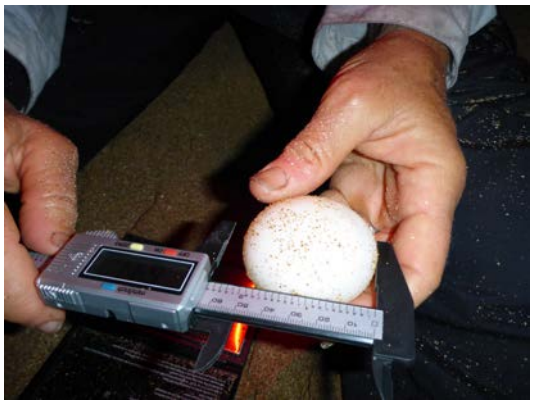
Marine Turtle Nesting Populations: Avoid Island Flatback Turtles, 2015-2016 breeding season



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Cover photographs:
Scenes from the census of nesting flatback turtles, *Natator depressus*, at Avoid Island, November 2015- December 2015. Photos by Nancy FitzSimmons and Dakota MacLoughlin

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This publication has been compiled by the Queensland Department of Environment and Heritage Protection (EHP).

MARINE TURTLE NESTING POPULATIONS: AVOID ISLAND FLATBACK TURTLES, 2015-2016 BREEDING SEASON

Nancy N. FITZSIMMONS and Colin J. LIMPUS

EXECUTIVE SUMMARY

- This report summarises the results of monitoring the eastern Australian flatback turtle nesting population at a representative index beach towards the northern extent of the population's nesting range during the 2015-2016 breeding season.

- Turtle nesting activity was monitored during a standard 14 day census period from 22 November – 5 December 2015 during the peak nesting season, as well as an additional six nights after the census.

- A total of 76 individual flatback turtles were identified during the two-week census period. During the census we observed 143 nesting crawls and a total of 90 clutches laid. Two additional turtles, 29 crawls and an additional 18 successful nests were observed from 6 - 11 December 2015.

- This is only the fourth consecutive season for which census data have been collected, so meaningful trend analyses are not yet possible.

- During the census 26.3% of nesting turtles were females not previously tagged and would include "new recruits" to the breeding population and some older turtles being recorded for the first time. This value should continue to decline as we expect that not all experienced turtles currently using this rookery have been tagged.

- As observed at other nesting beaches, the eastern Australian nesting flatback turtles at Avoid Island display a high fidelity to the island, with all remigrant turtles having been tagged previously at Avoid Island.

- These turtles display normal demographic features for the eastern Australian flatback turtle stock:

    - Nesting females had a mean curved carapace length = 93.9 cm (range 87.7-99.9) and laid, on average, 52 eggs per clutch. Data on successive clutches were obtained for eight turtles the 14-day census period and an additional 20 turtles after the census.

- Beach erosion from Cyclones Dylan in 2014 and Cyclone Marcia in 2015 was still apparent in terms of preventing access to the dunes along sections of South Beach and in loss of nesting habitat on the northern end of North Beach.

- Emergence data were obtained from 1 – 5 February 2016 for 85 nests that were either marked or found nearby while digging for marked nests. These nests had an average incubation success of 80.4% and hatchling emergence success of 80.7%.

- Existing management at Avoid Island is providing important protected habitat for the eastern Australian nesting population of flatback turtles in an area free of mammalian predators.

MARINE TURTLE NESTING POPULATIONS: AVOID ISLAND FLATBACK TURTLES, 2015-2016 BREEDING SEASON

INTRODUCTION

This report provides a summary of results from monitoring marine turtle nesting activity at Avoid Island during the 2015-2016 breeding season. This is the third year of this study under this contract, the 4th consecutive year of data collection and the 5th year overall of population census since standardised monitoring commenced in 2007.

Avoid Island, -21.9744ºS, 149.6500ºE, is a continental island located just north of Broad Sound and lying approximately 18 km from the nearest mainland shore and approximately 125 km southeast of the town of Mackay on the mainland coast of eastern Australia. The island is owned by the Queensland Trust for Nature (QTFN), which manages the island as a nature refuge. Avoid Island sits within a Habitat Protection Zone of the Great Barrier Reef Coast Marine Park and the Great Barrier Reef Marine Park. The island is closed to visitation by the general public and is uninhabited except by the turtle monitoring team during annual monitoring visits, and periodic visits by QTFN personnel for maintenance. As a consequence, the turtle nesting habitat of Avoid Island and the immediately adjacent inter-nesting habitat are managed to provide a high level of habitat protection to the turtle nesting population. There is a house, built in the 1970s, on the highest point on the island, and a shed. There are 4wd tracks that circle the island and a grass airstrip, which are maintained with a tractor mower. For the 2015-2016 turtle season QTFN had solar power and two composting toilets installed on the island, which substantially improved the living situation.

The Island is approximately 1.6 km long and 0.4 km wide, and has undulating terrain with a rise on the northern end of the island. There are three main nesting beaches (South Beach, Middle Beach, North Beach) on the eastern side of the island that are bordered by rocky outcrops and each beach is fronted by tidal sandy mud flats with scattered rocky shelves (Figure 1). These beaches are backed by dunes, providing nesting habitat on the beach slope and dunes, which are highest at South Beach. Other beaches on the island are either too narrow or rocky to provide suitable nesting habitat, though occasional nesting occurs on West Beach, the largest westerly facing beach (Jones and Venz, 2008, Kevin English, pers. comm.).

Avoid Island supports a moderate density of nesting flatback turtles of the East Australian (EA) stock (FitzSimmons and Limpus 2014b) and has been selected as an index beach for long term monitoring of flatback turtles within the EA stock. An initial census of the Avoid Island flatback turtle nesting population was conducted during the 2007-2008 breeding season (Jones and Venz 2008) and annual monitoring commenced in the 2012-2013 breeding season (FitzSimmons, 2013; FitzSimmons and Limpus 2014a, FitzSimmons and Limpus 2015).

METHODOLOGY

Standard Queensland Department of Environment and Heritage Protection (EHP) Threatened Species Unit Turtle Conservation Project methodologies (Limpus *et al*. 1983; Limpus, 1985) were followed for the project to monitor nesting females and their clutches.

Nesting females

Three beaches were monitored nightly from 22 November - 5 December 2015 in conjunction with students from a conservation biology class run through the University of New South Wales. We used two teams of three to four students and one-two experienced people to monitor South Beach (A3) and Middle Beach (A2) and a third team to monitor the North Beach (A1). Additional monitoring on South Beach occurred from 6 – 11 December by experienced people. On 7 and 8 December the teams included students and teachers from the North Mackay and Sarina high schools. Nightly monitoring began at least two hours before high tide and continued for at least four hours after high tide, depending if turtles were still active on the beach. Procedures included:

- Properly tagged turtles left the beach with a minimum of two titanium tags (manufactured by Stockbrands Australia) in the front left and right flippers at a designated tagging position (Limpus 1992), generally proximal to the flipper scute closest to the body. If scar tissue from previous tagging made this position unsuitable for tagging, tags were applied distally to this scute or on a hind flipper.
- Passive Integrated Transponder (PIT) tags, used as a second tagging method for identification of flatback turtles (Parmenter, 1993), were injected into the upper left (or occasionally right) shoulder (just below the carapace) of nesting females.
- Curved carapace length (CCL ± 0.1 cm) was measured from the skin/carapace junction at the anterior edge of the nuchal scale, along the midline, to the posterior junction of the two post-vertebral scutes at the rear of the carapace using a flexible fibreglass tape measure. This was done multiple times by students and checked against the measurements of an experienced person to achieve a 0.3 mm agreement among measurements. Any barnacles living along the midline of the carapace were removed prior to measuring.
- Any damage to the turtle or unusual features were recorded and photographed if possible.
- A nest tag (flagging tape ~20 cm long) with the date of laying and a tag number of the turtle (Limpus 1985) was placed in the nest during oviposition for most clutches. The nest tag assists in identifying the female that laid the clutch when hatchlings emerge some two months later.
- Some clutches of eggs were counted and ten eggs were selected to represent a cross-section of eggs from top to bottom of the nest. Each of these selected eggs was weighed (± 0.1 g) on a digital balance and measured for maximum and minimum diameter (± 0.01 cm) with vernier callipers. To minimise movement induced mortality of eggs (Limpus et al. 1979), all handled eggs were returned to their respective nests within two hours of being laid and with the minimum of rotation.
- Nest locations were recorded using a hand held GPS (global positioning system) unit (± 4 m) and measurements (± 1 cm) were taken to at least two nearby trees or shrubs using a 30 m tape measure and a map drawn for reference. Flagging

tape with the turtle ID number was placed around branches at the point of measurement for future reference. Habitat type of the nest location was recorded.

Emergence Success

A second trip to Avoid Island to determine incubation and hatchling emergence success for the previously marked nests, was conducted from 1 – 5 February 2016. Nest locations were determined using the GPS locations and nest maps and confirmed by the presence of nest tags.

- A clutch was assessed for incubation success and hatchling emergence success by excavating the nest site, usually 24 hr after the hatchlings have crawled from the nest. A count was made of hatched eggs, unhatched eggs with embryos, unhatched eggs with no signs of embryonic development (= undeveloped egg), eggs showing signs of predation by crabs or other animals (= predated egg), live hatchlings trapped in the nest, and dead hatchlings within the nest.

  Estimated clutch count = hatched eggs + unhatched eggs + undeveloped eggs + predated eggs'

  Hatching success = (hatched eggs/estimated clutch count)*100 %;

  Emergence success = (hatched eggs – [live+dead hatchlings]/estimated clutch count)*100 %.

  Counting error, the accuracy of counting broken egg shells = estimated clutch count following hatchling emergence - clutch count made when the eggs were laid.

- The depth to the bottom of the egg chamber was measured (± 5 mm) and observations on the nest environment were made, such as erosion and water inundation.

Turtle orientation

Because there are no recognized light pollution issues at Avoid Island, South Beach is being used as a control site to assess the variability in orientation in female turtles upon returning to the water after ascending the beach and in hatchlings after emergence. To measure orientation in nesting females, a line was measure 15 m out from the entry point and exit point of the body pit along the up track and return track, respectively, from individual nesting females. A bearing was sighted along these lines and compared to an estimated perpendicular bearing along the recent high tide mark, which represents the shortest possible route back to the water.

The level of light disorientation of hatchling turtles was assessed by measuring from the centre of the nest 5.3 m along the left and right side of the hatchling fan and recording a compass measurement along both of these lines. The average bearing was then compared to the bearing perpendicular to the high tide mark, which represents the shortest possible route back to the water. This was only possible for a few nests that were observed with emergent hatchling tracks.

A detailed analysis of adult female and hatchling orientation measures based on tracks will be the subject of a separate future report addressing turtle orientation with respect to horizons at multiple study sites.

Sand Temperature Monitoring
Vemvo Minilog II temperature data loggers have been deployed for a number of years at turtle nesting beaches in Queensland to measure sand temperatures at 50 cm depth at 30 minute intervals. These temperature recording instruments can record temperature continuously for up to 10 years.
Two sand temperature data loggers had been placed on site during the 2012- 2013 breeding season in representative nesting environments at a depth of 50 cm. They are located near the edge of the dune crest, marked by black star pickets:

- Data logger in shaded habitat: -21.97737^{o} S; 149.66575^{o} E
- Data logger in open sunny habitat: -21.97679^{o} S; 149.66597^{o} E.

Data from these instruments were last downloaded in February 2015 (FitzSimmons and Limpus 2015).

RESULTS

Tagging Census
A total of 76 individual flatback turtles engaged in nesting activities were identified during the two-week census period, 22 November – 5 December 2015 (Table 1). Two additional turtles were identified from 6 – 11 December, 20 other turtles observed in the additional time period had been encountered during the census. No other species of turtle was recorded as nesting during this period. All data discussed below are restricted to the census data unless otherwise noted.

During the 2015-2016 breeding season no flatback turtle was observed with tags that had been recorded nesting at any beach other than Avoid Island, although in the 2012-2013 season year, one turtle had been recorded that had been tagged originally at Wild Duck Island in 1988. For the 2015-2016 season 26.3% of turtles were previously untagged.

Size of nesting females
The mean size of all nesting female flatback turtles was CCL = 93.3 cm (SD = 2.4, n = 78, range = 87.7 - 99.9; Table 3, Figure 2). The mean CCL of primary tagged turtles (93.0 ± 2.4; n = 21), which includes first time breeding females and previously untagged remigrants, was not statistically different (t-test; p = 0.31) to that of remigrant turtles (93.3 ± 2.4; N = 57).

Nesting
There were 143 recorded flatback turtle nesting crawls during the census period. An additional 29 nesting crawls occurred from 6 – 11 December. The mean nightly number of turtles coming ashore for nesting (track count) was 10.2 (SD = 7.0, n = 14, range = 2 – 27; Table 2, Figure 3). After the census period an additional 29 crawls were observed on South Beach. As in previous years, most nesting activity (84.4% of nests) occurred on South Beach (A3), which is the largest beach (Figure 4).

A total of 90 clutches were laid during the two-week census and all of these were marked and mapped for determining emergence success (Table 2). The mean

number of clutches laid per night was 6.4 (SD = 3.9, n = 14, range = 2-13). After the census period an additional 18 clutches were recorded on South Beach from 6 – 11 December.

Nesting success, the proportion of nesting crawls that resulted in eggs being laid by the turtle, was 62.9% for the island during the census period. Nesting success was 80.0% at North Beach (12 nests) and 60.3 % at South Beach (76 nests). One turtle nested on Middle Beach, and one nested on the north end of the island. Turtles that failed to nest were observed to successfully nest from 0-2 days later (mean = 1.1; n = 12). One turtle was disturbed while nesting and only laid 27 eggs, but came back two nights later and laid another 16 eggs.

Inter-nesting intervals could be determined for 27 turtles that nested twice during the entire period of monitoring (22 November – 11 December). Inter-nesting intervals ranged from 11 to 15 days, with the most common interval being 13 days (mean = 12.8 ± 0.86; n = 15).

Remigration

Remigration interval, the number of years between recorded breeding seasons, could be determined for 54 turtles. The range in observed intervals was from 1 to 8 years, with the most common interval being 2 years (n = 34). On the assumption that the 8 year intervals observed for 3 turtles reflect missed years of nesting activity, the mean remigration interval was 2.1 ± 0.56 years (Table 3).

Eggs, incubation success and hatchlings

Egg counts and egg diameters are summarised in Table 4. The average number of eggs in nests was 52.0 based on clutches counted immediately after laying (n = 29). There was a large range in egg diameter (47.2 – 59.7 cm) and egg weight (64.1 – 90.7 g) among clutches.

The first clutch observed to have produced emerging hatchlings occurred after the census date on 8 December 2016.

The field trip to document incubation and hatchling emergence success ran from 1 - 5 February 2016. A total of 85 clutches were found, which included 11 clutches laid outside of the census period and 4 clutches with an unknown date of being laid. Only two nests were found by observing hatchling tracks, all other nests were either marked nests, or nests found accidently while digging for marked nests.

There was reasonable accuracy in assessing incubation success by counting the broken egg shells in the clutches from which hatchlings had emerged: mean counting error = -1.1% eggs per nest (SD = 1.24, n = 20 clutches).

The mean incubation success was 80.7% and hatchling emergence success was 80.4% (n = 85) (Table 4). Other observations included:

- three clutches suffered from inundation by high tides and these had low emergence success (0 – 46.4%).

- two clutches suffered from heat exposure where eggs were close to the surface, these both had an emergence success of 59.6%.
- maggots were observed in 17.7% of nests.
- one turtle was observed digging into a previously laid clutch, which destroyed four eggs.
- the only predation of the clutches was by crabs in 16 nests (18.8% of clutches). Crabs accounted for a loss of 57 eggs from an estimated total of 4437 eggs laid within clutches examined for incubation success. This represents a 1.3% loss of eggs to crabs.

Turtles selected preferred habitat for nesting, with most nests (87.1%) laid on the slope between the dune base and the recent high tide mark. An additional 10.6% of nests were laid on the first dune and 2.4% below the mean high tide mark. Most nests were laid in bare sand (54.1%), followed by nest laid under trees (37.6%) or in vegetation (8.2%). Average nest depth was 56 cm (Table 4).

Sand Temperature Monitoring

Sand temperature data were not down loaded during the 2015-2016 breeding season. The data loggers remain securely in place (Figure 5) and with data storage capacity for up to 10 years, the continuum of recorded data since February 2015 will be retrieved during the 2016-2017 breeding season.

Turtle orientation

Measurements of the bearing along the emerging and returning tracks of nesting females were collected for 65 females (Figure 6).

Orientation data were only obtained for hatchlings from three clutches, one of which had <5 tracks visible.

Health and injuries

None of the nesting turtles at Avoid Island displayed recent tissue damage or fractures except for two turtles with burrowing barnacles.

At least four turtles displayed healed scars from propeller damage or other major fractures to the carapace.

One turtle has extensive healed damage; missing all of one and half of the other front flipper and notches out of her carapace.

No fibropapilloma tumours were observed on any of the turtles.

DISCUSSION

Avoid Island supports a moderately sized rookery of flatback nesting turtles located at the northern extremity of the breeding range for the eastern Australian stock. It is an important site for comparative monitoring due to the lack of mammal and reptile

predators and lack of human disturbance or alteration to the nesting and internesting habitat, including a lack of light pollution.

This study has completed the fifth year of monitoring and the fourth consecutive year. The numbers of individual tagged flatback turtles, track counts, and clutches laid during the 2015-2016 breeding season were similar to or greater than those recorded for the 2012-2013 through 2014-2015 seasons, all of which are higher than counts from the 2007-2008 season (Jones and Ventz, 2008; FitzSimmons, 2013; FitzSimmons and Limpus 2014a) (Figure 7). The average number of tracks per night was higher than in previous years, because several turtles appeared to be more easily "disturbed" during their nesting attempts when confronted by trees or logs on the beach or steep dune slopes they could not ascend.

Beach erosion from Cyclone Dylan in 2014 was still apparent on South Beach, in regard to a steeper dune profile, which is still limiting access to the 1st dune by turtles. The beach slope looks similar to the previous season (Figure 8) and few nests were damaged by inundation. On North Beach, the northern end of the beach continues to be inundated by the higher high tides and was not used by turtles. The rest of the beach remains as good nesting habitat (Figure 8).

The study is nearing the point of being able to estimate the recruitment rate of first time breeding females into the adult nesting population, as measured by the proportion of first time tagged nesting females. As expected, this value has declined each year as follows: 78.2% in 2012-2013 (FitzSimmons 2013), 66.7% in 2013-2014 (FitzSimmons and Limpus 2014a) and 50.0%, 2014-2015 (FitzSimmons and Limpus 2015). Data from other rookeries suggest that the proportion of new recruits will continue to decline to around 10-20% (Limpus 2007). All remigrants in 2015-16 were originally tagged on Avoid Is. To date, only two turtles originally tagged at Wild Duck Island have been previously observed on Avoid Island. It is too soon to compare the nesting behaviour and nesting success of new versus remigrant turtles until more of the turtles in the population have been tagged.

Avoid Island should serve as an important control site for studying the orientation of turtles in an environment that is free of light pollution. The results of the introductory study assessing orientation of adults and hatchlings to light horizons at Avoid, Peak and Curtis Islands will be analysed in a separate report.

ACKNOWLEDGEMENTS

The Avoid Island flatback turtle project was conducted as a cooperative project between the Queensland Trust for Nature (QTFN), Wild Mob, the University of New South Wales (UNSW) and the Turtle Conservation Project of the Threatened Species Unit, Department of Environment and Heritage Protection. Ben O'Hara, Director of QTFN provided logistic support, organised transport and supplied accommodation for the field studies. Thanks to Kevin and Marie English for transporting equipment by barge and for keeping the airstrip and paths mowed. Thanks to Horizon Air for our safe transport. Thanks to the Wild Mob team of Andrew

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TABLES and FIGURES

Table 1. Tagging history of flatback turtles, *Natator depressus*, recorded nesting at Avoid Island during 22 November – 11 December 2015.

Tagging history of turtles	N
First time tagged females (Primary tagged turtles)	20
Recaptures from past nesting seasons at Avoid Island	
• Recaptured with tags previously recorded at Avoid Island (n =57)	
o 2007 (only)	3
o 2007, 2012	4
o 2007, 2012, 2013	3
o 2007, 2013	3
o 2012 (only)	7
o 2012, 2013	8
o 2012, 2014	4
o 2013 (only)	20
o 2013, 2014	1
o 2014	1
• Recaptured with tag scars only, previously applied tags lost, no PIT tag	3
TOTAL	**77**

Table 2. Nightly census of nesting flatback turtles, *Natator depressus*, at Avoid Island during 22 November – 05 December 2015: track count, observed clutches laid and clutches of hatchlings emerging.

Date	No. tracks	No. clutches laid	No. clutches of hatchlings emerged
22 Nov	10	7	0
23 Nov	7	4	0
24 Nov	7	2	0
25 Nov	27	13	0
26 Nov	9	6	0
27 Nov	2	2	0
28 Nov	17	12	0
29 Nov	3	2	0
30 Nov	3	3	0
01 Dec	7	6	0
02 Dec	5	3	0
03 Dec	14	8	0
04 Dec	21	13	0
05 Dec	11	9	0
Total	143	90	0

Table 3. Summary of curved carapace measurements and remigration intervals of nesting flatback turtles, *Natator depressus*, at Avoid Island during the monitoring period from 22 November – 11 December 2015 census period.

	Curved carapace length (cm)			
	Mean	**SD**	**Range**	**N**
1st breeding season and previously untagged remigrants (primary taggings)	93.0	2.4	89.1 – 97.5	21
All known remigrant turtles	93.3	2.4	87.7 – 99.9	57
All Turtles	**93.3**	**2.4**	**87.7 – 99.9**	**78**
	Remigration interval (yr)			
All remigrant turtles	2.5	1.45	1 – 8	54
Remigrant turtles w/out 8 yr intervals	2.14	0.56	1 - 3	51

Table 4. Flatback turtle, *Natator depressus*, nest descriptions, incubation and hatchling emergence success at Avoid Island during the 2015-2016 breeding season.

	Mean	**SD**	**Range**	**# Clutches**
Eggs per clutch	51.93	6.106	38 -67	29
Yolkless eggs per clutch	0.10	0.409	0-2	29
Multiyolked eggs per clutch	0	-	-	29
Size of eggs				
Egg diameter, mean (cm)	51.739	6.614	47.2-59.7	290 (29 clutches)
Egg weight, mean (g)	76.84	5.227	64.1-90.7	290 (29 clutches)
Nest depth, bottom (cm)	56.3	6.4	41 - 74	83
Return interval				
Renesting interval (d), following a successful oviposition	12.8	0.86	11-15	27
Return interval (d), following an unsuccessful nesting attempt	1.1	-	0-2	12
Incubation success				
Hatching success of eggs (%)	80.7	21.9	0 - 100	85
Hatchling emergences success (%)	80.4	22.0	0 - 100	85

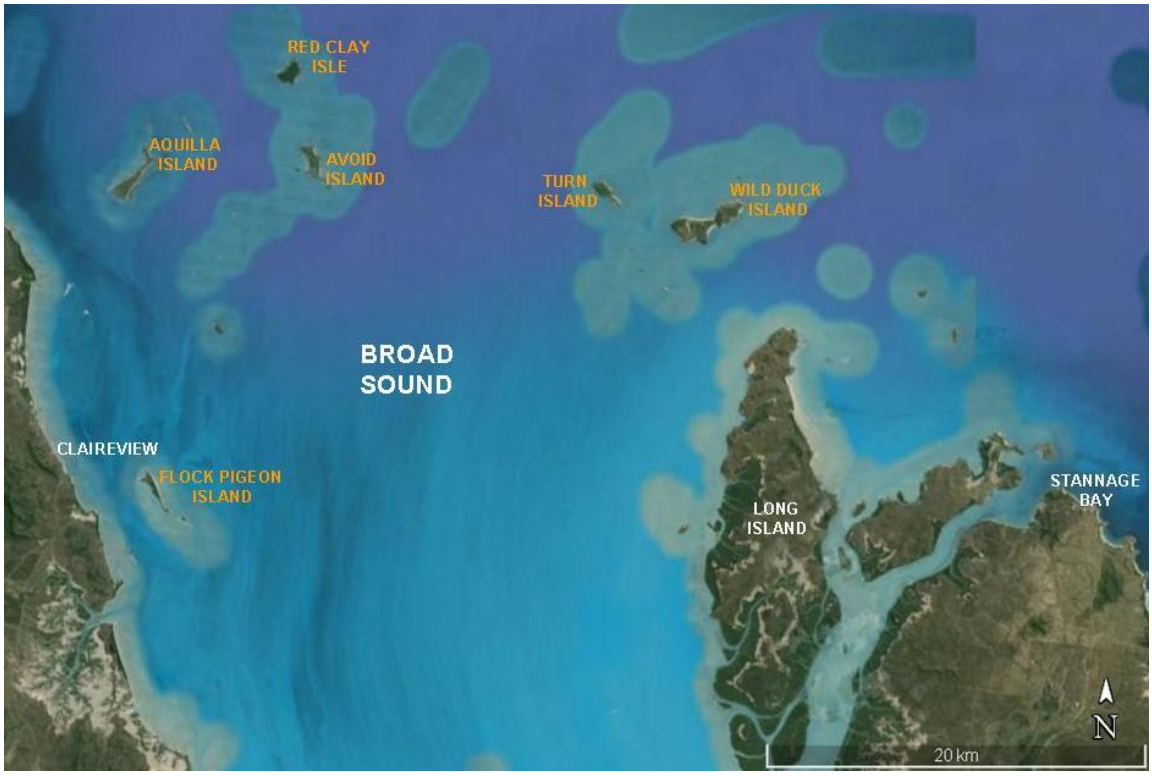

Figure 1a. Location of Avoid Island in relation to nearby landmarks.

Figure 1b. Turtle nesting beaches at Avoid Island and infrastructure locations.

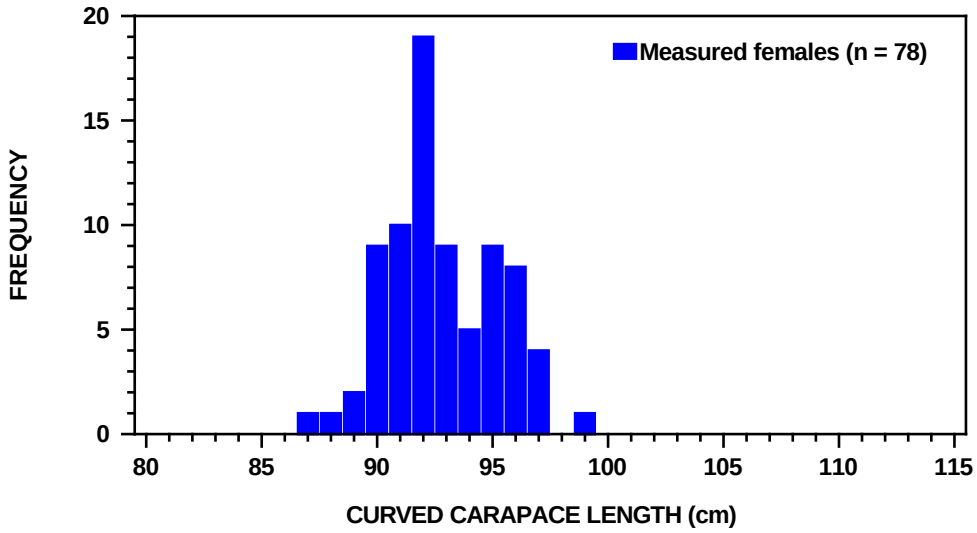

Figure 2. Size frequency distribution of nesting flatback turtles at Avoid Island during the 2015-2016 breeding season.

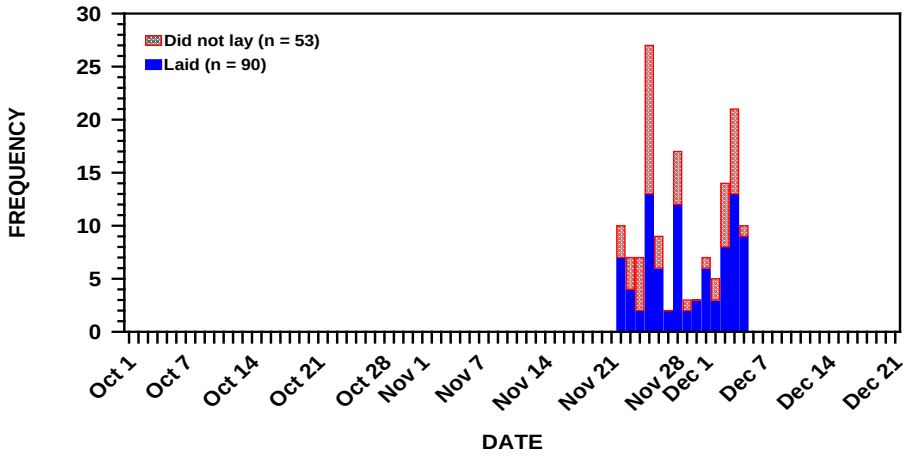

Figure 3. Nightly number of flatback turtles, *Natator depressus*, ashore for nesting on Avoid Island during the standard mid-season census period in 22 November – 5 December 2015.

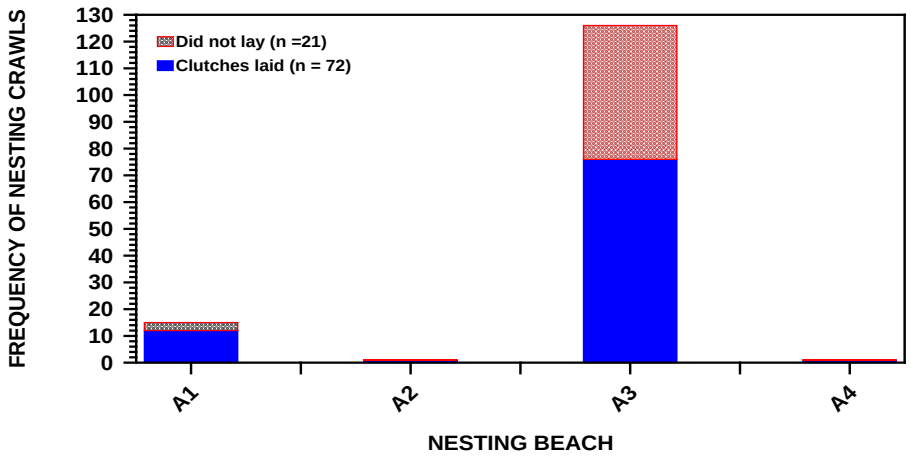

Figure 4. Frequency distribution of nesting crawls (tracks) and nesting success by beach location at Avoid Island during 22 November – 5 December 2015. A1 = North Beach, A2 = Middle Beach (n=1), A3 = South Beach, A4 = other (n = 1).

Figure 5. Locations of multi-year temperature probes in shaded and sunny flatback turtle nesting locations on the first dune slope, Avoid Island, photos taken February 2015.

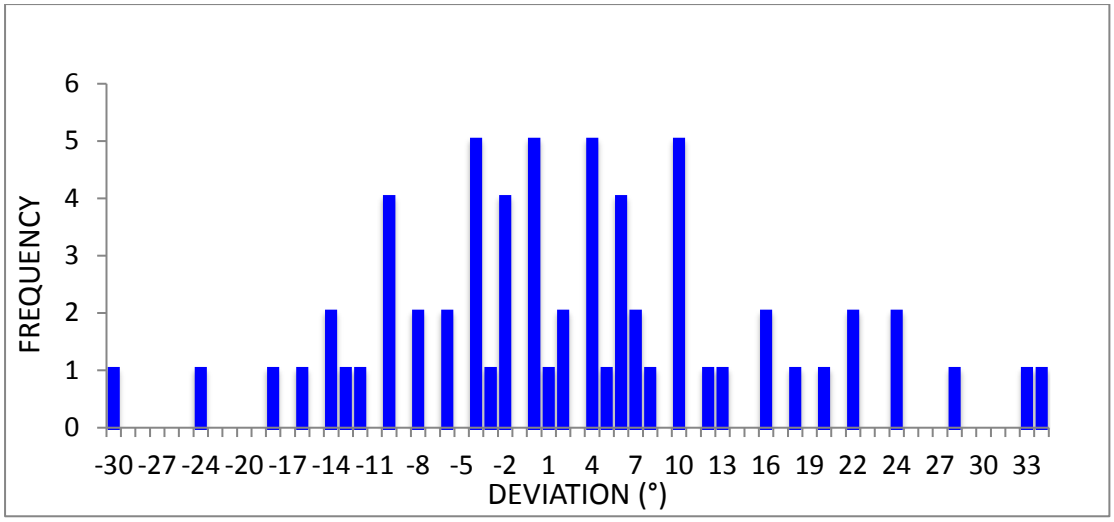

Figure 6. Frequency distribution of the deviation in degrees from the shortest direction to the water by nesting turtles as they return after nesting.

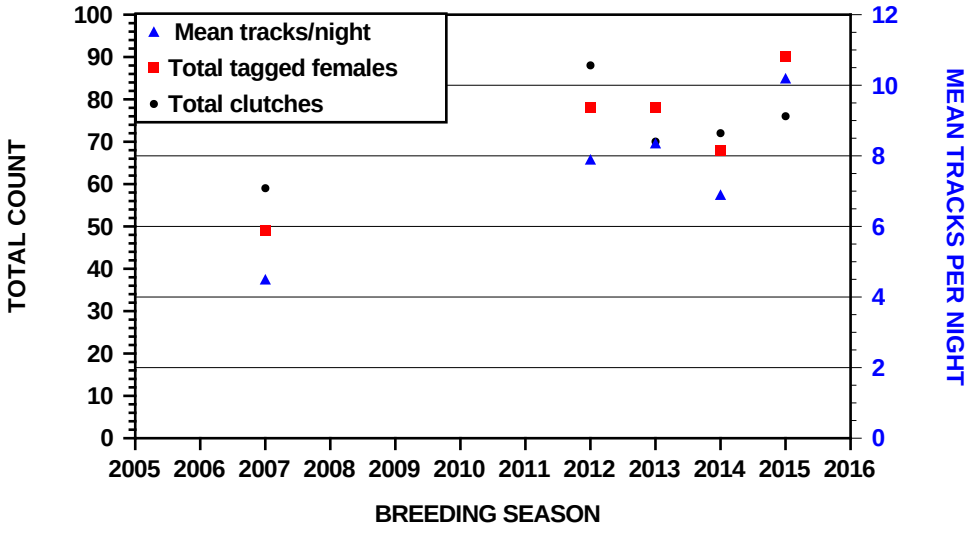

Figure 7. Comparison across years of total number of nesting females, total clutches laid and mean track counts per night during the mid-season nesting census of flatback turtles, *Natator depressus* at Avoid Island.

Figure 8. Beach profile of South Beach (left) and North Beach (right) of Avoid Island, December 2015.