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A report on the first 16 years of a long-term marine turtle conservation project in Malaysia

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ABSTRACT

This paper highlights basic data collected over the first 16 years of a long-term marine turtle conservation project in the Chagar Hutang Turtle Sanctuary (5° 48.778' N and 103° 0.502' E) in Malaysia. Green turtles accounted for 98.2% (6947 clutches) of the total nesting observed while hawksbills accounted for the rest (126 clutches). Over 80 % of the clutches deposited have been incubated in-situ, with the production of 387,322 and 8094 live green turtle and hawksbill hatchlings respectively. The 16-year average hatching and emergence success for green turtles and hawksbills were 81 and 78.5%; and 63.6 and 59.6% respectively. A total of 928 green turtles and 17 hawksbills were tagged. Annual average curved carapace length and width of green turtles ranged from 98.9-100.9 and 87.1-89 cm. In hawksbill turtles, these values ranged from 78.8-87.5 and 68.9-74.2 cm. A total of USD345,650 had been raised through public outreach projects over the last 11 years of the 16 year period. It is concluded that marine turtle conservation projects can be self-sustaining and that long-term egg protection is effective in rehabilitating marine turtle populations in decline.

Key words: green turtles, hawksbills, nesting, hatchlings, tagging.

INTRODUCTION

In 1993, the author co-founded a long-term marine turtle conservation project in Chagar Hutang Beach, Redang Island, Terengganu, under the branch campus of University Putra Malaysia, later renamed University Malaysia Terengganu. This project, that was conducted under the Sea Turtle Research Unit (SEATRU) of the university, has been quite well documented (Chan, 2010a; 2010b; 2005, Chan and Liew, 2002; 1999a; 1999b). It started as a fully-funded project that executed *in-situ* egg incubation and a saturation tagging program to monitor nesting activities of green and hawksbill turtles, the two species found to nest in the locality.

When the project lost its corporate sponsor in 1998 due to the Asian economic crisis, fund-raising activities were implemented. This component, given the acronym "STOP" (Save our Turtles Outreach Program) introduced turtle and nest adoption schemes as well as a volunteer program to the general public. These were novel ideas in Malaysia at that time and became very popular. The nest adoption scheme was particularly relevant as eggs had to be purchased from licensed egg collectors for incubation before the beach was accorded sanctuary status in 2005. It then became known as the Chagar Hutang Turtle Sanctuary. When the author retired from the university in 2009, she had managed the project for 16 years. Continuity in this important conservation project was assured when a former student of the latter was appointed to replace her. This report provides a summary of the nesting density, number of egg clutches and eggs incubated, number of hatchlings produced, hatching and emergence success, and number of turtles tagged per year versus number of tag returns for both green and hawksbill turtles for the period 1993-2008. Average sizes of the turtles are also highlighted.

Data on number of volunteers who have participated in the program, and nests and turtles adopted are also provided. The gross revenue generated through STOP from 1998-2008 to support the research and conservation work conducted is highlighted to demonstrate how a marine turtle conservation program can be self-sustaining through innovative programs.

MATERIALS AND METHODS

The Chagar Hutang Turtle Sanctuary

The sanctuary (5° 48.778' N and 103° 0.502' E) is located in the northernmost part of Redang Island. This island (5° 44' – 5° 50' N and 102° 59' – 103° 5' E) is situated in the South China Sea, off the east coast of Peninsular Malaysia (Figure 1, Plate 1). It has a land area of about 25 square km and is about 45 km north northeast of Kuala Terengganu.

The sanctuary has a length of 350 m and is backed by virgin forest, with rocky promontories at its extreme western and eastern ends creating a secluded bay in front of the beach (Figure 1). A stream occurs at each end of the beach and flows into the sea only after heavy rainfall (Chan, 2010a).

Monitoring of Nesting Activity

Beach patrols have been conducted every night in Chagur Hutang since 1993 by project staff assisted by a team of volunteers. Prior to 1998, volunteers consisted

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of university students. With the implementation of STOP in 1998, volunteers were drawn from the general public. The nightly patrols were conducted hourly starting from 2000 hours and lasted till 0600 hours the following morning. The monitoring period commenced in June and was terminated in September in 1993, but the duration was progressively prolonged over the years till 2008 when monitoring was carried out from January until December (Table 1).

Turtles that were encountered were allowed to nest undisturbed until egg deposition was completed. Nests were marked in their original locations by labeled wooden stakes and covered with a 1.5 x 1.5 m square netlon mesh to afford some protection from monitor lizards (Plates 2 and 3). Hourly day patrols were carried out by volunteers to keep monitor lizards at bay and to check for signs of predation by ants or crabs. If a nest was found to have been infiltrated by ants, it was excavated and eggs that were still intact were relocated.

Data on number of clutches monitored and the number and proportion of clutches incubated under *in-situ* conditions are provided. Clutch data has also been presented in an earlier paper by the author (Chan, 2010a).

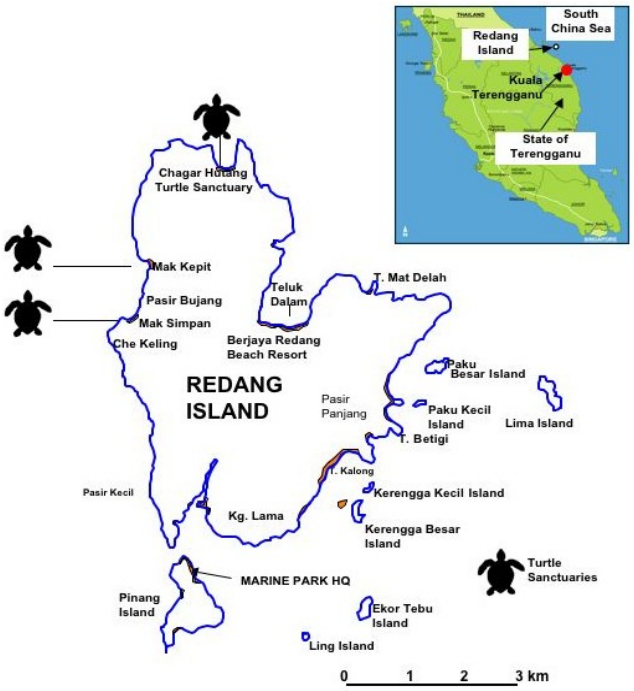

Figure 1. Map of Redang Island showing the location of turtle sanctuaries in the northern and north-western part of the island. Most of the resorts are located on the eastern part of the island. This map is extracted from Chan, 2010a.

Determination of hatching success

All hatched nests were excavated several days after emergence to determine hatching success. Total number of hatched eggshells (X), unhatched eggs (Y) and pipped eggs with live hatchlings (Z), and dead and live hatchlings found were counted. Hatching success was calculated as follows:

Hatching success = (X + Z) / (X + Y + Z)

The number of eggs found in each nest (X + Y + Z), representing the eggs that were incubated, was totaled for each year and plotted as line charts. A grand total was obtained for the 16 year period.

Dead hatchlings in the nest were attributed mostly to invasion by predacious native red ants. From this, the number of live hatchlings from each nest that successfully made it to the ocean is estimated as follows:

No. of live hatchlings = No. of empty eggshells – Number of dead hatchlings in the nest.

The total number of life hatchlings produced each year was plotted as line charts as well and a grand total for the 16 year period obtained.

Tagging of turtles

Titanium tags were used initially but later replaced with inconel tags as they were cheaper and easier to procure. All turtles were tagged on the trailing edge of both front flippers at one of the three large scales closest to the body of the turtle. Each turtle was examined for presence of tags immediately after completion of egg deposition. Tag numbers were read and recorded. If old tags were found to be loose, they were replaced with new tags and the new numbers recorded accordingly. If the turtle did not bear any old tags, it was tagged as described. The curved carapace length and width of the turtle was also measured using a tailor's measuring tape. This report will provide only a record of the number of newly tagged turtles and number of turtles bearing old tags (remigrants) for each year. Range in carapace length and width of the turtles and their averages are also provided. The detailed analysis of tagging data is being prepared for a separate publication.

Plate 1. A bird's-eye view of the Chagar Hutang Turtle Sanctuary.

STOP – Save our Turtles Outreach Program

Volunteers were charged a fee for participating in the program. Students paid RM300 while the general public paid RM450 for a one-week stay on the nesting beach. This covered all meals and basic accommodations. Initially, only four volunteers were accepted per week, but was increased to eight persons later due to the popularity of the program. The ratio of student and non-student volunteer was about 1:1. Each nest adoption cost

USD60 while a turtle adoption cost USD30. Number of volunteers, nests and turtles adopted were recorded each year, and annual gross revenue estimated.

RESULTS AND DISCUSSION

Nesting activity

Green turtles are by far the major species nesting in the Chagar Hutang Turtle Sanctuary, accounting for 98.2% of the clutches deposited from 1993-2008. Hawksbill turtles are comparatively rare, contributing only 1.8% of the nesting observed over the 16 year period.

Plate 2. Freshly-laid green turtle eggs.

The total number of green turtle clutches recorded per year fluctuated from a low of 221 in 2005 to a high of 687 in 1999. (Table 1, Figure 2). Inter-annual variation is evident, with years exhibiting high densities separated by an interval of one to four years. In other green turtle nesting population, biennial fluctuations have been reported (Weishampel *et al*., 2003). Chan (2010a) did a trend analysis on this population and suggested a decline in the first ten years, followed by an inflexion point in 2003 when a gradual incline in the curve was observed. A total of 6947 green turtle clutches were deposited and recorded over the 16 year period.

The hawksbill nesting population in the Chagar Hutang Turtle Sanctuary appears to be a remnant population, with clutches deposited ranging from 0 in 2003 to 21 in 1996, the highest recorded in the 16 year period (Table 1, Figure 3). The trend analysis in Chan (2010a) indicated a sharp decline from 1993 – 2001, but from 2004 onwards, a steady increase was noted. A total of 126 clutches were deposited over the 16 year period.

Egg incubation, hatchlings produced and success rates

The project has been able to commit an overall high percentage of the clutches for incubation, at 80% for both green and hawksbill turtles combined for the 16 year period. In the initial four years (1993-1996), the project was given a quota by its sponsor for egg purchase, accounting for the relatively lower level of protection. Additionally, before the nesting beach was actually accorded sanctuary status, it was not possible to procure 100% egg purchase from the licensed egg collectors. Level of egg protection for green turtles rose to 100 % from 2005 onwards when the beach was declared a turtle sanctuary, ending decades of egg exploitation. As for hawksbill turtles, the project strove for 100% incubation from 1998 onwards due to its rarity (Table 1). In summary, 5561 and 106 green and hawksbill clutches have been protected and incubated respectively over the 16 year period. (Figures: 2 and 3).
The total number of eggs protected, hatchlings produced and hatching and emergence success for green and hawksbill turtles from 1993-2008 are shown in Figure 4 to 7. A total of 493,290 green turtle eggs have been from 1993-2008, with 387,322 hatchlings successfully re-

Plate 3. In-situ turtle nests undergoing incubation. The netlon mesh provide some protection from monitor lizards.

turned to the ocean to replenish the population (Figure 4). The overall average emergence success was thus 78.5% while the actual overall average hatching success was 81%. The ranges in values are shown in Figure 5. Leh (1994) reported hatch success of 71.8% in the Sarawak Turtle Islands of Malaysia.

In the case of hawksbill turtles, 13,586 eggs have been incubated from 1993-2008 with the production of 8094 hatchlings that made it back to the ocean (Figure6) Overall emergence success was much lower, compared to green turtles, at 59.6% while average hatching success was 63.6%. Figure 7 shows the range in values. Hawksbill eggs were more prone to depredation by monitor lizards as the nests of hawksbill turtles are shallow and more easily dug up. There were no hatchlings produced in 2003 as no hawksbills nested that year. As a comparison, Hitchins *et al* (2004) reported an average hatching success of 64.3% over four seasons in Cousine Island, Seychelles.

Saturation tagging

The number of new turtles tagged in each year, and number of turtles bearing old tags are given in Figures 8 and 9. Every turtle that landed to nest was monitored and tagged. Over the 16 year period, a total of 928 individuals of green turtles and 17 hawksbill turtles were tagged.

The number of green turtles that landed to nest each year ranged from 44 in 2005 to 140 in 1993 with an

Table 1. Data on the monitoring period, percentage of egg clutches incubated, newly tagged turtles and turtles with old tags (remigrants), and average curved carapace length (CCL) and width (CCW) of green and hawksbill turtles that nested in the Chagar Hutang Turtle Sanctuary from 1993-2008. These data are not presented in the Figures.

Year	Monitoring Period	Green Turtles					Hawksbill Turtles				
		% Clutches Incubated	% Newly Tagged Turtles	% Turtles with Old Tags	Avg. CCL (cm)	Avg. CCW (cm)	% Clutches Incubated	% Newly Tagged Turtles	% Turtles with Old Tags	Avg. CCL (cm)	Avg. CCW (cm)
1993	Jun – Sept	47	100	0	98.9	87.4	17	100	0	82.4	73.2
1994	May – Oct	66	100	0	100.1	87.7	57	100	0	84.1	71.6
1995	May – Oct	65	97	3	99.6	88.4	25	0	100	87.5	75.8
1996	May – Oct	54	67	33	100.4	89.0	86	33	67	81.7	71.9
1997	May – Oct	79	74	26	99.4	88.4	83	100	0	84.9	73.8
1998	Apr - Oct	88	64	36	100.2	88.3	100	67	33	80.0	68.9
1999	Apr - Oct	77	58	42	100.2	88.6	100	0	100	82.6	72.9
2000	Apr - Oct	77	54	46	100.6	88.7	100	100	0	79.8	71.1
2001	Apr - Oct	95	58	42	100.4	88.6	100	50	50	81.3	74.0
2002	Apr - Oct	99	49	51	100.7	88.4	100	0	100	85.0	71.2
2003	Apr - Oct	72	45	55	100.4	88.0	100	0	0	-	-
2004	Apr - Oct	91	58	42	100.0	87.1	100	0	0	79.5	71.4
2005	Apr - Oct	100	45	55	101.4	89.6	100	50	50	81.9	71.1
2006	Mar - Oct	100	55	45	100.2	87.9	100	50	50	79.9	73.9
2007	Mar - Oct	100	58	42	100.9	88.6	100	50	50	82.6	69.4
2008	Jan - Dec	100	65	35	100.9	87.1	100	33	67	78.8	74.2
	Average		68	32	100.3	88.2		53	47	82.1	72.3

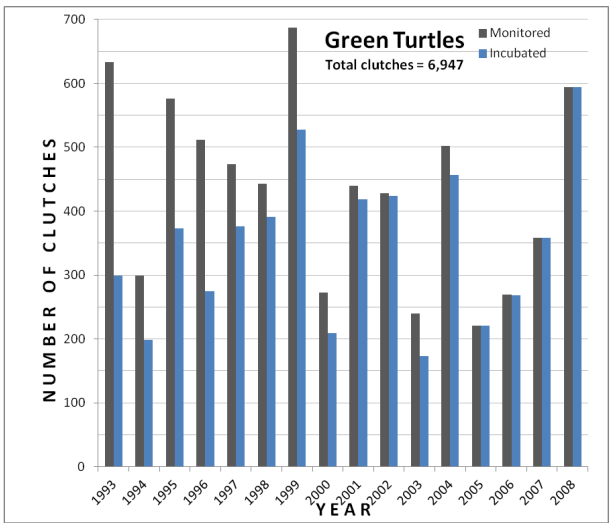

Figure 2. Number of green turtle clutches monitored and incubated in the Chagar Hutang Turtle Sanctuary from 1993 – 2008.

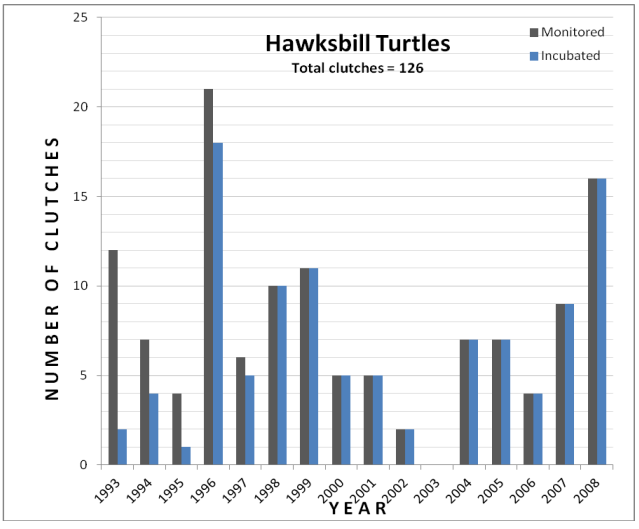

Figure 3. Number of hawksbill turtle clutches monitored and incubated in the Chagar Hutang Turtle Sanctuary from 1993 – 2008.

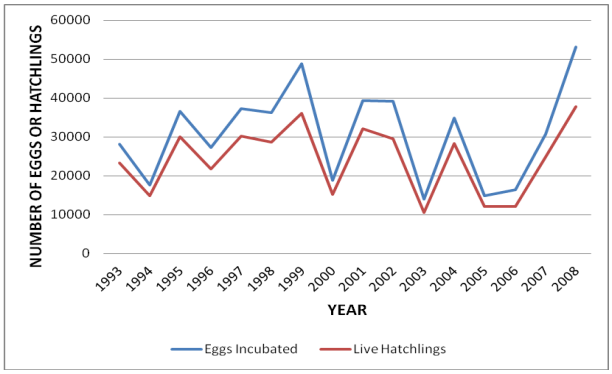

Figure 4. Number of green turtle eggs incubated and hatchlings produced in the Chagar Hutang Turtle Sanctuary from 1993 – 2008. A total of 493,290 green turtle eggs incubated from 1993-2008, while total number of live hatchlings produced was 387,322 .

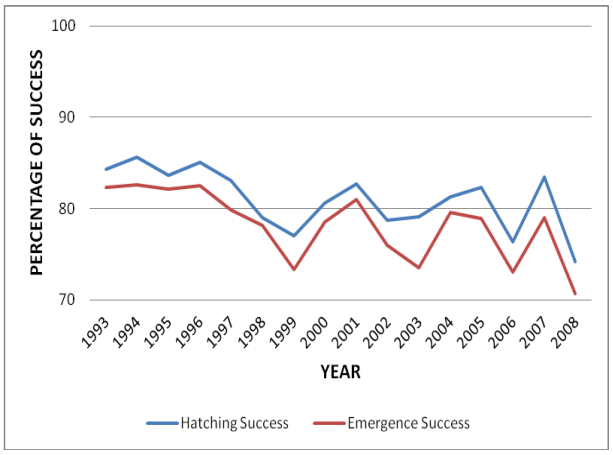

Figure 5. Hatching and emergence success of green turtle eggs in the Chagar Hutang Turtle Sanctuary from 1993 – 2008.

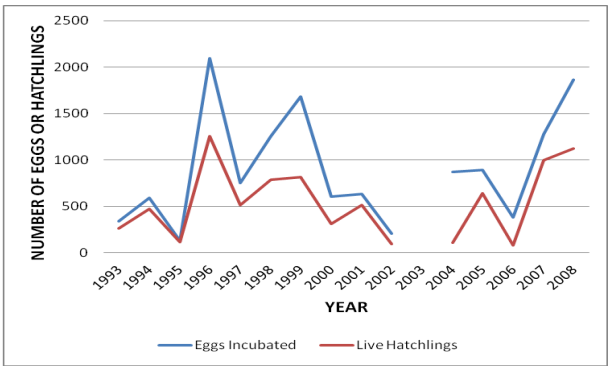

Figure 6. Number of hawksbill turtle eggs incubated and hatchlings produced in the Chagar Hutang Turtle Sanctuary from 1993 – 2008. No hawksbill nesting occurred in 2003. A total of 493,290 hawksbill turtle eggs incubated from 1993-2008, while total number of live hatchlings produced was 387,322.

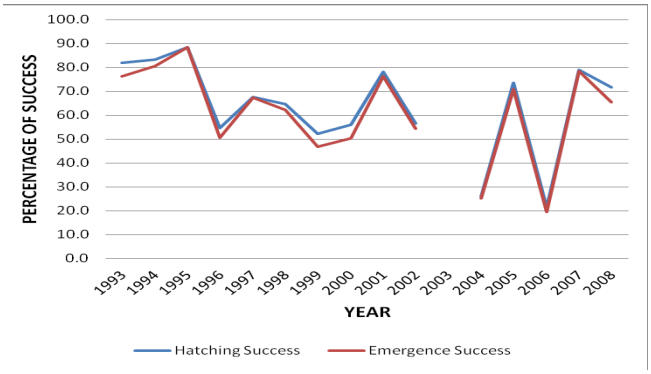

Figure 7. Hatching and emergence success of hawksbill turtle eggs in the Chagar Hutang Turtle Sanctuary from 1993 – 2008. No hawksbill nesting occurred in 2003.

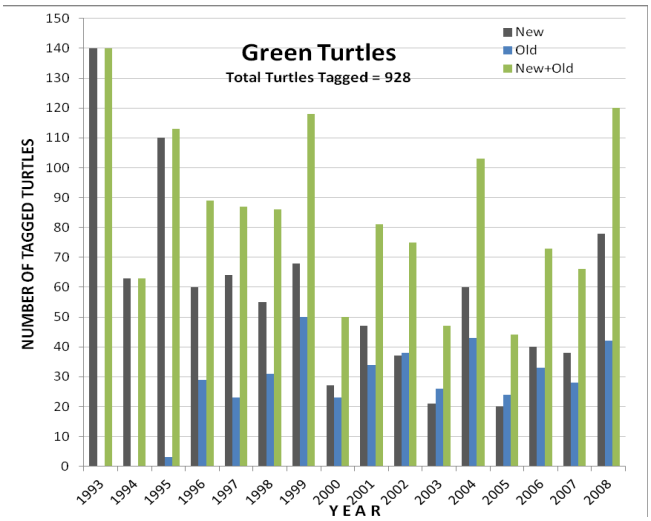

Figure 8. Number of green turtles newly tagged, bearing old tags and total number monitored (newly tagged turtles + turtles bearing old tags) recorded in the Chagar Hutang Turtle Sanctuary from 1993-2008.

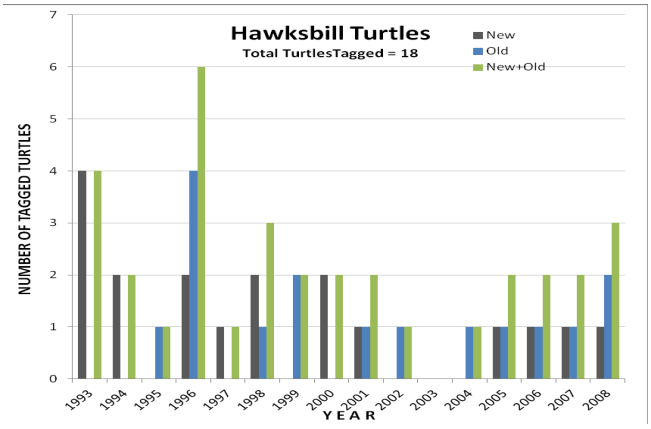

Figure 9. Number of hawksbill turtles newly tagged, bearing old tags and total number monitored (newly tagged turtles + turtles bearing old tags) recorded in the Chagar Hutang Turtle Sanctuary from 1993-2008.

average of 85 turtles per year over the 16 year period (Figure 8). Proportion of newly tagged turtles exceeded remigrants (turtles bearing old tags) in most years. The first appearance of remigrants occurred in 1995, i.e. two years after the initiation of the tagging program. Only three of the 113 turtles that nested bore old tags first applied in 1993. Over the 16 year period, remigrants accounted for an average of 32% of the turtles that nested

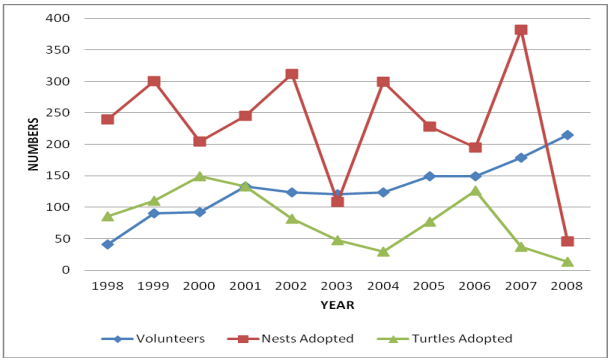

Figure 10. Total number of volunteers, nests and turtles adopted in STOP (Sea Turtle Outreach Program) from 1998-2008.

Table 2. Number of volunteers who participated in the program, number of nests and turtles adopted per year since the inception of STOP (Sea Turtle Outreach Program) and total gross revenue generated.

Year	No. of Volunteers	No. of Nests Adopted	No. of Turtles Adopted
1998	41	240	86
1999	90	300	110
2000	92	204	149
2001	133	245	133
2002	124	312	82
2003	121	108	48
2004	124	299	30
2005	149	228	77
2006	149	195	126
2007	179	382	37
2008	215	46	13
Total	**1417**	**2559**	**891**
Total Gross Revenue Generated	USD162,200	USD156,200	USD27,200

while neonates or newly tagged turtles accounted for 68%.

The number of hawksbill turtles that nested in the sanctuary per year ranged from 0 in 2003 to 6 in 1996 with an average of two turtles per year. This small population exhibited a higher remigration rate, compared to the green turtles (Figure 9).

Size of the turtles

The average curved carapace length (CCL) and width (CCW) of both green and hawksbill turtles recorded from 1993-2008 are shown in Table 1. Average annual CCL and CCW for green turtles ranged from 98.9– 100. 9 cm and 87.1 – 89 cm respectively. The average for the 16 year period was 100.3 cm for CCL and 88.2 cm for the CCW. In Hirth (1997), average CCL from different oceans ranged from 81 to 123 cm.

In hawksbills, annual averages in CCL and CCW ranged from 78.8 - 87.5 and 68.9 - 74.2 cm respectively. The overall average for the 16 year period was 82.1 cm in CCL and 72.3 cm in CCW (Table 1). Witzell (1983) documented average CCL for hawksbills from the Atlantic, Pacific and Indian Oceans that ranged from 66.0 – 90.7 cm.

STOP –Save our Turtles Outreach Program

Number of volunteers who participated in the program, number of nests and turtles adopted are shown in Figure 10 and Table 2. The volunteer program was very popular and over-subscribed since its inception. An increasing trend is observed as the number of volunteers accepted was increased from four to eight. Additionally, the monitoring period was also increased as the years went by.

Number of nests and turtles adopted fluctuated and good years were those when corporate agencies made adoptions. Although nest adoptions were more expensive than turtle adoptions (USD60 per nest adoption compared to USD30 per turtle adoption), more nests than turtles were adopted. As shown in Table 2, the gross revenue generated from 1998-2008 from the volunteer program and nest adoptions were quite similar. A total of USD345,650 was raised from STOP in the 11 years that the author served as its project leader and manager. The average of USD31,420 raised per year was sufficient to execute the conservation program. Research aspects were covered by grants from government agencies and collaboration with foreign scientists. Before the Asian economic crisis, corporate sponsorship of USD30,570 per year enabled its execution.

CONCLUDING REMARKS

1. The long-term saturation tagging program in the Chagar Hutang Turtle Sanctuary has become one of the most long-standing and sustained marine turtle tagging projects in Malaysia.
2. Long-term egg protection is effective in rehabilitating marine turtle populations in decline.
3. Innovative public outreach programs can serve to educate the public as well as raise funds for marine turtle conservation work.
4. It is possible to carry out self-sustaining marine turtle conservation programs.

ACKNOWLEDGMENT

The author would like to acknowledge her former employers, University Putra Malaysia and University Malaysia Terengganu under which she was able to co-found the long-term marine turtle conservation project and managed it till her retirement in 2009. Mr. Liew Hock Chark is also acknowledged for co-founding and co-managing the project with her till 2003. The data collected would not have been possible without the help of project staff recruited from the local village and research

assistants employed to conduct the nightly beach patrols with the hundreds of volunteers who have participated in the program. The deepest appreciation and thanks are accorded to the project's major sponsors, Berjaya Corporation Berhad and UDA Holdings Berhad, the Terengganu State Government and the many participants of STOP. Finally, thanks to Chen Pelf Nyok who edited the initial draft of this paper.

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