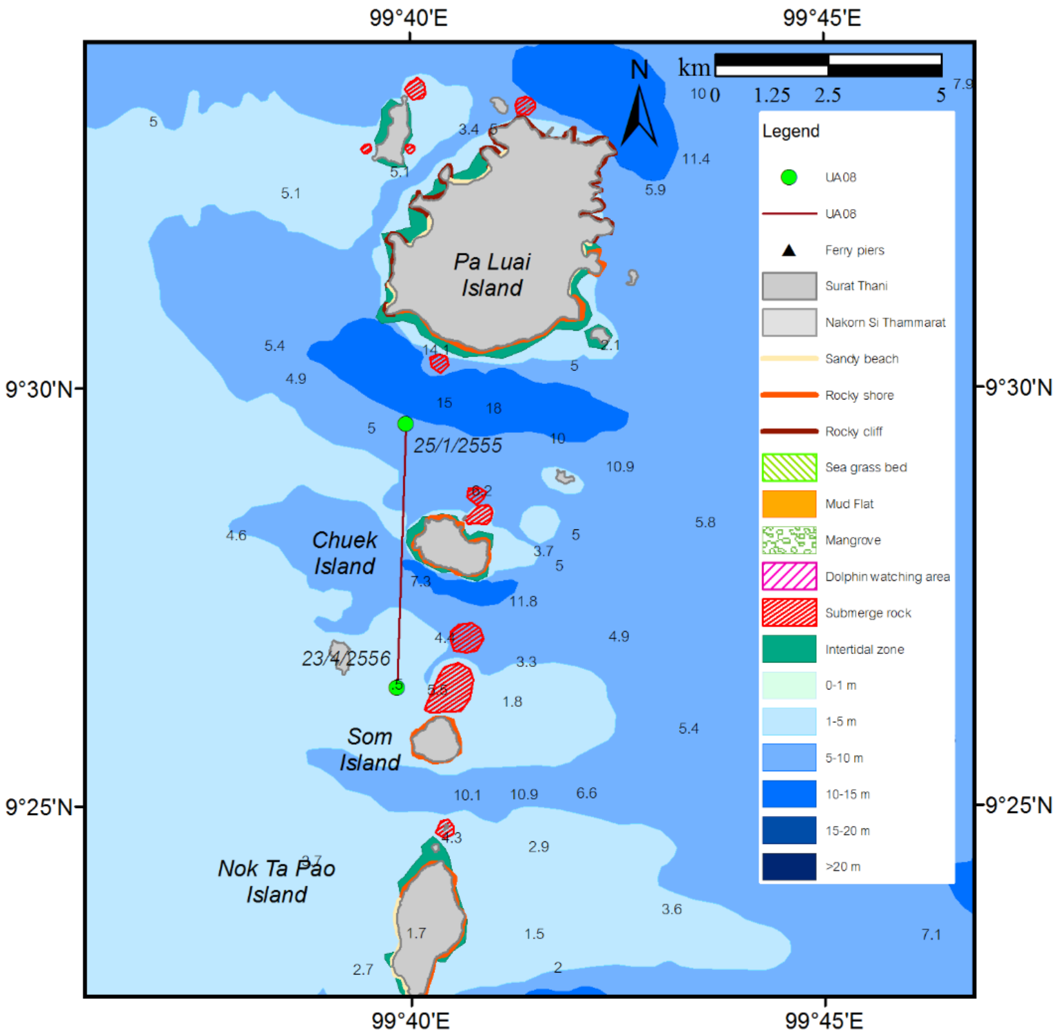
Number: 08

Code: UA08

Encountered history

No.	Date/Time	Area Code
1	25/1/55 13.28	N09°29.527′, E099°39.943′
2	23/4/56 11.41	N09°26.370′, E099°39.828′



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Right side

Number: 09

Code: UA09

Encountered history

No.	Date/Time	Area Code
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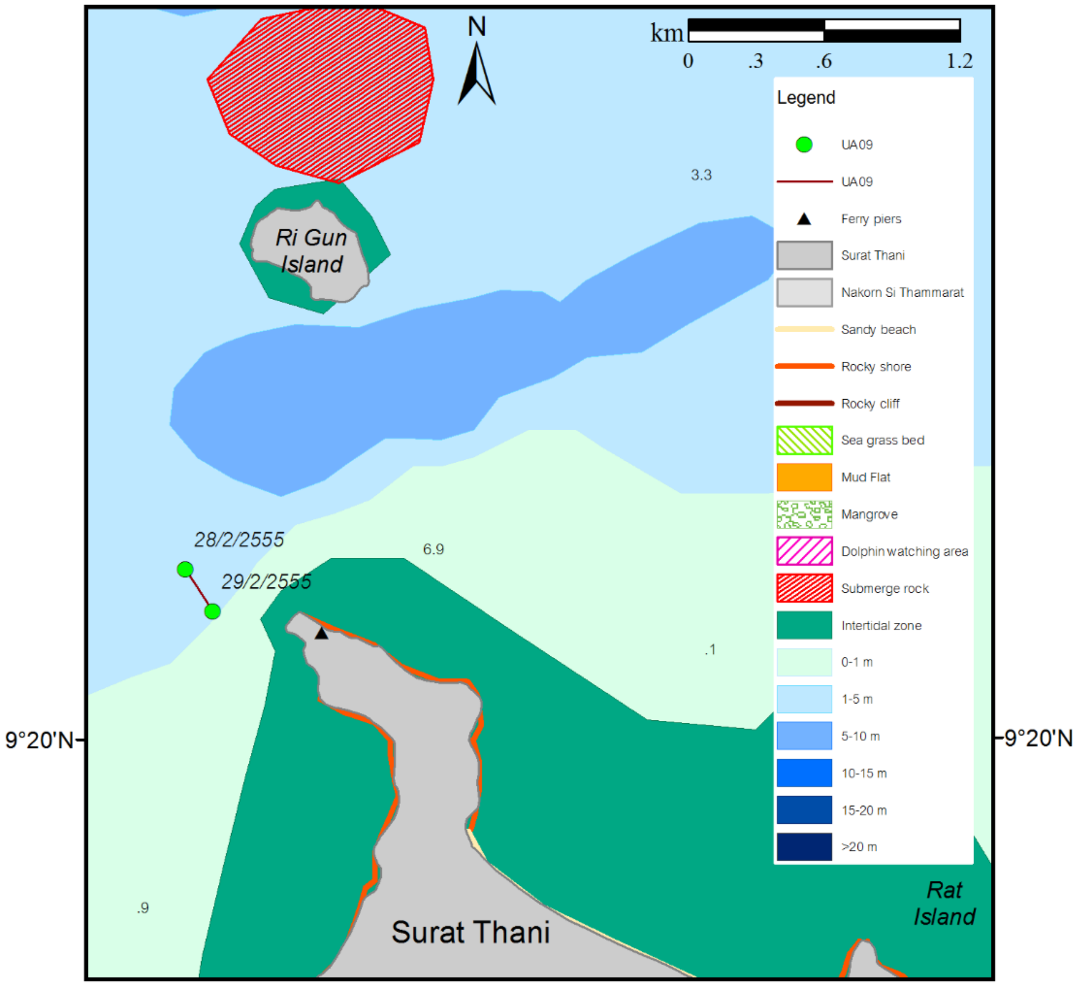
2	28/03/13 11.47	N09°20.260′, E099°40.699′

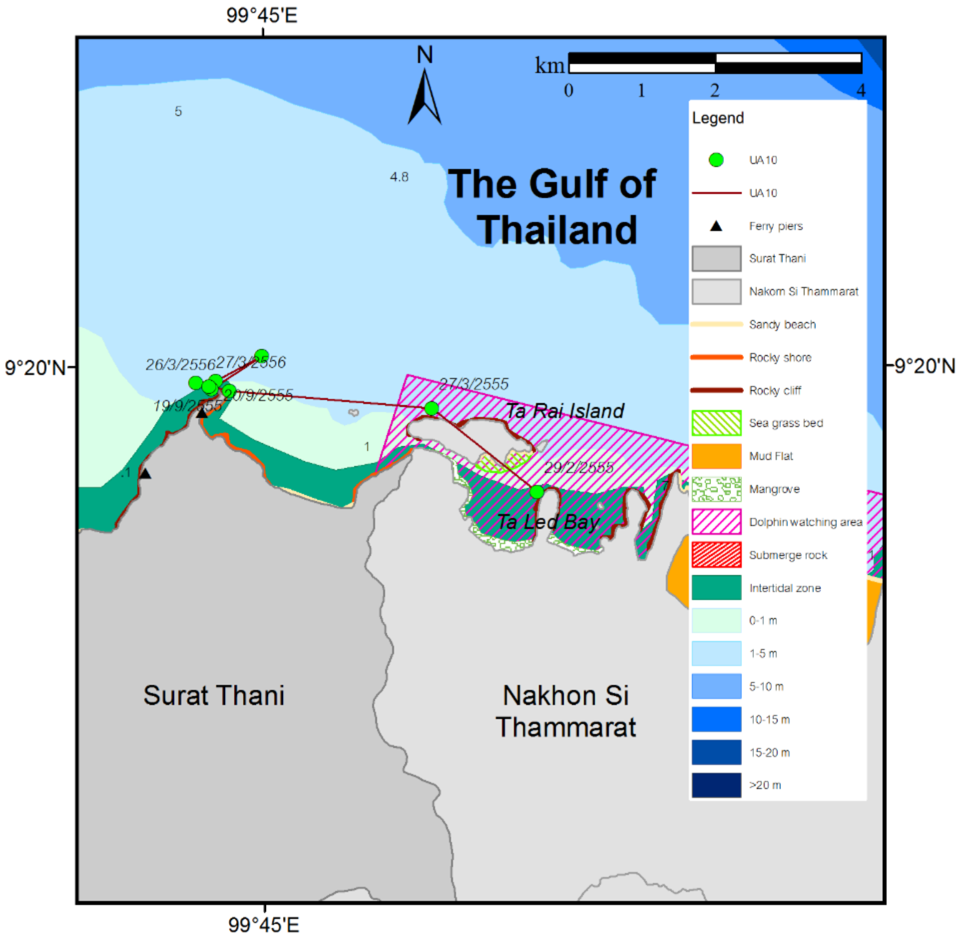


Left side	Number: 10
	Code: UA10

Right side

Encountered history

No.	Date/Time	Area Code
1	29/2/55 10.01	N09°19.023′, E099°47.034′
2	29/3/55 08.55	N09°19.648′, E099°46.246′
3	22/8/55 11.41	N09°19.783′, E099°44.743′
4	19/9/55 08.16	N09°19.842′, E099°44.490′
5	20/9/55 09.45	N09°19.856′, E099°44.642′
6	19/02/56 10.12	N09°20.039′, E099°44.980′
7	26/03/56 13.17	N09°19.796′, E099°44.602′
8	27/03/56 8.59	N09°19.812′, E099°44.583′



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<tr><td>2</td><td>18/9/55 12.33</td><td>N09°24.569′, E099°39.878′</td></tr>
<tr><td>Right side</td><td>3</td><td>26/03/56 11.30</td><td>N09°28.315′, E099°41.437′</td></tr>
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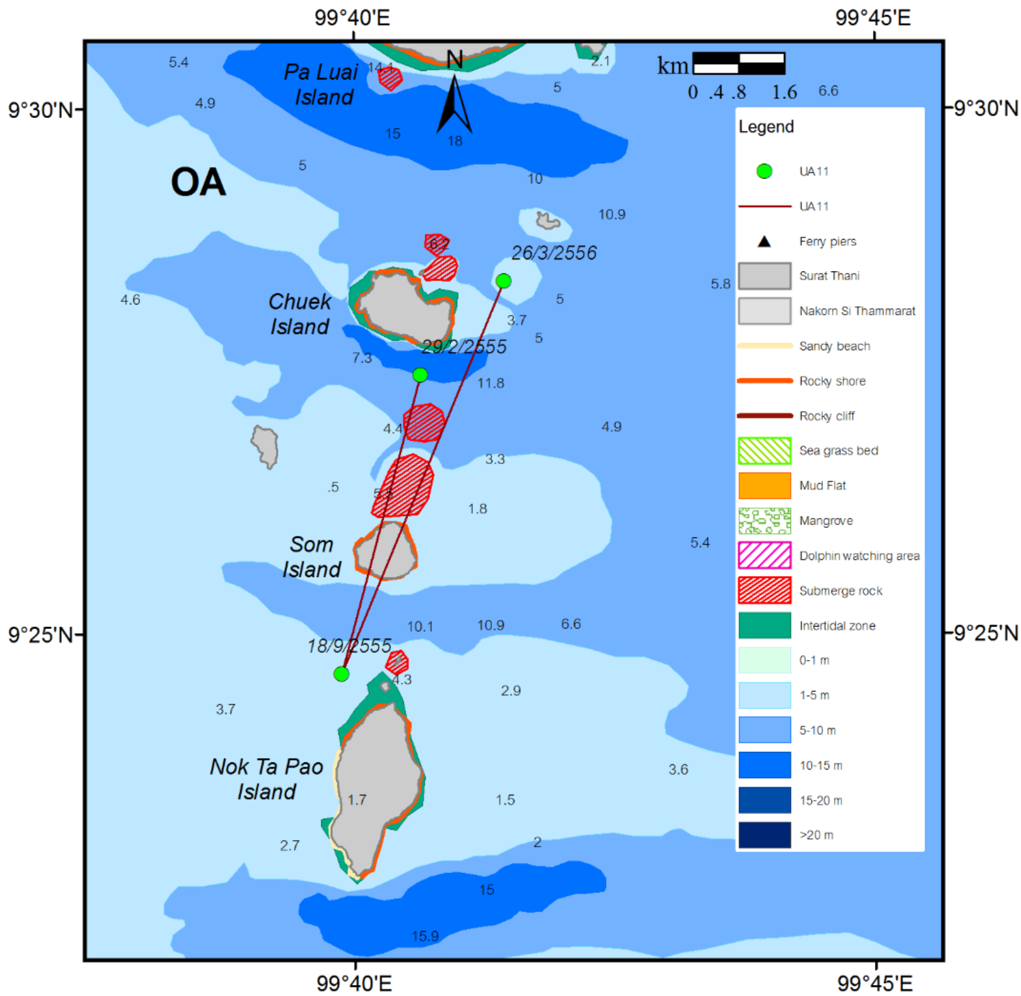
<tr><td colspan="4">
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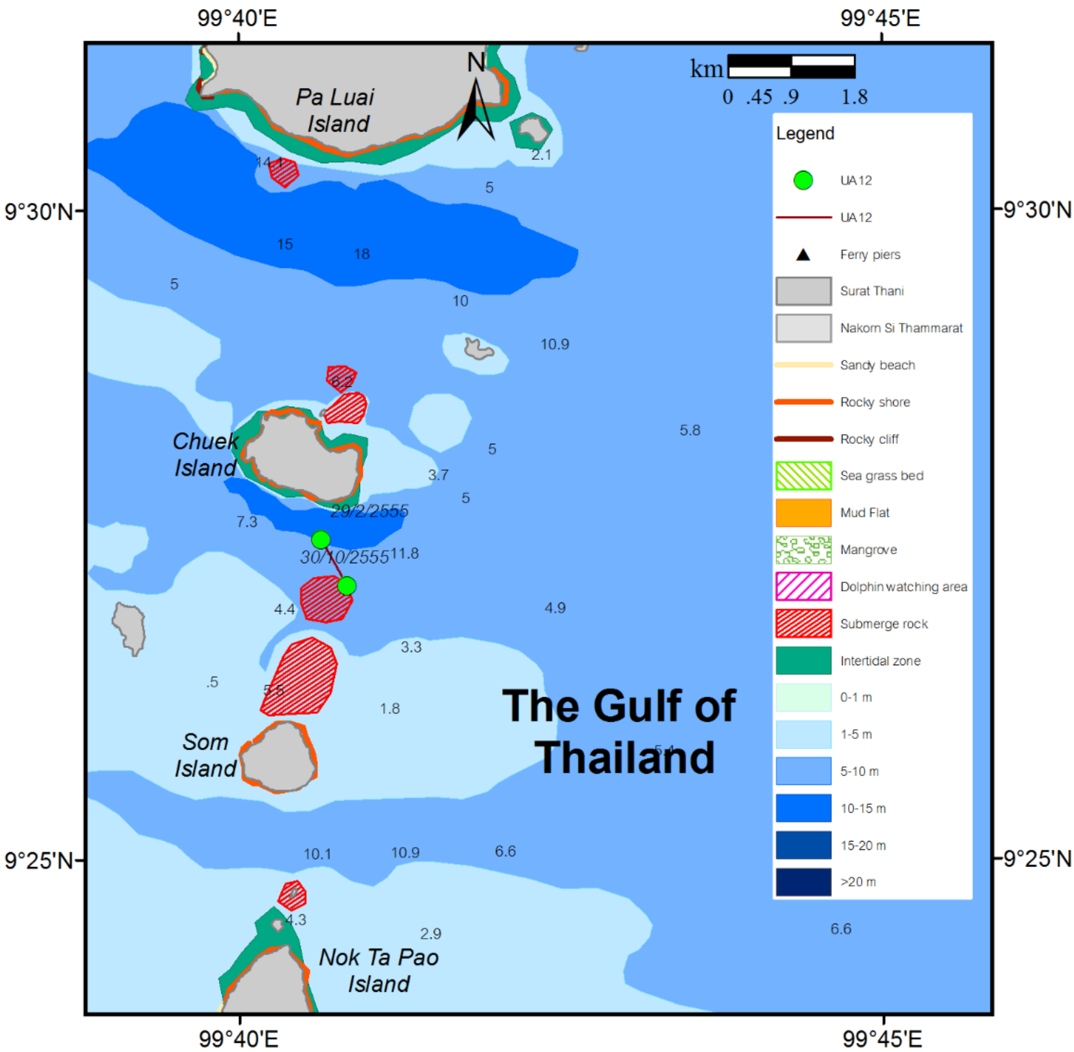
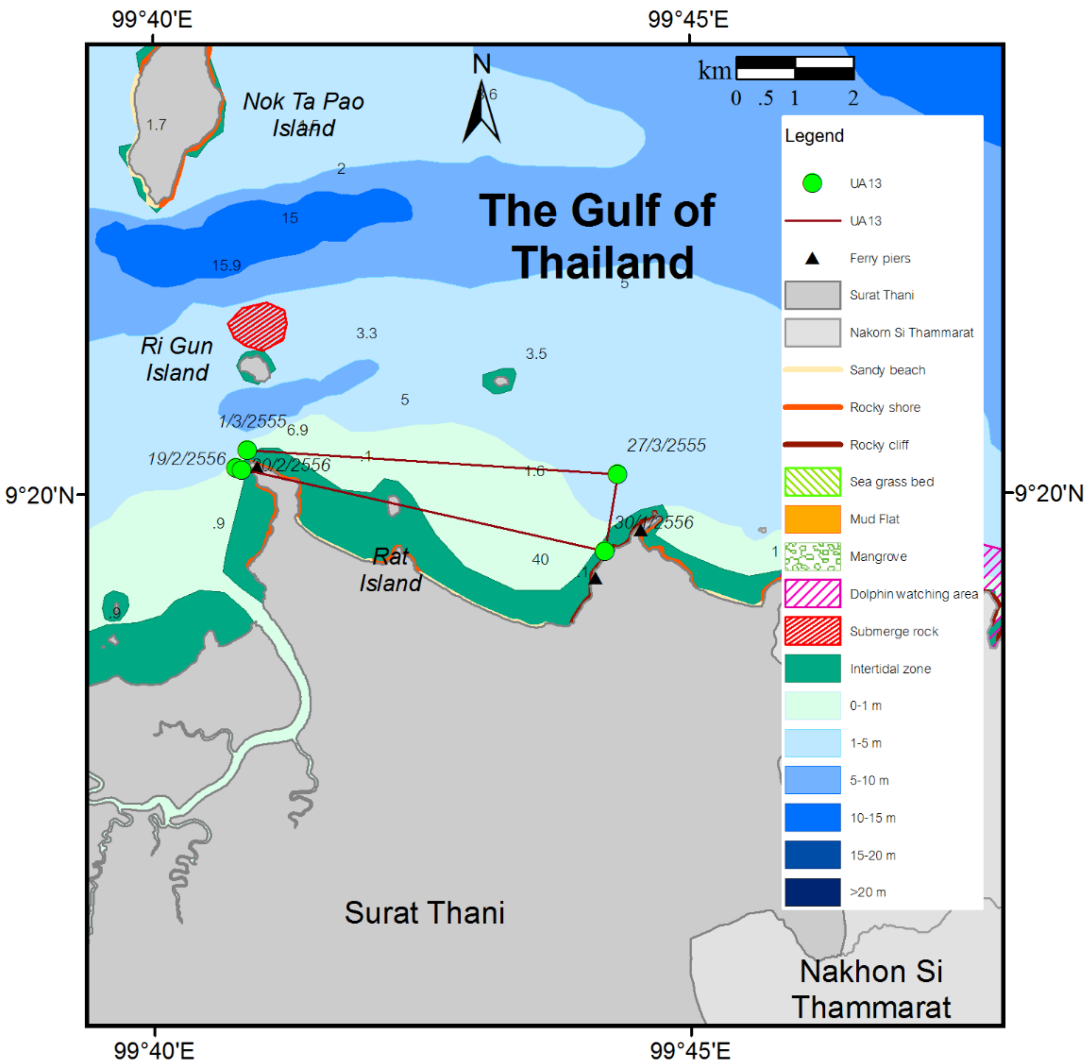


Left side	Number: 13
	Code: UA13
Right side	Encountered history
	

No.	Date/Time	Area Code
1	1/3/1207.37	N09°20.361′, E099°40.867′
2	27/3/1209.22	N09°20.135′, E099°44.318′
3	30/1/13 09.08	N09°19.426′, E099°44.194′
4	19/02/13 12.30	N09°20.203′, E099°40.763′
5	20/02/13 11.40	N09°20.182′, E099°40.812′



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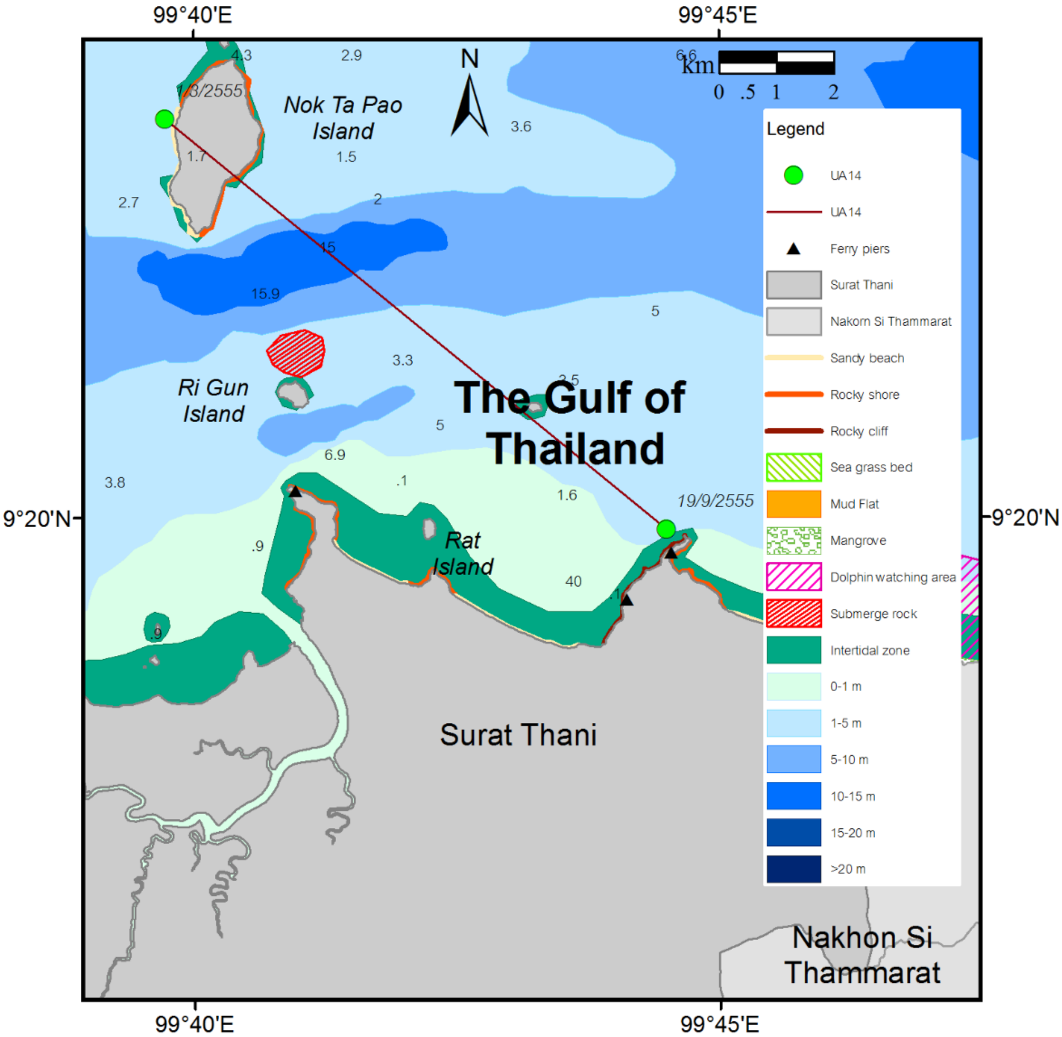
<tr><td colspan="4"></td></tr>
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Right side	Encountered history
	

No.	Date/Time	Area Code
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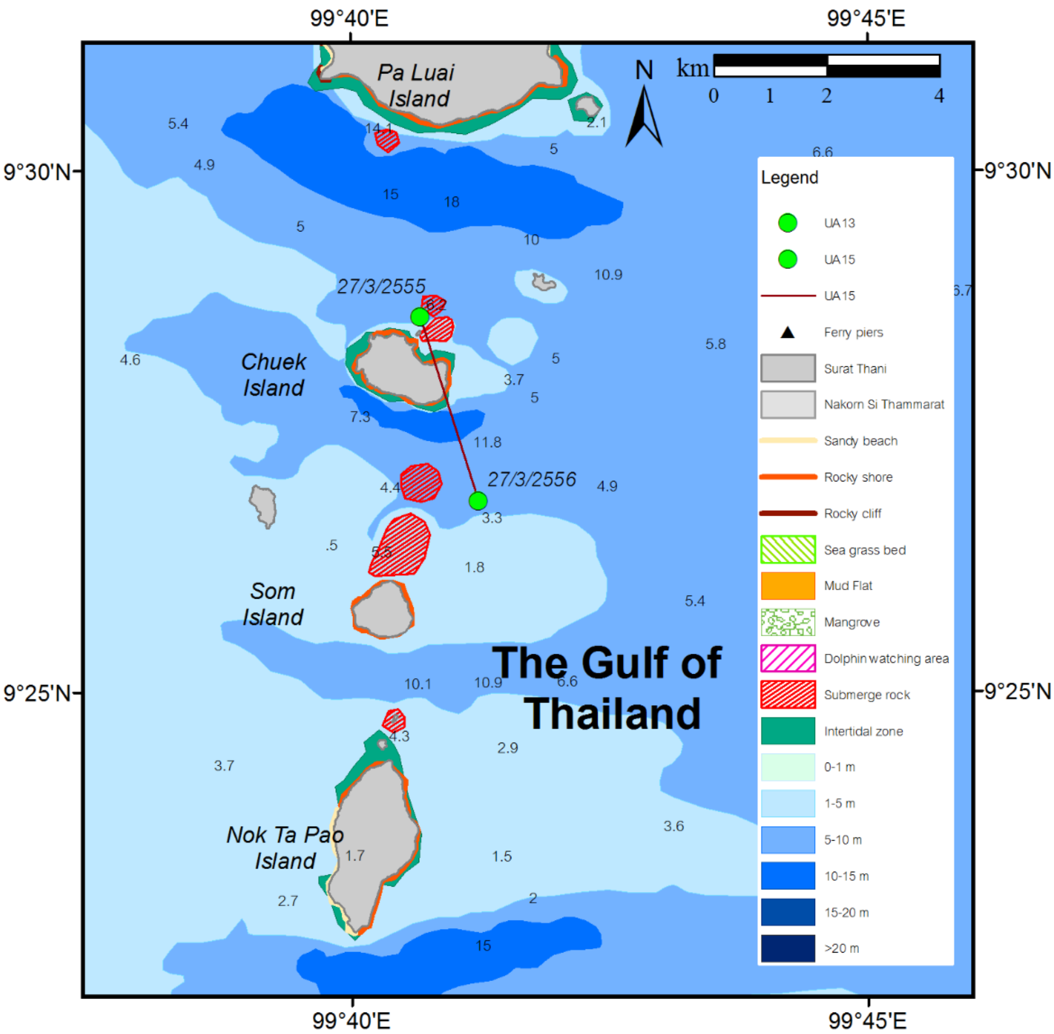
2	27/03/13 11.02	N09°26.782′, E099°41.228′



Left side	Number: 16		
	Code: UA16		
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	No.	Date/Time	Area Code
	1	27/3/1211.09	N09°28.553′, E099°40.664′
Right side			
			

Left side	Number: 17		
	Code: UA17		
	Encountered history		
	No.	Date/Time	Area Code
	1	29/3/55 12.20	N09°33.287′, E099°41.320′
Right side			
			

Left side	Number: 18		
	Code: UA18		
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	29/3/12 12.20	N09°33.287′, E099°41.320′
			

Left side	Number: 19		
	Code: UA19		
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	29/3/12 12.20	N09°33.287′, E099°41.320′
			

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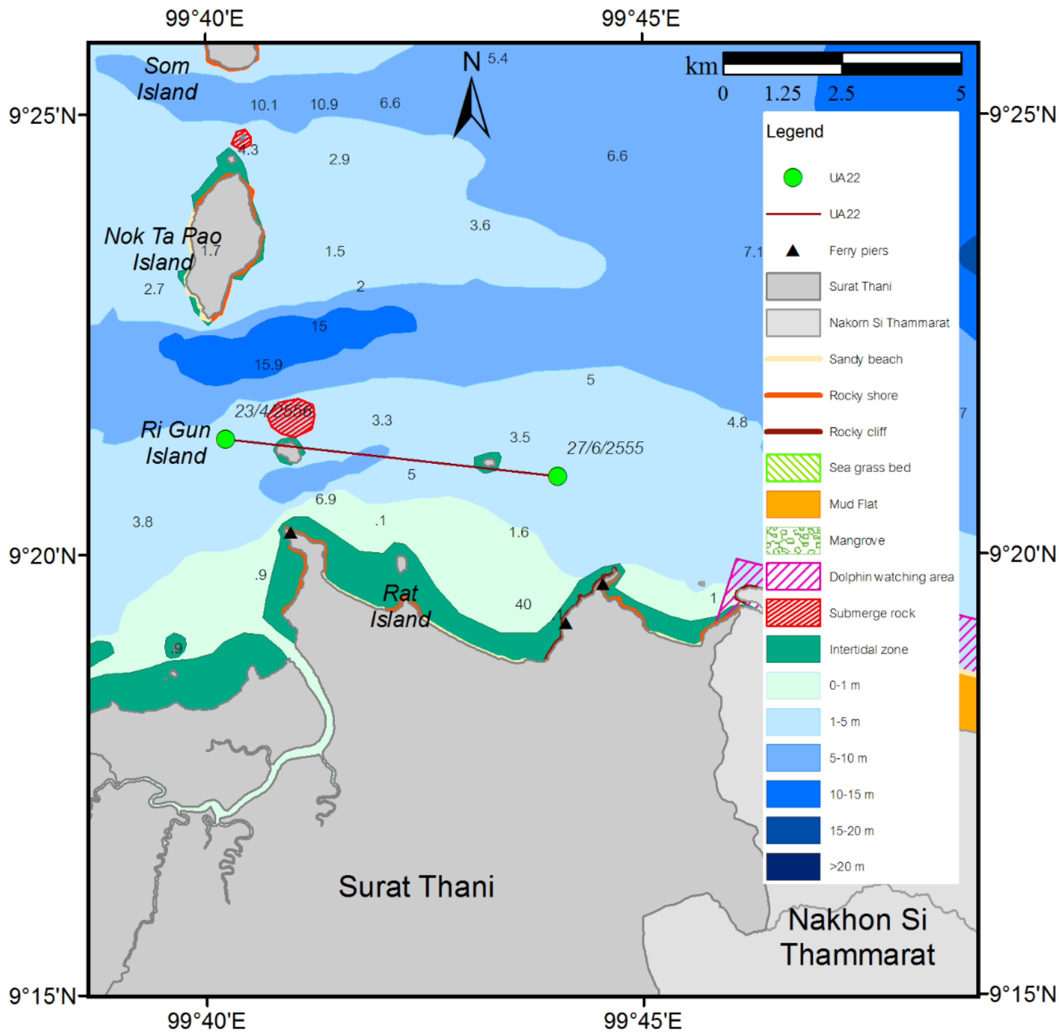
<tr><td colspan="4">
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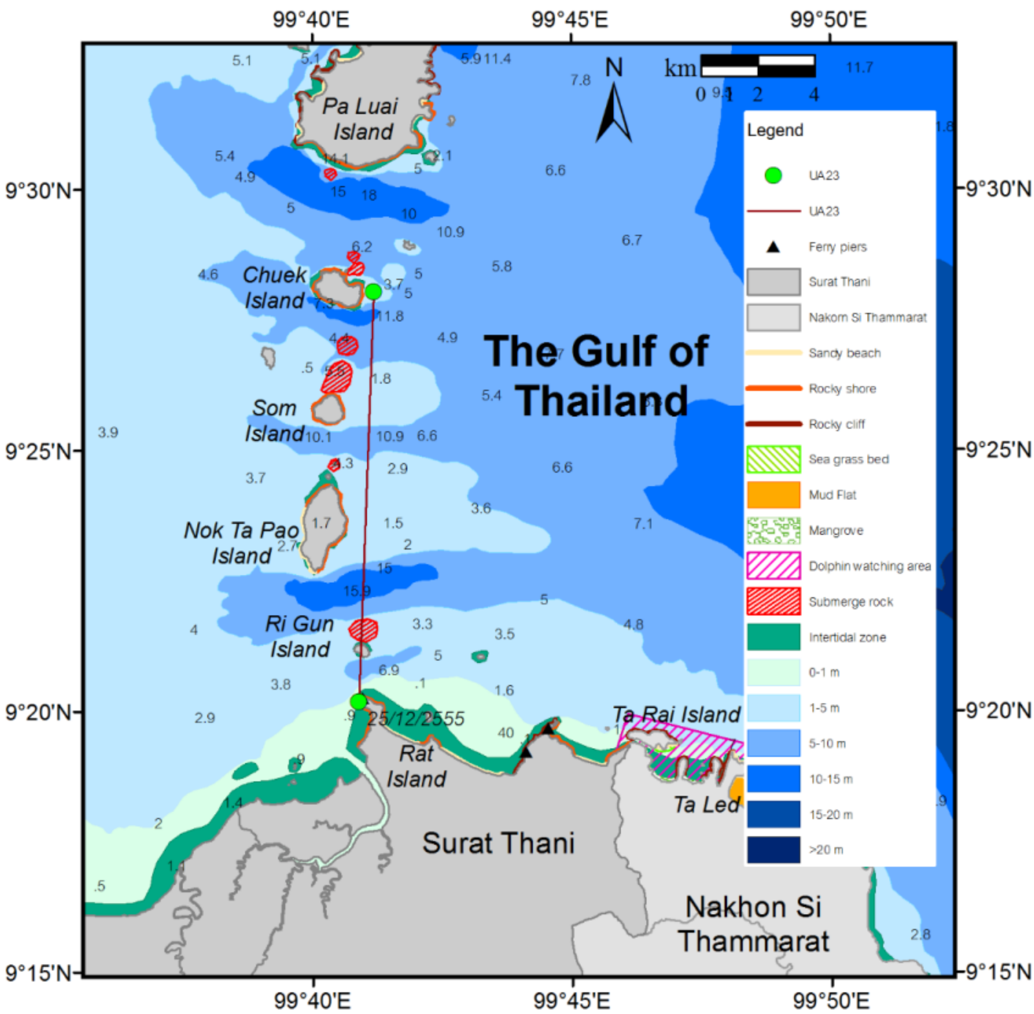

Left side

Right side

Number: 24

Code: UA24

Encountered history

No.	Date/Time	Area Code
1	20/9/12 09.45	N09°19.856′, E099°44.642′
2		

Left side

Right side

Number: 25

Code: UA25

Encountered history

No.	Date/Time	Area Code
1	18/9/12 12.33 .	N09°24.569′, E099°39.878′
2		

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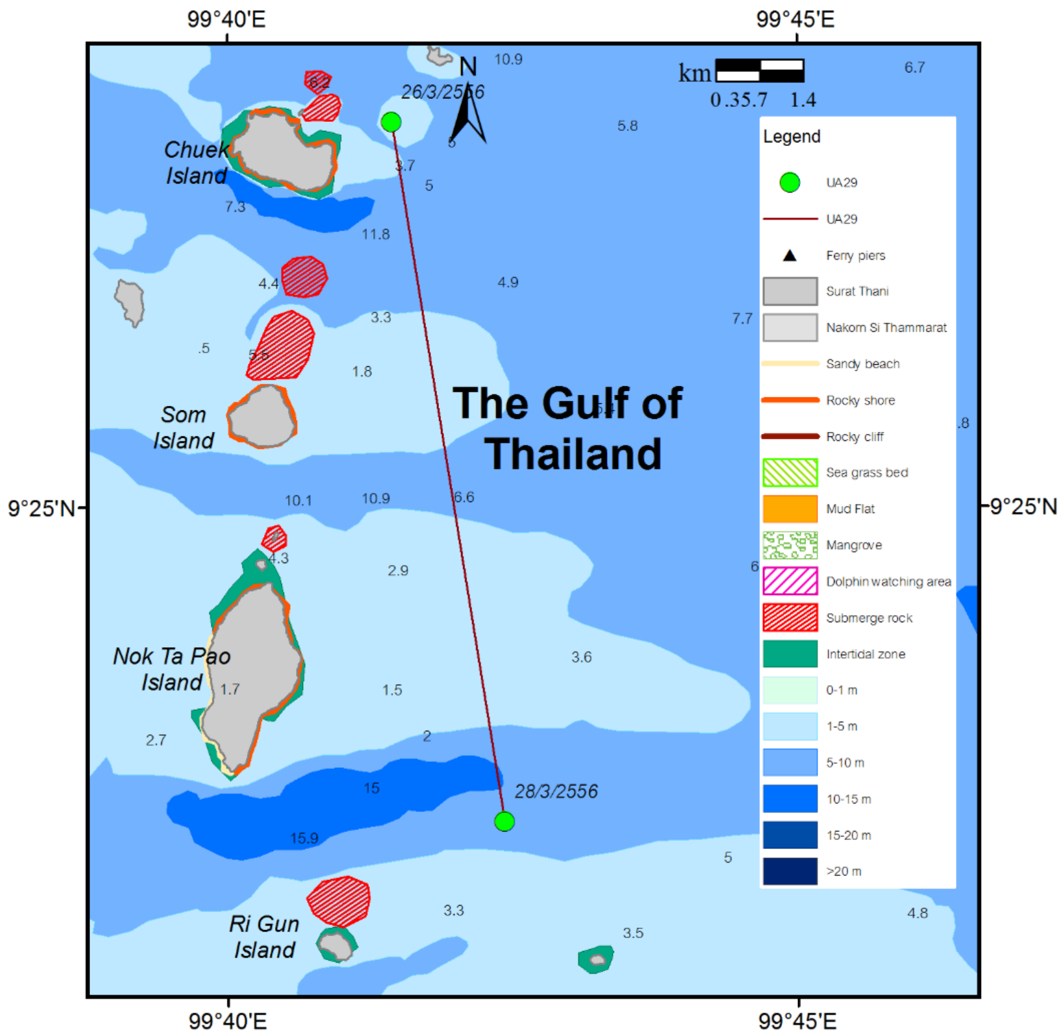

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	Encountered history		
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Right side			
			

Left side	Number: 31		
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	Encountered history		
	No.	Date/Time	Area Code
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Right side			

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	Encountered history		
	No.	Date/Time	Area Code
Right side	1	28/03/13 10.15	N09°22.205′, E099°42.420′
			

Left side	Number: 35		
	Code: UA35		
	Encountered history		
	No.	Date/Time	Area Code
Right side	1	28/03/13 10.15	N09°19.246′, E099°47.704′

Left side	Number: 36		
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	Encountered history		
	No.	Date/Time	Area Code
Right side	1	23/04/13 9.01	N09°21.275′, E099°40.218′
			

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<tr><td>No.</td><td>Date/Time</td><td>Area Code</td></tr>
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Left side

Right side

Number: 41

Code: UA41

Encountered history

No.	Date/Time	Area Code
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Left side

Right side

Number: 42

Code: UA42

Encountered history

No.	Date/Time	Area Code
1	23/04/13 13.11	N09°21.275′, E099°40.218′

VITAE

Name Mr.Suwat Jutapruet

Student ID 5310033004

Education Attainment

Degree	Name of Institution	Year of Graduation
M.Sc.(Computaional Science)	Walailak University	2009
B. Sc. (Computer Engineering)	Suranaree University of Technology	2002

Scholarship Awards during Enrolment

- Songklanakarind Ph.D. student scholarship, Prince of Songkla University
- Graduate School Support Funding for Thesis, Prince of Songkla University
- Oversea Research Scholarship, Prince of Songkla University

Work-Position and Address

2012-present Lecturer at the Faculty of Science and Industrial Technology
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List of Publications and Proceedings

Jutapruet, S., K. Kittiwattanawong, and Pradit, S. 2014. Population size and habitat patterns of Indo-Pacific Humpback Dolphins (*Sousa Chinensis*) in Donsak, Surat Thani, Thailand, *Chiang Mai Journal of Science*, 41(x):1-12, (*in press*)

Jutapruet1, S., Shiang-Lin, H., Li, S., Lin, M, Kittiwattanawong, K, and Pradit, S. 2014 Population size and habitat characteristics of the Indo-Pacific humpback dolphins (*Sousa chinensis*) off Donsak, Surat Thani, Thailand, *Aquatic Mammal*, (*in press*)

Jutapruet, S., K. Kittiwattanawong, and Pradit, S. 2014. A Survey of Dolphin Sightings Experienced by Local Fishermen in Donsak District, Surat Thani Province, Proceeding of the 1st Environment and Natural Resources International Conference (ENRIC 2014), Bangkok, November 6th-7th, 2014, Bangkok, Thailand, pp.180-188.