Tropical Life Sciences Research, 23(1), 63–76, 2012

The Distribution and Conservation Status of Green Turtles (*Chelonia mydas*) and Olive Ridley Turtles (*Lepidochelys olivacea*) on Pulau Pinang beaches (Malaysia), 1995–2009

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Abstrak: Penyu agar atau penyu hijau (*Chelonia mydas*) dan penyu lipas (*Lepidochelys olivacea*) adalah dua spesies penyu yang direkodkan mendarat di perairan laut Pulau Pinang. Penyu agar mempunyai rekod pendaratan tertinggi di Pulau Pinang sejak tahun 1995. Daripada statistik pendaratan penyu yang dikeluarkan oleh Jabatan Perikanan Pulau Pinang dari tahun 2001 hingga 2009, Pantai Kerachut dan Telok Kampi telah disenaraikan sebagai lokasi dengan pendaratan tertinggi penyu agar dengan pendaratan pada hampir setiap bulan dan pada sepanjang tahun. Sarang dan trek pendaratan penyu agar dijumpai hampir di keseluruhan pantai di Pulau Pinang iaitu di Batu Ferringhi, Tanjong Bungah, Pantai Medan, Pantai Belanda, Telok Kumbar, Gertak Sanggul, Pantai Moonlight, Telok Duyung, Telok Aling dan Telok Katapang. Tiada rekod pendaratan penyu lipas di Pantai Kerachut and Telok Kampi, tetapi trek dan sarang dijumpai di Telok Kumbar, Tanjong Bungah, Pantai Medan, Telok Duyung dan Gertak Sanggul. Justeru, Pusat Konservasi Penyu ditubuhkan di Pantai Kerachut untuk melindungi spesies ini daripada terus diancam kepupusan. Kajian ini akan menbincangkan tentang rekod dan taburan penyu agar dan penyu lipas di Pulau Pinang dari tahun 1995 hingga 2009.

Kata kunci: Penyu Agar, Pantai Kerachut, Telok Kampi, Taburan, Pokok Merambong, Musim Kemuncak

Abstract: The Green Turtle (*Chelonia mydas*) and Olive Ridley Turtle (*Lepidochelys olivacea*) are the only sea turtles with recorded landings in the Pulau Pinang coastal area. The Green Turtle has been the most abundant and widely distributed sea turtle in this area since it was first surveyed in 1995. Statistical analysis by the Pulau Pinang Department of Fisheries on the distribution of sea turtles from 2001 through 2009 has identified Pantai Kerachut and Telok Kampi as the most strongly preferred beaches for Green Turtle landings, with records for almost every month in every year. Green Turtle tracks and nests have also been found along the coast of Pulau Pinang at Batu Ferringhi, Tanjong Bungah, Pantai Medan, Pantai Belanda, Telok Kumbar, Gertak Sanggul, Moonlight Beach, Telok Duyung, Telok Aling, Telok Bahang and Telok Katapang. The Olive Ridley Turtle is present in smaller numbers; landing and nesting have only been recorded on a few beaches. There are no previous records of Olive Ridley landings at Pantai Kerachut and Telok Kampi, but tracks and nests have been found at Telok Kumbar, Tanjong Bungah, Pantai Medan, Telok Duyung and Gertak Sanggul. A Turtle Conservation Centre has been established at Pantai Kerachut to protect these species from extinction in Pulau Pinang. This paper presents details of the records and distribution of sea turtles in Pulau Pinang from 1995 through 2009.

Keywords: Green Turtle, Pantai Kerachut, Telok Kampi, Distribution, Merambong Tree, Peak Season

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INTRODUCTION

Mainland Southeast Asia has long been regarded as a hotspot of chelonian diversity (van Dijk *et al*., 2000). However, no recent findings on the status and distribution of marine turtles in Pulau Pinang coastal areas have been published. Sea turtles are thought to be declining in Southeast Asia for a number of reasons. In Laos, Cambodia and Vietnam, the exploitation of chelonians for food and medical markets is widespread (Jenkins, 1995), and hunters in rural villages capture turtles and tortoises for local consumption or to sell to traders (Stuat & Platt, 2004). According to Hamann *et al*. (2006), the greatest current threats to sea turtle populations in Vietnam are habitat degradation, accidental or opportunistic turtle capture by fishermen and the direct take of nesting females and their eggs. Turtles in Malaysia face similar threats. In Pulau Pinang, the major threats to turtles are egg stealing (TRAFFIC 2004) and the capture of adults for consumption and trade. In Terengganu, management, recording and research for the leatherback are conducted by the Turtle and Marine Ecosystem Center (TUMEC). Currently, approximately 25000 leatherback eggs are purchased yearly for hatching in Rantau Abang (Brahim *et al.* 1987; Chan 1989).
Four species of marine turtles (Green, Leatherback, Hawksbill and Olive Ridley) reside in Malaysian waters (Heng & Chark, 1989), and only two species, the Green and Olive Ridley, are presumed to nest on Pulau Pinang's beaches. Few people are aware that active landing activity of sea turtles occurs in Pulau Pinang. Consequently, there has been little study, research, publication or exposure. Before the establishment of the Turtle Conservation Centre in early 1990's, turtles in the region faced the problems listed above because it was not possible to fully monitor the turtle nests and protect them from fishermen and illegal trade. To prevent this situation from continuing, a tagging system was introduced in 2001 to collect systematic data and to trace each turtle's landing to ensure that the nest records were reported accurately and to control and fully protect beaches from human disturbance.

This paper documents the results of surveys of 13 beaches in Pulau Pinang and compares the numbers of nests recorded during 2 periods: 1995–2000 and 2001–2009. The objectives of the paper are (1) to report the preferred nesting locations of Green Turtles from 2001–2009 among 13 beaches surveyed in Pulau Pinang; (2) to report on conservation efforts from 1995–2009 in the context of the annual totals of nests recorded, nest relocations and the annual mean hatch rate for the Green Turtle and Olive Ridley Turtle; and (3) to report on the selection of preferred nest sites by Green Turtles at Pantai Kerachut and Telok Kampi for 2008 and 2009.

MATERIALS AND METHODS

Determination of Distribution

Thirteen beaches on Pulau Pinang were surveyed (see Fig. 1).
Four staff members of the Pantai Kerachut Turtle Conservation Centre, working under the Conservation Department and 2 licensed fishermen hired by the

Department patrol the beaches at night up to 4–5 times a week, sometimes accompanied by the Head of the Conservation Department, to verify, tag, and relocate turtle nests for incubation according to the standard guidelines. For beach monitoring, two types of surveys were conducted: intensive nocturnal surveys (evening surveys) and morning track counts (morning surveys). Turtles encountered were tagged on both flippers during intensive nocturnal surveys, and within this time all the necessary data were collected and recorded. This information included nest site selection, the total number of eggs laid, and the time of emergence. To ensure that no turtle landings were overlooked during the night surveys, the results were verified the following day with morning track counts.

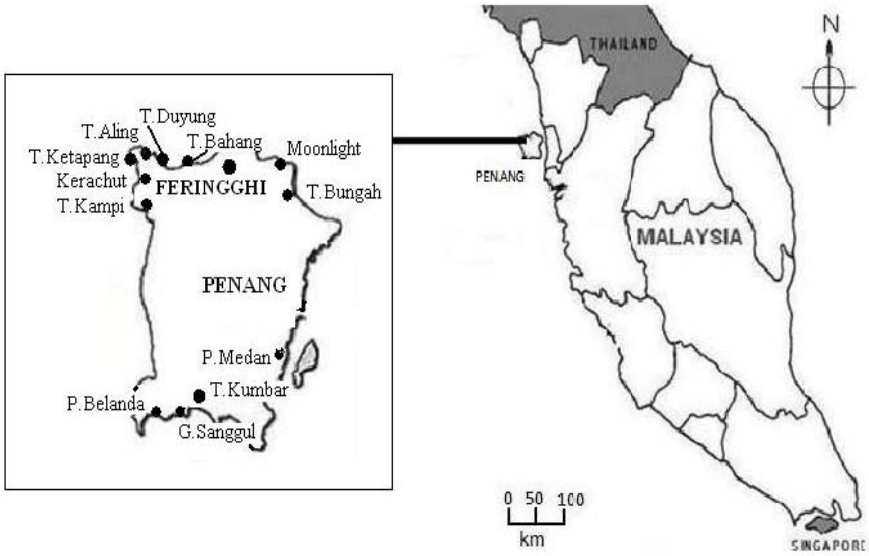

Figure 1: Map of Pulau Pinang showing location in Peninsular Malaysia and the locations of the 13 surveyed beaches (inset).

Surveys from 1995 to 2000

Between 1995 and 2000, conservation focused on daily monitoring at Pantai Kerachut, Telok Kampi and 11 other beaches. Regular interviews were conducted with residents and fishermen in these areas twice each month. Nocturnal and morning surveys were conducted at Pantai Kerachut and Telok Kampi 3–4 times a week by one staff member. The surveys at Telok Kampi were based on information provided by three hired fishermen.

Surveys from 2001 to 2009

Intensive nocturnal surveys and morning track counts were performed 365 days a year at Pantai Kerachut, Telok Kampi and Telok Ketapang from 2001 through 2009. Surveys were performed by Department staff except during a seven-day holiday period when two fishermen were hired to assume survey responsibilities.

Pantai Kerachut, Telok Kampi and Telok Ketapang

Because the Turtle Conservation Centre is situated at Pantai Kerachut, surveys were easily conducted at the two adjacent beaches, Telok Kampi and Telok Ketapang. Four persons (two staff, one fisherman and the head of the conservation department) began to monitor turtle crawls starting at 2000 hrs at Pantai Kerachut. The beach was monitored approximately four times by walking along the sandy beaches of Pantai Kerachut, and minimal light was used to verify the occurrence of emergence tracks. Between 0200 and 0400 hrs, the fishermen and one staff member went to Telok Ketapang by boat (a 5 minute journey from Pantai Kerachut), surveyed the beach there, and then surveyed Telok Kampi (also a 5 minute journey from Pantai Kerachut). The surveys at both beaches were performed with a torch, either by moving slowly along the beach or by observing from the boat. The boat was stationed a distance offshore to prevent the sound of the engine from disturbing the activities of the turtles. After Telok Ketapang had been surveyed, the team returned to Telok Kampi and stayed on the boat approximately 20 m from the beach to monitor any emergences until 0400 hrs.

If a turtle emergence was observed, the light source was extinguished. The team then followed the turtle at a distance of approximately 5 m and monitored the nesting activity. After the turtle had finished nesting and compacting the sand, both front flippers were tagged. The eggs were collected after the turtle had returned to the sea. Nesting activity was timed from the moment at which the turtle began to dig the 'real nest', defined as a nest that an adult excavated and in which the adult laid eggs. If an adult attempted to dig but did not lay eggs, the nest was not classified as a 'real nest'.

If no landings were observed during this period, the three beaches were surveyed on foot the following morning (morning track counts). The morning surveys began at approximately 0800 hrs. Pantai Kerachut was surveyed first, followed by Telok Kampi and Telok Ketapang. These surveys were particularly important during seasonal bad weather. If nests were encountered in the morning, the standard procedure for relocating eggs to the hatchery was followed.

Telok Aling and Telok Duyung

Morning track counts were conducted daily on foot beginning at approximately 0900 hrs.

Telok Bahang

Twice-weekly interviews with approximately 10 local fishermen were conducted by Department staff.

Batu Ferringhi, Moonlight Beach and Tanjung Bungah

Four fishermen (residents of these three locations) provided information on turtles around these areas and were paid based on the number of eggs found.

Gertak Sanggul, Pantai Belanda, Pantai Medan and Telok Kumbar
Interviews with residents were conducted by 2–3 department staff 4–6 times a month. Nocturnal surveys were conducted at certain times based on information supplied by residents.

Egg Relocation
Eggs from almost all nests encountered at the 13 beaches were relocated to the hatchery at Pantai Kerachut Turtle Conservation Centre between 1995 and 2009. Only 438 of 539 Green Turtle nests (81%) were relocated from 1995–2009. The hatchery was located next to the Centre, occupied an area of 10 m × 5 m and was fully covered with black netting to provide shade and avoid overheating the eggs. The remaining 19% of the nests from 1995–2009 were left to incubate naturally to compare the natural rate of hatching with the hatchery rate.

The decision to relocate eggs from the nests to the hatchery was made for several reasons. Eggs are frequently destroyed by roots from surrounding vegetation, flooding, theft by humans or predation by Monitor Lizards (*Varanus salvator*). In addition, new hatchlings face a high risk of predation. Moreover, the Department lacks adequate human resources to fully protect all original nests.
The basic equipment for egg relocation consisted of a large plastic bucket and gloves. Eggs were removed and counted by carefully excavating the nest as soon as the turtle had returned to the sea (Hays & Speakman 1993). This procedure was unlikely to affect the survival of the eggs adversely. Previous studies had shown that the careful excavation and handling of sea turtle eggs shortly (less than three hours) after they had been laid did not induce egg mortality (Parmenter 1980; Harry & Limpus 1989). Additionally a study by Chan (1989) showed that the eggs must be handled with extreme care to prevent the horizontal or vertical rotation of the eggs. Chan *et al.* (1985) reported that rough handling of eggs involving vertical and horizontal rotation more than five hours after the turtles lay their eggs can significantly reduce the hatching rate of the leatherback turtle. After a bucket had a full load of eggs, a small amount of sand was then added to fill the bucket and maintain the temperature. The bucket was then transported directly to the hatchery. The bucket was moved in a way that produced the least possible vibration. After the eggs were transferred, they were immediately incubated. The eggs were re-buried in hatchery nests excavated to a depth of approximately 60 cm and a width of 25 cm. After all eggs were placed in the nest chamber, the nests were fully compacted with the remaining sand and left for incubation. The final step was to label the clutch using a bamboo stick and to cover the nest with a protective net to avoid predation attempts. The relocated nests were monitored four times a day until hatchling emergence.

Procedure for Releasing Hatchlings into the Sea
After the hatchlings emerged, they were collected, counted and transferred to a bucket. They were counted again before the preparations were made to release them at night. Prior to the release, all lights were switched off so that the hatchlings were not artificially disoriented (Mrosovsky 1978). To avoid predation by eagles, the hatchlings were not released during the day. All hatchlings were released into the sea off Pantai Kerachut under observation to ensure that they

all reached the sea (in practice, all the hatchlings that emerged at night successfully reached the sea).

Nest Site Selection

Two surveys were conducted from January through December in 2008 and 2009 at Pantai Kerachut and Telok Kampi to investigate the selection of preferred nest sites. The nest sites selected were classified into three categories: nests located under the vegetative cover of merambong trees, nests in open sand and nests under bushes. Nest site selection was determined after the female had finished nesting and returned to the sea. The combined data for 2008 and 2009 were then analysed as described below.

Statistical Analysis

An independent-samples *t*-test was used to compare the mean scores on continuous variables for two different groups of subjects.

RESULTS

Annual Distribution of Green Turtles from 2001 to 2009

The continuous annual distribution of Green Turtles located from 2001 through 2009 is plotted in Figure 2. The mean number of clutches collected monthly from 2001 through 2009 was 4.7 (SD = 3.9, range = 0 to 18). The four peak collections ranged from 16 to 18 clutches per month. The time periods between these peaks ranged from 2 to 3 years. It is probable that these peaks are related to the nesting season. The four peaks corresponded to the years in which the greatest numbers of adults landed in Pulau Pinang and in which the greatest numbers of nests were collected. The highest number of clutches collected was at Pantai Kerachut (81), followed by Telok Kampi (55) (Table 1). Together, these clutches constituted 82.4% of all nests found on the 13 beaches surveyed between 2001 and 2009.

An independent-samples *t*-test was performed to compare the total clutches collected at Pantai Kerachut and Telok Kampi from 2001–2009. There was a significant difference in scores for Pantai Kerachut (mean = 5.7, SD = 3.9) and Telok Kampi [mean = 3.3, SD = 1.8; $t(33) = 3.5$, $p = 0.001$].

Green Turtle and Olive Ridley Turtle Nesting Activity and Adult Records from 1995–2009

Table 2 shows the results of increased monitoring effort in terms of the number of nests found and relocated. Between 1995 and 2000, the number of Green Turtle nests found showed a gradual decrease. No nests were found in 1999 or 2000. This outcome was the result of insufficient manpower to control human encroachment and nest poaching at both beaches. It is probable that the declining trend was the result of the uncontrolled collection of turtle eggs in the early 1980s. Between 1995 and 2000, there were no records of Olive Ridley Turtle nesting. This information suggests that the Olive Ridley Turtle was no longer landing in Pulau Pinang. However, due to improved survey coverage and

the allocation of sufficient manpower by the Department of Fisheries, the percentage of Green Turtle nests successfully located over the entire study period has increased from 6.12% in 1995–2000 to 93.88% in 2001 and subsequent years.

After the introduction of a tagging system in 2001, most Green Turtles observed nesting were tagged, and the number of clutches relocated to the hatchery increased. This change was due to the implementation of a more systematic protocol for locating turtles by the Department. A systematic protocol for the surveys allows the improved protection of turtle habitat and also successfully controls human activities at the beach. The result of these improvements is that more adults are attracted to land. Due to improved surveys, more turtle nests are being recorded and relocated. This change caused the identification of higher numbers of nests from 2001 to 2009 and the relocation of higher numbers of eggs to the hatchery. The highest number of eggs was collected in 2009. Most encouraging was the reappearance of Olive Ridley Turtles beginning in 2001 due to improved protection.

Because no tagging system existed from 1995–2000, we depended on the morphological characteristics of each adult to differentiate individuals. This approach was possible because each adult is a different length and width. Figure 3 shows that the smallest numbers of adults landing were recorded from 1995 through 2000. However, the numbers increase beginning in 2001. The highest numbers of adults landing were recorded in 2006 and 2009. In 2008, 18 tagged Green Turtle adults were recorded landing; in 2009, 16 Green Turtle adults and 2 Olive Ridley Turtle adults were recorded landing. The numbered tag on the front flipper allowed the activity of individual turtles to be monitored. For example, a female with tag number MY2515 returned to Pantai Kerachut and nested 6 times at the same beach in 2004.

Research into nest site selection during 2008 and 2009 at Pantai Kerachut and Telok Kampi found that 60.4% of Green Turtle nests were located under merambong trees, 24.8% were located under bushes and 14.9% were on the open beach (Table 3). It is probable that open beach sites were less popular due to the high risk of predator disturbance. Most Pantai Kerachut beaches are fringed by merambong trees, under which 14 nests were found in 2008 and 27 nests in 2009. A few other tree and grass species also grow in this area of the beach, but these plants do not provide as much shade as merambong trees.

Nesting activity was analysed according to three time periods: 2000–2400 hrs, 0000–0300 hrs, and 0300–0600 hrs. The highest Green Turtle nesting activity (2001–2009) is in the period 0000–0300 hrs, with 42% of the total observations, followed by 2000–2400 hrs, with 38% of the observations. The least nesting activity was recorded during 0300–0600 hrs, with 16.9% of the observations. As part of the 2001–2009 site selection survey, the proximity of the nests to human settlement was noted. 93% of the Green Turtle nests were found on beaches fringed with vegetation (500–1000 m from human settlement), 5% of the nests were found at the beach near human activity (50–100 m from human settlement) and 2% of the nests were found in the grassland/open beach areas (200–300 m from human settlement) (Table 4). Although Telok Kumbar is near

human activity, three nests were found at the beach because it has wild growing vegetation suitable for turtle nesting.

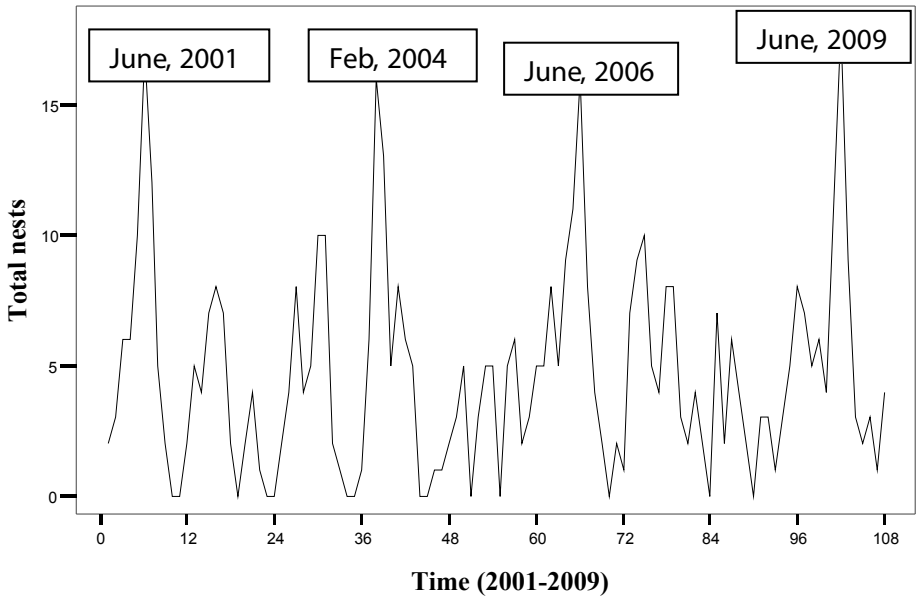

Figure 2: Numbers of Green Turtle nests located at 13 beaches on Pulau Pinang, 2001–2009, showing seasonal pattern of occurrence.

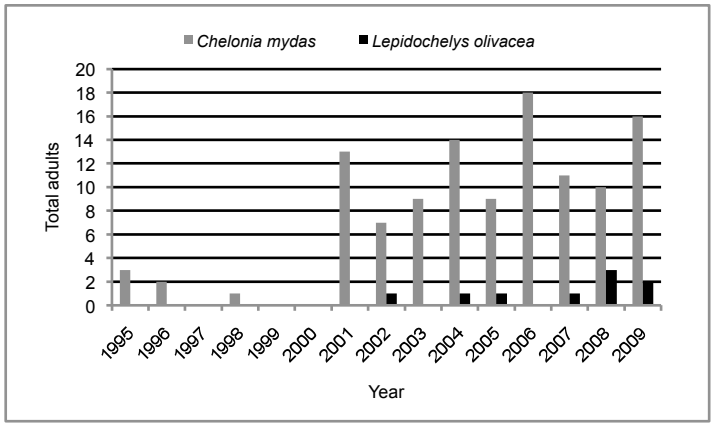

Figure 3: Annual totals of Green Turtle and Olive Ridley Turtle adults found at 13 beaches on Pulau Pinang, 1995–2009.

Table 1: Number and percentage of Green Turtle clutches collected at each of the 13 beaches surveyed on Pulau Pinang, 2001–2009.

Location	Number of clutches collected	Percentage (%) of total number
Pantai Kerachut	81	49.1
Telok Kampi	55	33.3
Telok Ketapang	9	5.5
Telok Kumbar	4	2.4
Batu Feringghi	4	2.4
Tanjong Bungah	1	.6
Moonlight Beach	2	1.2
Pantai Medan	1	.6
Pantai Belanda	1	.6
Telok Duyung	1	.6
Gertak Sanggul	1	.6
Telok Bahang	1	.6
Telok Aling	4	2.4
Total	165	100.0

Table 2: Nesting data for *Chelonia mydas* and *Lepidochelys olivacea* on Pulau Pinang, 1995–2009.

Species	Years	Total nests located	Total nests relocated	Mean clutch size	SD	Mean hatch rate	SD
C. mydas	1995	15	14	109.9	24.7	71.8	29
	1996	11	9	95.4	26.7	76.2	22.8
	1997	4	3	87.5	21.8	46.5	16.34
	1998	3	3	109.7	6.03	61.3	24
	1999	–	–	–	–	–	–

(*continued on next page*)

Table 2: (*continued*)

Species	Years	Total nests located	Total nests relocated	Mean clutch size	SD	Mean hatch rate	SD
C. mydas	2000	–	–	–	–	–	–
	2001	66	53	105.1	22.3	68.6	32.4
	2002	39	24	100.1	24.4	55	40.5
	2003	47	35	110.5	18.7	76	27.5
	2004	62	50	113.6	20.3	60.8	43.2
	2005	42	37	102	27.6	44.9	44.1
	2006	71	55	110	28.4	66.3	45
	2007	62	52	119.3	20.8	67.8	44.3
	2008	44	38	102.6	32.9	80.4	42.4
	009	73	65	109.2	20.3	65.4	42.4
L. olivacea	1995	–	–	–	–	–	–
	1996	–	–	–	–	–	–
	1997	–	–	–	–	–	–
	1998	–	–	–	–	–	–
	1999	–	–	–	–	–	–
	2000	–	–	–	–	–	–
	2001	–	–	–	–	–	–
	2002	1	1	81	0	60	–
	2003	–	–	–	–	–	–
	2004	1	1	98	0	82	–
	2005	1	1	98	0	92	–
	2006	–	–	–	–	–	–
	2007	1	1	100	0	88	–
	2008	3	3	116	14	80.7	6.7
	2009	2	2	131	12.7	74.5	6.4

Table 3: Nest site selection of Green Turtles surveyed at Pantai Kerachut and Telok Kampi in 2008 and 2009.

Nest site selection	2008		2009		Total	%
	P. Kerachut	T. Kampi	P. Kerachut	T. Kampi		
Under the shade of merambong trees	14	4	27	16	61	60.4
In open sand	6	0	7	2	15	14.9
Under bushes	8	2	6	9	25	24.8
Total	28	6	40	27	101	100

Table 4: Distribution of Green Turtle nests in relation to the distance from human settlement.

Site and distance from human settlement	Nests		Total	Percentage (%)
	2008	2009		
Vegetated zone far from settlements (500–1000m)				
Pantai Kerachut (800m)	22	33	55	55.6
Telok Kampi (1000m)	6	25	31	31.3
Telok Aling (500m)	3	3	6	6.1
Total	31	61	92	93
Open beach/grassland (200–300m)				
Telok Bahang (200m)	1	0	1	1
Moonlight beach (300m)	1	0	1	1
Total	2	0	2	2
Near to human settlement/night activity (50–100m)				
Batu Ferringhi (50m)	1	0	1	1
Gertak Sanggul (100m)	1	0	1	1
Telok Kumbar (100m)	1	2	3	3
Total	3	2	5	5
Total observations	72	126	198	100

DISCUSSION

Natural Vegetation, Beach Site Selection, Emergence Time and the Environmental Conditions that Affect the Landing of Sea Turtles

The results of the study suggest that natural vegetation and darkness have a positive effect on the selection of landing and nesting sites by sea turtles in Pulau Pinang. This finding is consistent with the hypothesis formulated by Wang and Cheng (1998) that vegetation has a significant influence on nest site selection by the green turtles of Wan-An Island. The presence of merambong trees has a positive effect and is of major significance in attracting adults because the trees provide shelter, privacy and darkness.

Pantai Kerachut and Telok Kampi were the most preferred beaches. In all, 82% of the emergences occurred at these 2 beaches because these beaches provide optimal conditions for turtle nesting, with natural vegetative growth (primarily dominated by the merambong tree) available to provide a silent and serene environment far from human activity. The protection of the natural habitat, strict law and the reduction of nocturnal activity were additional important factors.

The majority of sea turtles preferred to emerge between 0000–0300 hrs. At both beaches, this period provides the quietest environment for turtles to land. In contrast, the environment was disturbed between 2000–2400 hrs and after 0300 hrs by the noise from fishermen's engines and lights because the fishermen were active during these periods. The occurrence of emergence was also related to the tide level. When the tide is high, the turtles can conserve energy by swimming towards the sand rather than crawling. Substantial amounts of energy are needed for turtles to negotiate obstacles, select a nesting place, dig an egg chamber, lay the eggs and finally cover them with sand again.

Telok Kampi is one of the most undisturbed and natural beaches on Pulau Pinang. With wide stands of rapidly growing merambong trees, remoteness from human activity, low beach height and long shores, it provides perfect turtle habitat. Kikukawa *et al.* (1999) demonstrated the positive effects on nesting turtles of distance from the nearest human settlement. The present analysis appears to confirm that nesting females prefer to emerge on beaches distant from human activities.

Conservation Efforts and Improved Management

Few nests were relocated during 1995–2000 due to a lack of coverage because the available manpower was insufficient for full monitoring. The Pantai Kerachut Turtle Conservation Centre still lacked facilities, staff and legal jurisdiction, so it was unable to monitor or control human activities in the area.

Beginning in 2001, manpower and resources increased. As a result, more nests were located. The numbers of staff members were sufficient to monitor some beaches for 365 days a year and to conduct regular interviews and receive regular information from residents at other beaches. Adults were tagged, enabling the movements of individual turtles to be monitored with more accuracy. Finally, improved enforcement by patrols helped protect and conserve nesting habitat and limit human activities at nesting beaches at night.

The hatchery at Pantai Kerachut is the only hatchery in Pulau Pinang. Its purpose is to incubate turtle eggs found in the Pulau Pinang area and to produce hatchlings to be released into the sea. Pantai Kerachut was selected as the location for the hatchery because it provides optimal temperatures relative to the pivotal temperature and can therefore produce a high percentage of hatchlings (Department of Fisheries, Pulau Pinang, unpublished data).

ACKNOWLEDGEMENT

Special thanks to the Director, En. Awangku Isa, Assistant Director, Puan Aishah, and staff of the Department of Fisheries, Pulau Pinang for the use of equipment and sharing of knowledge and information. Thanks to Penang National Park for their additional support. This research was financially supported by Universiti Sains Malaysia's (USM) Graduate Grant Scheme. Logistical support was furnished by the Department of Fisheries, Pulau Pinang. The first author was supported by a Graduate Assistantship from USM.

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