2018 ANNUAL REPORT

Pulau Lang Tengah

SUMMARY

60	Volunteers hosted
3	Interns
15	Research assistants
665.5	kg waste removed from beaches and recycled
41	Total sea turtle nests
4,851	Eggs incubated
9	Nesting mothers
76.17	Hatching success (%)

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ACKNOWLEDGEMENTS

Lang Tengah Turtle Watch team would like to express their deepest gratitude to the Department of Fisheries and Summer Bay Resort for their help, guidance and trust into the organisation and its conservation efforts on Pulau Lang Tengah. The support provided by every party is crucial for the successful conduct of the operation of our projects. In addition, Lang Tengah Turtle Watch would also like to thank all the research assistants and volunteers for their help in all aspects of marine conservation, patrolling the nesting beaches on a daily basis as well as collecting nesting and landing data.

OVERVIEW

The Project in General

Lang Tengah Turtle Watch (LTTW)'s mode of operation has been heavily focused on paid volunteer ecotourism since its inception in 2014. Volunteers taking part in the turtle conservation project primarily help by patrolling the nesting beaches to deter poaching and predation, assist in nest relocation and collecting sea turtle landing data as well as carrying out nest check and post-hatch inspection (PHI) on all nest laid in Pulau Lang Tengah. LTTW also continued to hold outreach programs with local schools as well as beach clean-ups on the island. This season, LTTW also initiated a new project to gather baseline data of Lang Tengah's beach profile.

Interns and Research Assistants

Interns were unpaid volunteers who stay on camp for ten weeks and have their in-country travels and accommodation as well as food within the camp covered. During each monitoring period, an intern was recruited to assist with volunteer management as well as to partake in all monitoring project.

Research assistants were unpaid volunteers, similar to interns, but pay for all their travel expenses on their own. A total of 15 research assistants from seven countries (Malaysia, England, France, Australia, Canada, America and South Africa) were recruited in groups of five for each research period to assist with the new monitoring projects for eight weeks.

Interns and research assistants recruited must fulfill the minimum criteria set by the field project managers in charge of the research projects. Upon arrival on Pulau Lang Tengah, they underwent training on research methodology for 3–4 weeks before being allowed to carry out surveys around Pulau Lang Tengah and collect data required by the field project managers.

Interns:
Holly Baigent (25 February–29 April)
Jonathan Fry (28 June–7 August)
Gilles Bernard (12 August–20 October)

Research Assistants:
Gilles Bernard
Sarah Drescher
Lim Aik Hean
Tara Goodbody
Martin Cloix
Alexandra Kellam
Katie Shepard
Justin Kelly
Joanne Kelly
Denny Lee Townsend
Alexander Fish
April Dowie
Jordan Gledhill
Lou Hoskin
Sinead McMahon

Volunteers

A total of 60 volunteers – 30 internationals and 30 locals, participated in the volunteer program that ran from 4 March to 20 October 2018. With an increased number of interns and research assistants, there were less participants in the volunteer program compared to previous years as the project could only accommodate three volunteers for a fortnight during each monitoring period. The minimum stay has also been prolonged to 14 days compared to previous years.

With a longer staying period, the volunteers were able to actively aid on the conservation efforts carried out on the island. More education and research opportunities were provided to the volunteers as they aided with ongoing and new research projects. The volunteers were also provided with more education on marine conservation with new presentations made to raise awareness on pressing environmental issues such as plastic pollution.

ONGOING PROJECTS

Sea Turtle Monitoring

The sea turtle monitoring project is continued to keep track of the nesting sea turtle population as well as the hatching and emergence success rate of all nests laid on Pulau Lang Tengah. LTTW staff, interns, research assistants and volunteers were involved in patrolling the nesting beaches, nest checks and PHI. In 2018, a new nest monitoring protocol was introduced to study the impact of nest check and relocation on hatching success rate and to determine the risk of predation from leaving empty egg shells on turtle nesting beach. Nests laid were categorised into the four categories – (i) in-situ, protected, inspected; (ii) in-situ, non-protected, non-inspected; (iii) relocated, protected, inspected and (iv) relocated, non-protected, non-inspected. Nests with odd number fall under category (ii) and (iv) and were left undisturbed with no form of protection until the hatchlings emerge. Even numbered nests fall under category (i) and (iii) and were protected from predation with a mesh netting and checked starting from day 45 of incubation and then every five days until hatchlings were found in the nest. If the inspected nest had serious fungal infection or predation by crab, the frequency of nest check was increased to every three days until hatchlings were found. All nests were excavated and inspected three days after the hatchlings emerge. The nest content was recorded and the success rate was calculated.

Community Outreach

Beach clean-ups were conducted with volunteers and occasionally with resort guests on a weekly to biweekly basis to keep the nesting beaches clean. Recycling trips were organised in May and August to collect and send recyclable items from the island resorts and camp to be recycled at a local recycling centre on the mainland. This season, 665.5 kg of recyclable waste was removed from Pulau Lang Tengah and sent to RD Papers, a recycling centre at Gong Badak, Terengganu for processing. Money earned from the recycling effort was given back to individuals that collected the recyclable items.

Three school visits were organised during the community outreach period – May and August. Forty students from SBPI Bukit Rakit and 20 students from International School of Kuala Lumpur participated in our school visit which ran from 9 a.m. to 5 p.m. The students started their day with a beach clean-up, removing waste from Lang Sari, one of the turtle nesting beaches on Pulau Lang Tengah. A series of interactive presentations on sea turtle ecology and marine pollution were carried out with the students after the beach clean-up. The students then got involved in a game and quiz session or a poster making session. To end their day on the island, students are given a guided nature walk and a certificate of participation, together with treats and amenities. The itinerary of the school visits is as shown below.

0800 School group head to Pulau Lang Tengah from Merang Waterfront jetty
0845 Students arrive at Turtle Bay, Pulau Lang Tengah
Introduction to LTTW team
Beach clean-up briefing and hand out of gloves and recycling sacks
0900 Beach clean-up at Lang Sari
1005 Head back to Turtle Bay
1030 Camp Tour
1100 Turtle and marine pollution talk
1200 Lunch and prayer session
1330 Games/Poster design session
1500 Guided nature walk to Batu Kuching
1600 Price and certificate presentation; Photography session
1630 School group head back to Merang Waterfront Jetty

NEW PROJECT

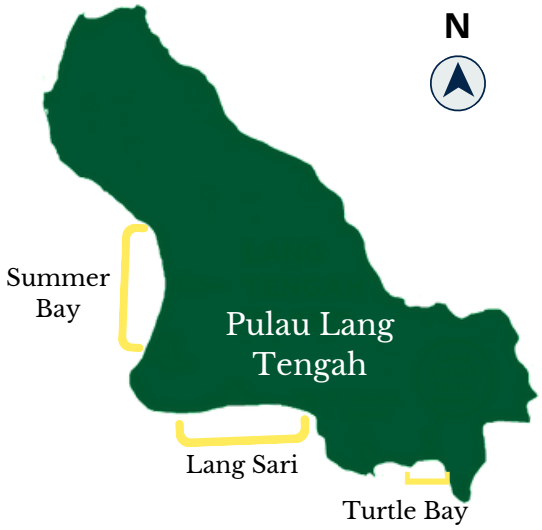
Beach Profiling

For the first time since the project started, both nesting beaches on Pulau Lang Tengah were profiled to record the changes in the contour of the beach. Turtle Bay was profiled on 21 July 2018 while Lang Sari was profiled on 22 July 2018. Both beaches were profiled within two hours of the low tide period. Beach profiling was conducted along profile transects that run from the vegetation line to the tide line. Measurements of the gradient were taken at every 2 m along the profile transect. Turtle Bay has 15 profile transects that are 5 m apart while Lang Sari has 19 profile transects that are 20 m apart. The coordinate of each transect point was also recorded to ensure that measurements will be made at the same spot every season to track beach erosion and accretion.

METHODOLOGY

Study Area

Pulau Lang Tengah lies approximately 20 km off the coast of Terengganu in Peninsular Malaysia. Like many of the neighbouring islands and much of the mainland of Terengganu, Pulau Lang Tengah is an important sea turtle nesting site for the endangered green turtle (*Chelonia mydas*) and the critically endangered hawksbill turtle (*Eretmochelys imbricata*; International Union for Conservation of Nature [IUCN], 2015).



Pulau Lang Tengah has three sandy beaches: Turtle Bay, Lang Sari and Summer Bay. They cover a distance of coastline measuring 80 m, 400 m and 500 m. All three beaches are located on the southern side of the island. Both Land Sari and Turtle Bay face the south while Summer Bay is west-facing. The northern coast of Pulau Lang Tengah is composed of granite rocks which is unsuitable nesting habitat for sea turtles. All three beaches provide ecologically suitable nesting habitat for sea turtles, with reports of landings occurring on all of them. However, Summer Bay is subjected to high levels of disturbance from light and noise pollution due its heavy commercial development. Light and noise pollution are major deterrents to nesting individuals, and thus, Turtle Bay and Lang Sari are considered to be the principal nesting beaches on Pulau Lang Tengah.

Patrolling

Patrols were conducted on an hourly basis at Turtle Bay and Lang Sari, from 9 p.m. to 6 a.m. daily, with staff, interns, research assistants and volunteers split into groups of two people. The average nesting time for a green turtle is 1–1.5 hours for a hawksbill turtle. Patrolling once an hour ensures that no nesting female is missed and that disturbance on the nesting beach is minimal. Summer Bay was patrolled in September when reports of turtle nesting were received.

Relocation

Turtle nests were allowed to incubate at their original location if there is any reasonable likelihood of survival. Relocation were considered as a last resort in terms of nest management. Nests were only moved when one or more of the following situations exist:

- The nest was laid on beaches such as Lang Sari and Summer Bay which were prone to poaching activities.
- The nest was laid below the high tide line where regular inundation would result in embryonic mortality.
- The nest was laid in an area known to be susceptible to termite infestation.
- The nest was laid in an area with lots of roots or coral rubbles which could inhibit hatchlings from safely emerging.

Relocations were conducted by staff and interns of LTTW. Volunteers were only allowed to help in data recording.

- The depth (from beach surface to bottom of egg chamber) and width of egg chamber (at the top of the egg chamber, approximately 10 cm below the hind flipper of the nesting turtle) were measured twice and the average reading was used for the construction of the new egg chamber. The measurements were taken as the turtle was laying the eggs.
- The relocated nest was placed in an egg chamber of similar depth and width as well as similar shading condition as the original nest.
- The depth from beach surface to top of first egg in the chamber was measured twice and recorded for the new egg chamber.

Turtle Identification

Inconel Flipper Tag

When the turtle started to cover the egg chamber, the front flippers of the turtle were checked for existing Inconel flipper tag. The flipper tags are usually secured between the second and third scale or third and fourth scale away from the body of the turtle, on the trailing edge of the flipper (Figure 1).

If tags were not present on either side of the turtle's flipper, new tags were placed by trained LTTW staff. A method known as 'double-tagging' was employed, whereby a tag was placed on both front flippers. This is to ensure the greatest chance of the turtle retaining at least one of its identity tags over the course of its migration period. If one of the tags is missing upon an individual's return to the nesting beach, then another tag is inserted and the identity form for that individual is updated.

Figure 1. A flipper tag placed between the second and third scales (Eckert & Beggs, 2006).

Photographic Identification (Photo-ID)

Sea turtles can be identified based on their unique facial scale patterns. LTTW started to photograph every nesting turtle on Pulau Lang Tengah since 2015 to ensure that the nesting turtles can be identified even if they lose both their flipper tags in the near future.

Once the nesting turtle is tagged, the facial profile of the nesting turtle was cleared of sand as much as possible and then photographed either using a DSLR camera or handphone (Figure 2). The photograph is then edited prior to being analysed using Interactive Individual Identification System (I3S) Pattern, a photo-identification software that uses natural markings to identify individuals.

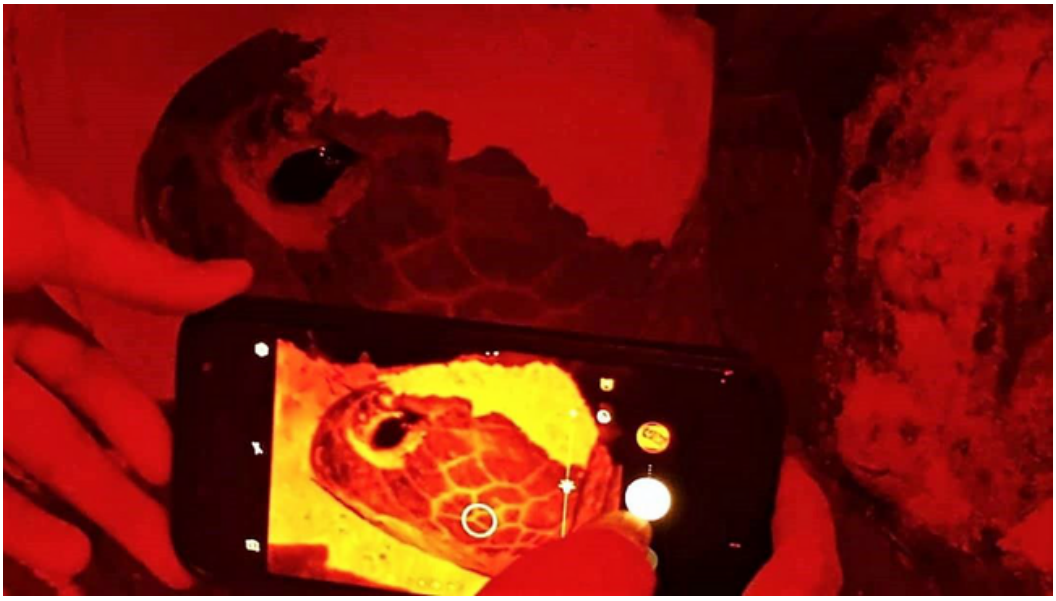


Figure 2. Nesting turtle being photographed under red light after sand was cleared from its face.

In the event that the turtle had no tag and tagging effort was unsuccessful, the individual turtle was identified based on their facial scale patterns using the software (Carpentier et al., 2016; Dunbar et al., 2014). High resolution photographs that clearly depict the facial scale patterns of the turtle were inputted into the local database and shared with the Malaysia Sea Turtle Photo-ID Network database to check for any matches between the islands at the east coast Malaysia and Philippines.

Biometric Data Collection

The curved carapace length (CCL) and curved carapace width (CCW) of the nesting turtle were only taken once the turtle started to cover the egg chamber. Measurements were taken using a flexible measuring tape to the nearest 0.1 cm. The biometric data were taken according to the guidelines set by Wyneken (2001).

Nest Monitoring

With the new nest monitoring protocol in place to study the impact of nest check on hatching success rate, half of the nest laid on Pulau Lang Tengah were left undisturbed with no protection from predation. Nests under the category (i) and (iii) were provided protection from crab and monitor lizard predation and were checked starting from day 45 of incubation.

Nest Protection

A mesh net was placed 5 cm from the beach surface, covered with sand. Within three days after hatchlings were found in inspected nest, the mesh net was removed at 1900 to allow hatchlings to safely emerge. The mesh net was placed back on top of the nest by 0630 the next morning to prevent predation by ghost crabs (*Ocypode ceratophthalmus*) and Asian water monitor (*Varanus salvator*). The protected nests were also inspected daily for any visible signs of predation.

Nest Check

Nests under the category (i) and (iii) were checked starting from day 45 of incubation, and subsequently checked every five days until hatchlings were recorded within the nest. This time period allows for constant and thorough monitoring of the eggs, with as little human interference and chance of contamination as possible. If the inspected nest had serious fungal infection or predation by crab, monitor lizard or termite, the frequency of nest check was increased to every three days until hatchlings emerged.

Post-Hatch Inspection (PHI)

Post-hatch inspections were carried out three days after the hatchlings emerged to sea to determine the hatching and emergence success rate of every nest. If hatchlings did not emerge from the nest after 71 days of incubation, PHI was conducted on day 72 of incubation.

The nest contents excavated were categorised into the following categories.

- Empty egg shells
- Dead in nest: Dead hatchlings found in nest)
- Live in nest: Live hatchlings found in nest)
- Undeveloped: Uunhatched eggs with no obvious embryo)
- Unhatched
  - Stage 1: Egg that contains a blood spot
  - Stage 2: Egg that contains an embryo between 10–20 mm long with pigmented eyes
  - Stage 3: Eggs that contain an embryo larger than 20 mm,with pigmented eyes and carapace
- Unhatched term: Egg with full-term embryo in egg shell, with a small amount of external yolk sac
- Predation: Crab, termite, maggot, fungus, monitor lizard)

After PHI was carried out, the nest content was buried at the area the nest was originally laid at.

RESULTS

Nesting

The 2018 nesting season documented nine nesting turtles laying a total of 41 nests with 4,851 eggs on Summer Bay, Lang Sari and Turtle Bay. The amount of nesting was triple compared to the 2017 nesting season. Of the 41 nests laid, one hawksbill nest was only discovered after the hatchlings emerged and one green turtle was discovered on Summer Bay as the turtle headed back to sea. Thus, there were possibly two unidentified nesting turtles. Table 1 provides detailed information on the nine nesting turtles, of which six were green turtles and three were hawksbill turtles. Two nesting turtles were returnees. 14H001 (Cassiopeia) was first recorded nesting on Pulau Lang Tengah in March 2014 and has since returned every two years to nest. 15G005 (Sharnazz) was first seen nesting in July 2015 at Lang Sari and returned to nest again throughout June to September 2018. The remaining nesting turtles were identified and tagged for the first time. The number of nests laid by each mother varied from 1–9 nests laid during the course of the season. 15G005 (Sharnazz) laid the most nests, with nine nests containing 1,064 eggs laid throughout June to September followed by 18G001 (Sonny) with seven nests containing 1,027 eggs and 18G002 (Aluna) with seven nests containing 531 eggs. A total of five nests have yet to emerge at the moment of writing – two nests laid by 15G005 (Sharnazz), two nests laid by 18G006 (Olivia) and one nest laid by an unknown green turtle.

The number of nests and eggs laid per month as well as hatchlings emerged from the nests laid are shown in Table 2 as well as Figures 3 and 4. The month of June yielded the highest number of nests and eggs laid. The nests were dispersed almost equally on the two main nesting beaches – Turtle Bay and Lang Sari. Only one nest was laid at Summer Bay.

Table 1. List of nesting turtles and nesting details.

Species	Turtle ID	Name	Left tag	Right tag	Number of nests	Number of eggs	Hatching success (%)	Emergence success (%)
Green	15G005	Sharnazz	MYTGG1494	2526	9	1,064	94.39	90.76
Green	18G001	Sonny	2418	2527	7	1,027	89.36	88.24
Green	18G002	Aluna	2523	2519	7	531	42.67	41.52
Green	18G003	Monica	N/A	2518	4	522	52.52	51.61
Green	18G004	Megan Sapphire	2516	2522	3	324	92.21	90.39
Green	18G006	Olivia	2507	2506	2	256	N/A	N/A
Hawksbill	14H001	Cassiopeia	1876	1878	3	379	95.27	95.01
Hawksbill	18H001	Paola	N/A	N/A	1	64	92,19	90.63
Hawksbill	18H002	Oprah Winfrey	2520	2521	3	464	69.91	69.72

Updated in 2021: Using photo-ID methods, 18G001 (Sonny) and 18G004 (Megan Sapphire) were identified as returning mothers from 2015 with an ID 15G002 (Sue) and 15G004 (Stevie Nicks) respectively.

Table 2. Number of nests and eggs laid per month and hatchlings emerged from nests laid.

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Nest									
Green	3	3	5	8	6	4	4	0	33
Hawksbill	1	2	2	2	1	0	0	0	8
Total	**4**	**5**	**7**	**10**	**7**	**4**	**4**	**0**	**41**
Egg									
Green	488	379	549	826	680	457	458	0	3,797
Hawksbill	129	250	214	362	99	0	0	0	1,054
Total	**577**	**629**	**763**	**1,188**	**779**	**457**	**458**	**0**	**4,851**
Hatchling									
Green	387	293	329	588	510	319*	0**	0	2,426
Hawksbill	117	243	179	233	83	0	0	0	855
Total	**504**	**536**	**508**	**821**	**593**	**319**	**0**	**0**	**3,281**

* One nest yet to emerge.
** Four nests yet to emerge.

Figure 3. Number of nests laid per month throughout 2018 nesting season.

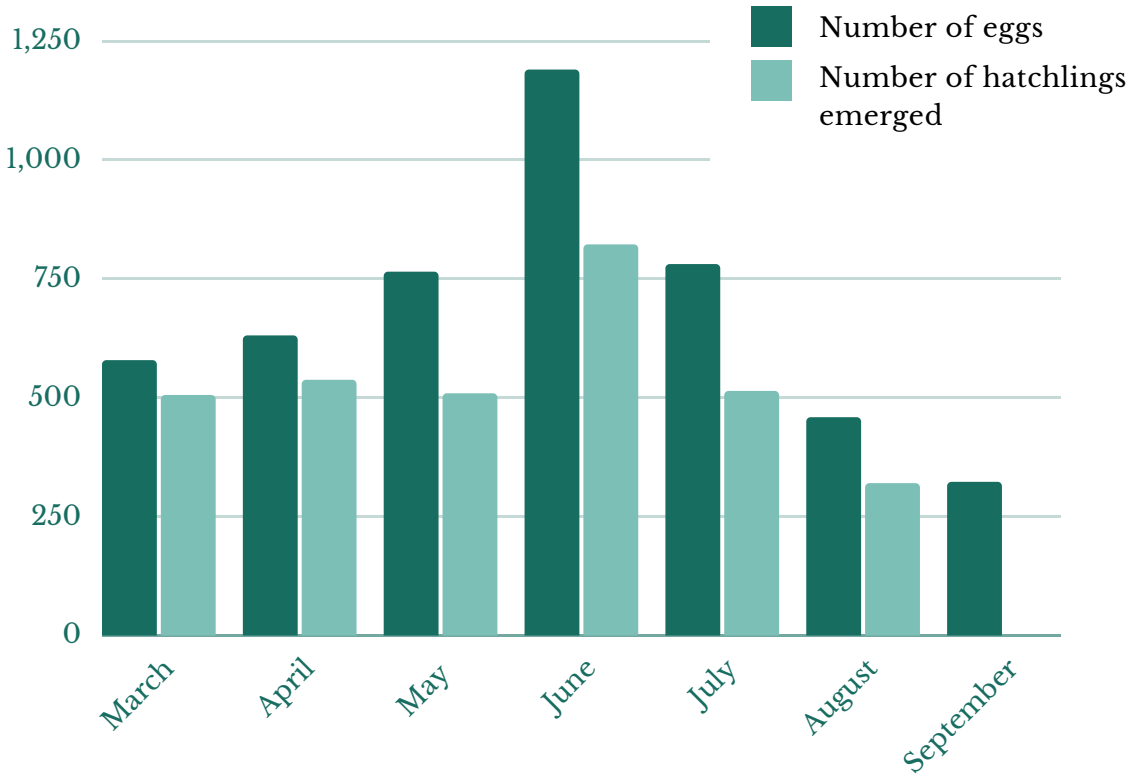


Figure 4. Number of eggs laid per month and hatchlings emerged from nests laid throughout the nesting season. Five nests have yet to emerge at the moment of writing – one from August and four from September.

Hatching & Emergence Success

At the moment of writing, hatching and emergence success rates were calculated for 36 of the 41 nests laid and are presented in Table 3. Out of 4,272 eggs that were laid, 28 eggs or egg shells (0.01%) were not found during PHI. Thus, the hatching and emergence success was calculated after deducting the number of eggs not found from the number of eggs laid. The success defined is based on Research and Management Techniques for the Conservation of Sea Turtles (Miller, 1999). Hatching success rate is defined as the percentage of turtles hatched out of the shell over the number of eggs laid. Emergence success rate is defined as the number of turtles emerged from the nest over number of eggs laid. The hatching and emergence success for 2018 are 76.17% and 74.97%, respectively.

The success between green and hawksbill turtle nests, checked and unchecked nest, as well as in-situ and relocated nest were also compared (Table 3 & Figure 5). Checked nests were nests in which nest checks were conducted while unchecked nests were left undisturbed until the hatchlings emerged. In-situ nest was characterised as nest laid at Turtle Bay or Lang Sari and was left to incubate at the original location until the hatchlings emerged. Relocated nest was characterised as nest laid on Turtle Bay or Lang Sari and was relocated as the nest was laid on areas full of roots or coral rubbles, prone to termite infestation or laid within 2 meters from the high tide line.

The hatching and emergence success of hawksbill turtle nests was 9.53% and 10.79% higher than green turtle nests. There is no significant difference between the hatching and emergence success of checked and unchecked nests. Relocated nests had a greater success with hatching success 23.61% higher and emergence success 22.32% higher compared to in-situ nests.

Table 3. Comparison of hatching and emergence success between nests differentiated according to three categories – species, nest check activity and location.

Analysed nests	Number of nests	Number of eggs	Hatching success (%)	Emergence success (%)
Total	**36**	**4,272**	**76.17**	**74.97**
Green turtle	28	3,218	74.05	72.64
Hawksbill turtle	8	1,054	83.58	83.13
Checked nest	17	1,995	74.36	73.15
Unchecked nest	19	2,277	77.79	76.60
In-situ nest	24	2,718	68.30	67.53
Relocated nest	12	1,554	91.91	89.85

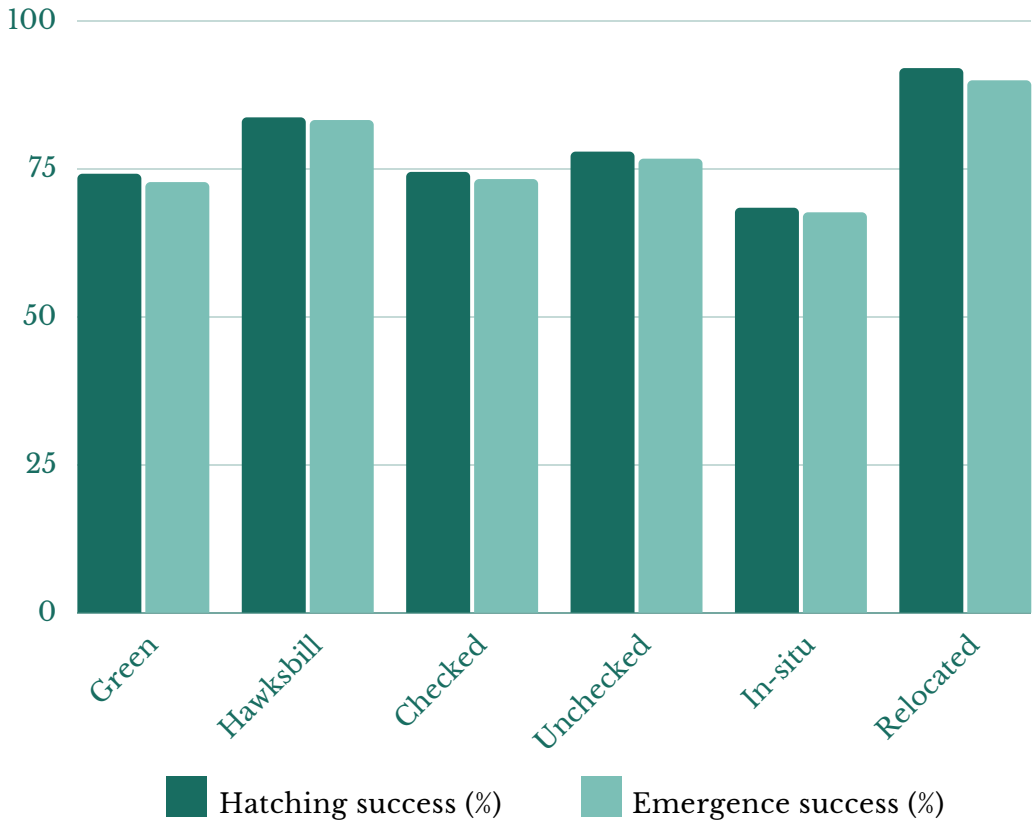


Figure 5. Comparison of hatching and emergence success of nest based on species, nest check activity and location of nest.

Unsuccessful Hatching & Emergence

During PHI, the nest content that was considered unsuccessful was divided into several categories - dead in nest, live in nest, undeveloped, unhatched (stage 1-3) as well as predation by crabs, termites, maggots, fungus and monitor lizard. Out of the 4,272 eggs laid, 28 eggs (0.01%) were missing and not considered for nest analysis. A total of 1,001 or 23.59% from the 4,244 analysed eggs and hatchlings was categorised as unsuccessful. Underdeveloped eggs (55.84%) accounted for most amount of unsuccessful eggs during the incubation process, followed by predation by crabs (14.69%). The results recorded are presented in Table 7 and Figure 6.

Table 7. Number and percentage of unsuccessful eggs and hatchlings.

Category	Quantity	Percentage (%)
Dead in nest	11	1.10
Live in nest	27	2.70
Undeveloped	559	55.84
Stage 1	45	4.50
Stage 2	35	3.50
Stage 3	103	10.29
Crabs	147	14.69
Termites	40	4.00
Maggots	1	0.10
Monitor lizard	0	0.00
Fungus	17	1.70
Combination	16	1.60
Total	**1001**	**100.00**

Of the 1,001 unsuccessful eggs and hatchlings, 221 (22.08%) eggs and hatchlings were predated upon by various animals (see Table 8 and Figure 8). Most of the eggs and hatchlings were by ghost crabs (*Ocypode ceratophthalmus*) and termites. There were no signs of predation by monitor lizard (*Varanus salvator*) this season.

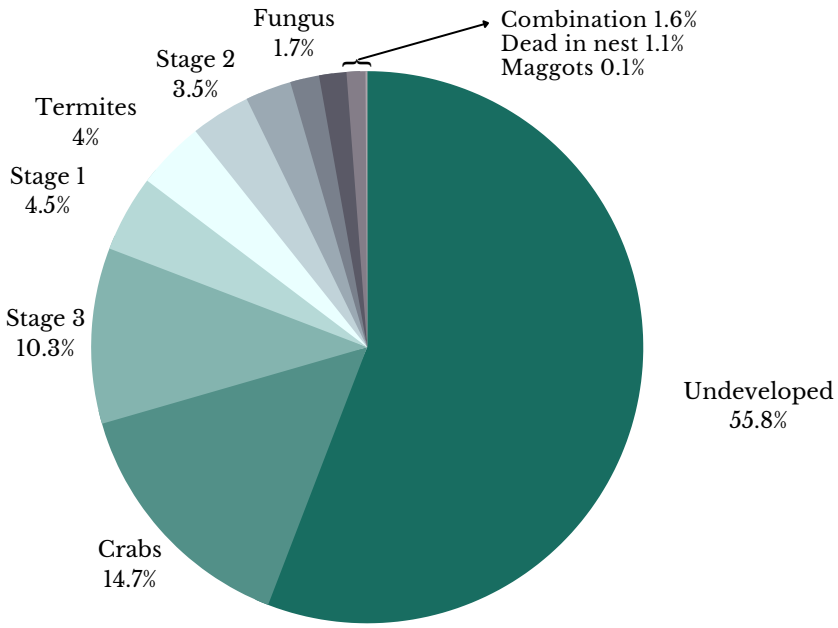


Figure 6. Percentage of eggs and hatchlings that did not hatch or emerge.

Table 8. Type of predation upon eggs and hatchlings

Type of predation	Number of eggs	Percentage (%)
Crabs	147	66.52
Termites	40	18.10
Maggots	1	0.45
Monitor lizard	0	0.00
Fungus	17	7.69
Combination	16	7.24
Total	**221**	**100.00**

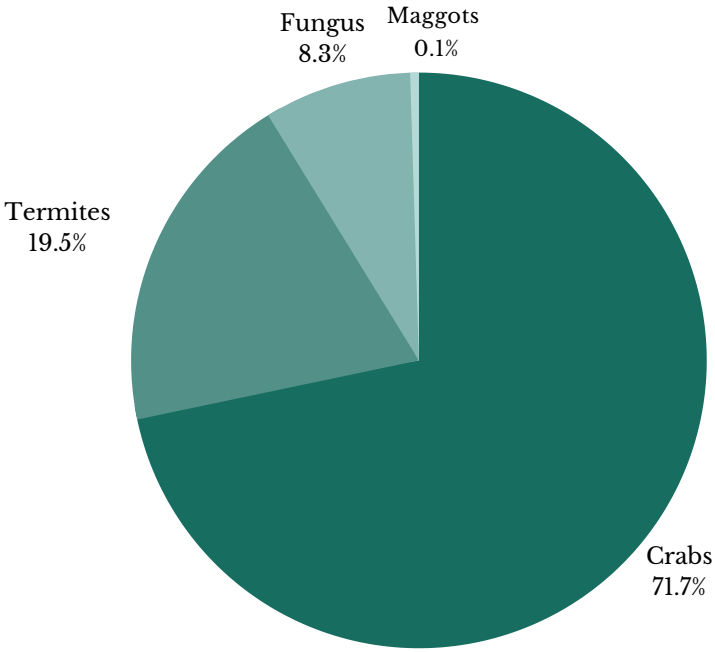


Figure 7. The pie chart shows the types of predation on eggs and hatchlings.

DISCUSSION

With the newly implemented nest check protocol, no significant difference was recorded on the hatching and emergence success rate between checked nests and undisturbed nests. However, more than 130 Asian monitor lizards (*Varanus salvator*) were caught and removed from the island by Vietnamese fishermen during the 2017 monsoon season (Govinder, resort staff at D' Coconut Lagoon Resort, personal communication, 2018). There is a likelihood that similar observations documented in 2017 could occur whereby majority of the checked nests were predated by monitor lizards due to the lingering smell of eggs detected by the monitor lizards. The nest check study will need to be continued for the next five years to determine whether nest check activity will increase the predation rate on nest.

The percentage of eggs and hatchlings predated this season decreased by 4.49% to 5.23% in 2018. This could be attributed to the more stringent nest check protocol that has been put in place this season. The nest check frequency was decreased to once every five days instead of every five days starting from day 45 of incubation and was halted once hatchlings were found within the nest. This allowed a reduced chance of monitor lizards being able to locate the position of the nest due to the lingering smell of the eggs after the nest check was conducted. Mesh net was also placed on all checked nests to deter ghost crabs and Asian monitor lizards from gaining easy access to the nests.

While the number of nesting has increased by threefold, from 12 nests in 2017 to 41 nests in 2018, there was a decrease in the hatching and emergence success despite the improved monitoring protocol. Hatching success decreased by 12.44%, from 88.60% in 2017 to 76.17% in 2018 while and emergence success dropped by 13.03%, from 88.00% in 2017 to 74.97% in 2018. The number of underdeveloped eggs found in the nests has risen by 10.99%, from 2.18% in 2017 to 13.17% in 2018. This could be attributed to global warming which has caused sea turtle population to be more female-biased as eggs are being incubated above the pivotal temperature (Jensen et al., 2018; Laloë *et al.*, 2014), meaning the number of males in the population might insufficient to fertilise all the eggs (Glen & Mrosovsky, 2004). Another possible cause could lie with the physiological condition of the nesting turtle as a high percentage of the underdeveloped eggs were found in nests laid by 18G002 (Aluna) and 18G003 (Monica) – 41.80% from seven nests with 531 eggs and 33.60% from four nests with 522 eggs.

The highlight for the 2018 nesting season is the total number of hawksbill turtle nests laid. Eight nests were laid by four hawksbill turtles, one of which was unidentified. This is the highest record of hawksbill nesting since the initiation of the project. Of 4851 eggs laid, 21.73% or 1054 eggs were laid by hawksbill turtles. Two returning nesting turtles were also recorded – 14H001 (Cassiopeia) and 15G005 (Sharnazz). Cassiopeia has been recorded nesting on Turtle Bay since March 2014 and has returned every two years to lay 3–4 nests per nesting season. Cassiopeia laid three nests with a total of 379 eggs. Sharnazz was first documented laying a total of 6 nests on Lang Sari throughout July to September 2015. In 2018, Sharnazz laid the most nests with nine nests containing a total of 1,064 eggs.

FUTURE RECOMMENDATIONS

In 2019, commission system for the designated nest check promoters need to be discussed and finalised. For the existing commission system, all guest are charged 20 MYR - 10 MYR was given to LTTW while the other 10 MYR was given to the promoters as commission. LTTW takes the full fee if no promoter was confirmed during their visit. At the end of 2018, Lisa (D'Coconut Lagoon Resort's receptionist) planned to charge each guest participating in the nest check 5–25 MYR as commission and 20 MYR to LTTW. Seeing that the conservation fee needs to be standardised for all "project promoters", decision needs to be made on how the commission system should be made. Dewa also plans to collaborate on this activity in 2019.

Camp tour and talks are often given to guests visiting camp on their own and sometimes they even participate in the nest check activity. In an effort to raise more funds for the project, a decision needs to be made if the different fee should be charged to guests only visiting camp and given a camp tour compared to guests participating in both camp tours and nest check activity. Seeing that volunteers will have a minimum stay of two weeks in 2019, they should be involved in giving camp tours or basic turtle talks to visiting guests to increase volunteer involvement in community outreach efforts.

While LTTW has been continuing the school outreach program, different schools could be approached, apart from continuing the engagement with SBPI Bukit Rakit and International School Kuala Lumpur. There are numerous local schools that can be approached to expand the school outreach program and local staff members or volunteers should be present to aid in translation on the day of the school visit. More outreach programs could be conducted with resort guests at the island resorts with permission from the management. Marine conservation topics could be presented on a weekly basis to resort guests. At the end of the presentation, nest check activities could be further promoted and merchandise could be sold as well.

CONCLUSION

We are pleased with the continuation and improvements to our projects on Pulau Lang Tengah. The projects have enabled LTTW to collect critical data required to assess the status of Lang Tengah's nesting turtle populations and to better conserve the marine environment together with local stakeholders. Volunteers also gained practical conservation experience by helping with research projects such as the beach profiling project. The data collected from all of our efforts will be analysed and used to aid local authorities such as Department of Marine Parks and Department of Fisheries to design better conservation management plans.

REFERENCES

Carpentier, A. S., Jean, C., Barret, M., Chassagneux, A., & Ciccione S. (2016). Stability of facial scale patterns on green sea turtles *Chelonia mydas* over time: A validation for the use of a photo-identification method. Journal of *Experimental Marine Biology and Ecology*, *476*, 15–21. https://doi.org/10.1016/j.jembe.2015.12.003

Dunbar, S. G., Ito, H. E., Bahjri, K., Dehom, S., & Salinas, L. (2014). Recognition of juvenile hawksbills *Eretmochelys imbricata* through face scale digitization and automated searching. *Endangered Species Research*, *26*, 137–146. https://doi.org/10.3354/esr00637

Eckert, K. L., & Beggs, J. (2006). *Marine turtle tagging: A manual of recommended practices*. WIDECAST Technical Report No. 2. Revised Edition. Beaufort, North Carolina. pp. 1–40. https://www.widecast.org/Resources/Docs/Eckert_Beggs_2006_Sea_Turtle_Tagging_Manual_revised_edition.pdf

Glen, F., & Mrosovsky, N. (2004). Antigua revisited: The impact of climate change on sand and nest temperatures at a hawksbill turtle (Eretmochelys imbricata) nesting beach. *Global Change Biology*, *10*(12), 2036–2045. https://doi.org/10.1111/j.1529-8817.2003.00865.x

International Union for Conservation of Nature. (2015). *The IUCN Red List of Threatened Species*. Version 2015–4.

Jensen, M. P., Allen, C. D., Eguchi, T., Bell, I. P., LaCasella, E. L., Hilton, W. A., Hof, C. A. M., & Dutton, P. H. (2018). Environmental warming and feminization of one of the largest sea turtle populations in the world. *Current Biology*, *28*(1), 154–159. https://doi.org/10.1016/j.cub.2017.11.057

Laloë, J. O., Cozens, J., Renom, B., Taxonera, A., & Hays, G. C. (2014). Effects of rising temperature on the viability of an important sea turtle rookery. *Nature Climate Change*, *4*(6), 513–518. https://doi.org/10.1038/nclimate2236

Miller, J. D. (1999). Taxonomy, external morphology, and species identification. In K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois, & M. Donnelly (Eds.), *Research and management techniques for the conservation of sea turtles* (IUCN/SSC Marine Turtle Specialist Group Publication No. 4, pp. 21–40). IUCN/SSC Marine Turtle Specialist Group. https://static1.squarespace.com/static/5e4c290978d00820618e0944/t/5e5034fa5b1cad41fad82929/1582314746117/21-determining-clutch-size-and-hatching-success.pdf

Wyneken, J. (2001). *The anatomy of sea turtles*. U.S. Department of Commerce NOAA TechnicalMemorandum NMFS-SEFSC-470. pp. 1–172. http://ibimm.org.br/wp-content/uploads/2017/05/Wyneken-2001-The-anatomy-of-sea-turtles.pdf