PROJECT REPORT

Expedition dates: 8 – 22 November 2010
Report published: October 2011

Beach combing for conservation: monitoring flatback turtles along the stunning coastline of Western Australia.

BEST VOLUNTEERING ORGANISATION	BEST FOR GREEN-MINDED TRAVELLERS	TOP RESPONSIBLE HOLIDAY	BEST WILDLIFE VOLUNTEERING HOLIDAY	BEST IN SUSTAINABLE TRAVEL	ENVIRONMENT AWARD	TOP HOLIDAY FOR NATURE
UK	UK	UK	UK	USA	Germany	Germany

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Beach combing for conservation: monitoring flatback turtles along the stunning coastline of Western Australia.

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Authors:
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Conservation Volunteers Australia

Matthias Hammer (editor)
Biosphere Expeditions

Abstract

The nesting population of Australian flatback *(Natator depressus)* sea turtles at Eco Beach, Western Australia, continues to be the focus of this annual programme, which resumes gathering valuable data on the species, dynamic changes to the nesting environment and a strong base for environmental teaching and training of all programme participants.

Whilst the Eco Beach population is not as high in density as other Western Australian nesting populations at Cape Domett, Barrow Island or the Pilbara region, it remains significant for the following reasons:

- The 12 km nesting beach and survey area is free from human development, which can impact on nesting turtles and hatchlings.
- The beach and almost non-existent nesting dune are subject to strong winds and high tides in excess of 10 m which, when combined, result in highly changeable beach dynamics and a loss of nests.
- Satellite transmitter tracking of female flatbacks indicates migratory routes are different from those of previously tracked southern stocks.
- High nest temperatures above an expected embryo mortality level are producing nest hatch success rates to 100%.
- 22% of turtles tagged so far have nested on a one year interval when a (published) two to five year cycle would be expected.

The Eco Beach Sea Turtle Monitoring Programme, managed by Conservation Volunteers with assistance from Biosphere Expeditions and others, is a Wild Futures initiative. Wild Futures is working to protect key species including flatbacks and their habitats in this West Kimberley region. Science-based survey work commenced at Eco Beach in October 2008 and continues today.

The flatback sea turtle is currently listed internationally as Data Deficient (IUCN Red List of Threatened Species) with a review to a potential Vulnerable classification still underway. Flatbacks in Western Australia are listed as Vulnerable. The data gained from the 2010 Eco Beach nesting season will add strength to other existing flatback monitoring programmes and in time should enable a more accurate reflection and management of the species.

The 2010 Eco Beach Sea Turtle Monitoring Programme tagging component, to which this report primarily relates, produced 217 data registrations comprising 65 nests and 152 false crawls (an incomplete nest with no eggs deposited) over a 40 night period. Despite high beach dynamics and nest predation by native animals during the nesting and hatchling period, an average of 87% hatchling emergence was recorded from exhumed nests.

Forty-two individual flatbacks (the only species recorded nesting) were identified by the patrols with an interclutch interval of 11 nights between nests. Fourteen re-migrant turtles tagged in previous years were observed successfully nesting during 2010 and two turtles tagged in 2008 have nested each year since. DNA samples from all encountered turtles were taken and two Platform Terminal Transmitters (PTT) deployed on 17 November and 16 December 2010. The daily progress of tracked flatbacks from the programme can be viewed at www.seaturtle.org listed as *CVA Eco Beach, Western Australia - Flatback Monitoring Programme*.

Key recommendations for the programme include a continuation of the conservation and research actions and adding to the dataset, relocation of doomed nests, which will be washed away by imminent high tides, further monitoring of nest predation levels, and an increased level of PTT tracking of future nesting Australian flatbacks.

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M. Hammer (editor)
Biosphere Expeditions

1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (biological or otherwise) required to join. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This project report deals with an expedition to Eco Beach, Western Australia that ran from 8 to 22 November 2010 with the aim of determining flatback turtle nesting numbers and how far dispersed this genetic population is along the seashore of Western Australia.

No known annual or consecutive recording of nesting turtles has occurred in the study site until now. Anecdotal evidence together with some past track counts by the Department of Environment and Conservation of Western Australia provided the basis for the establishment of this new annual monitoring programme.

While the flatback turtle (*Natator depressus*) is the prime nesting species, green turtles (*Chelonia mydas*) are quite likely to nest in the study site too. Other species such as hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and Olive Ridley turtles (*Lepidochelys olivacea*) are also known to inhabit the waters of the study site.

Extensive satellite transmitter tracking of nesting flatbacks further south along the coast of Western Australia shows migratory paths past the study site to northern foraging grounds off the coastline of Broome. Where the project's flatbacks fit in to this overall picture is of prime interest for future conservation measures. More satellite tagging is also planned for the future.

1.2. Dates

The project ran over a period of two weeks divided into two one-week slots, each composed of a team of international research assistants, scientists and an expedition leader. Slot dates were:

2010: 8 – 15 November | 15 – 22 November.

Team members could join for multiple slots (within the periods specified). The period was chosen to coincide with the flatback turtle nesting season for Western Australia.

1.3. Local Conditions & Support

Expedition base

The expedition was based in a remote region along Western Australian coastline. Eco Beach Wilderness Retreat (www.ecobeach.com.au) was the base for this project with accommodation in spacious safari-style tents featuring a private verandah, mattress bed, linen and pillow.

Weather

Day temperatures during the expedition were warm to hot between 25 and 34°C and top temperatures of up to 40°C. Research work was mainly conducted at night when temperatures were slightly lower.

Field communications

Mobile phone coverage (Telstra's Next G network) was available at base and in most parts of the study site. Landlines were also available at base as well as field radios when on patrol. The expedition leader also sent an expedition diary to the Biosphere Expeditions HQ every few days and this diary appeared on www.biosphere-expeditions.org/diaries and excerpts of it also appeared on www.facebook.com/biosphere.expeditions1.

Transport & vehicles

Team made their own way to the Broome assembly. From there onwards and back to the assembly point all transport and vehicles were provided for the expedition team, for expedition support and emergency evacuations. Beach driving was conducted under strict beach driving protocols.

Medical support and insurance

The expedition leader and the expedition scientist were trained first aiders, and the expedition carried a medical kit. Further medical support was provided by Eco Beach and the nearest hospital in Broome is about 1.5 hours by car, 45 minutes by boat or 18 minutes by private plane. Safety and emergency procedures were in place, but did not have to be invoked as there were no serious medical incidences during the expedition.

1.4. Local Scientist

Glenn McFarlane is the Marine Species Manager for CVA and has more than seven years experience working hands-on with sea turtles in Central America and Australia. Glenn moved to Costa Rica in 2004 with the aim of building the first secure turtle hatchery at Cahuita National Park. This achieved, along with a vastly reduced local poaching rate of eggs and turtles plus years of gained experience at many projects, he returned home to Australia to continue working with CVA establishing sea turtle conservation and research projects. Glenn has led more than 500 turtle patrols, walked over 6,000 km and handled more than 37,000 eggs in his efforts for turtle conservation.

1.5. Expedition Leaders

The expedition was led by Matthias Hammer (group 1) and Wren McLean (group 2).

Biosphere Expeditions was founded in 1999 by Dr. Matthias Hammer. Born in Germany, he went to school there, before joining the Army at 18, and serving for several years amongst other units with the German Parachute Regiment. After active service he came to the UK and was educated at St Andrews, Oxford and Cambridge. During his time at university he either organised or was involved in the running of several expeditions, some of which were conservation expeditions (for example to the Brazil Amazon and Madagascar), whilst others were mountaineering/climbing expeditions (for example to the Russian Caucasus, the Alps or the Rocky Mountains). With Biosphere Expeditions he has led teams all over the globe. He is a qualified wilderness medical officer, ski instructor, mountain leader, divemaster and survival skills instructor. Once a rower on the international circuit, he is now an amateur marathon runner and Ironman triathlete.

Wren McLean was born in Australia and grew up breeding reptiles and caring for other orphaned and injured wildlife. She is an environmental science graduate and has participated in many wildlife research projects including Australian gliding possums, marine turtles, marsupial moles, humpback whales, migratory wader birds and seabirds. She has a strong dedication to environmental justice and worked on numerous campaigns and expeditions to protect biodiversity and natural resources. Wren is also a yoga teacher and artist who loves long distance swimming and kayaking.

1.6. Expedition Team

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of all ages, nationalities and backgrounds. They were (with country of residence):

8 – 15 November 2010

Jügen Hatzenbichler (Austria), Mehri Homayunfard (Australia), Ritva Honkanen (Finland), Deborah Jackson (Australia), Annie Johns (Australia), Mary Loughran (USA), Keith Millar (UK), Petra Schneider (Germany), Rasha Skybey (Australia), Valma Spencer-Sun (Australia), Stephen Swan (UK), Gordon Thomson (UK).

15 – 22 November 2010

Tamara Caddy (Australia), Christine Cheong (Singapore), Vanessa Croll (Australia), Tyler Herbst (Australia), Jade Marquez (USA), Katherine Sablan (USA), Hooi Hoon Teo (Singapore), Cameron Wilson (Australia).

1.7. Other Partners

Our main partner on this project is Conservation Volunteers Australia (CVA), a leading Australian non-profit and non-political, practical conservation organisation operating in all States and Territories of Australia as well as New Zealand. Other partners are the Cable Beach community-based monitoring programme in Broome, the Western Australian Department of Environment and Conservation, the Chelonia Wildlife & Rehabilitation Centre, Environs Kimberley and Seagrass Watch. Our Eco Beach resort base also has a relationship with the traditional aboriginal owners of the land, the Yawuru Native Holders Aboriginal Corporation. Corporate support comes from Land Rover, Swarovski Optik and Snowgum, an Australian outdoor equipment retailer.

1.8. Expedition Budget

Each team member paid towards expedition costs a contribution of £980 per person per 7 day slot. The contribution covered accommodation and meals, supervision and induction, special non-personal diving and other equipment and air, and all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses such as telephone bills, souvenirs etc., as well as visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	£
Expedition contributions	16,185
Expenditure	
Base camp and food includes all board & lodging and sundries at Eco Beach Resort	5,669
Equipment and hardware includes research materials & gear, etc.	169
Staff includes local & international salaries, travel and expenses	2,679
Administration includes registration fees, sundries etc	21
Scientific services & logistics organisation Payment to Conservation Volunteers Australia	5,006
Team recruitment Western Australia as estimated % of PR costs for Biosphere Expeditions	3,320
Income – Expenditure	**- 679**
Total percentage spent directly on project	**104%***

*This means that in 2010, the expedition ran at a loss and was supported over and above the income from the expedition contributions by Biosphere Expeditions.

1.9. Acknowledgements

This study was conducted by Conservation Volunteers Australia in association with Biosphere Expeditions, which runs wildlife conservation expeditions all over the globe. Without our expedition team members (who are listed above) who provided an expedition contribution and gave up their spare time to work as research assistants, the research would not have been possible. The support team and staff (also mentioned above) were central to making it all work on the ground. Thank you to all of you, and the ones we have not managed to mention by name (you know who you are) for making it all come true. Biosphere Expeditions would also like to thank members of the Friends of Biosphere Expeditions and donors, Land Rover and Swarovski Optik for their sponsorship, as well as Sherie Blackwell and Ben Rees for their help with editing this report, and Joanne Davis of Conservation Volunteers for getting this successful collaboration off the ground.

The management and staff of Eco Beach Wilderness Retreat and Australian Eco Constructions contribute annually to this sea turtle monitoring programme for which we extend our thanks. General Manager Jodie Mott and her staff were supportive of the research teams. It was thanks to the generosity of Managing Director Karl Plunkett that funding was made available for one of the two satellite transmitter deployments.

The efforts of Research Assistant Tony Dingwall of NSW cannot be understated for his professionalism and good company working with sea turtles at night. The authors would like personally to thank Research Assistants Kerry Hadley, Amber Kennedy, Julia Rau, supporting staff of Conservation Volunteers and the many volunteers who conducted the patrols during the 40 nights of the programme. Heartfelt thanks also to naturalists Dave and Fiona Harvey for their enthusiasm and assistance in recording early season nesting activity.

Western Australia Department of Environment and Conservation: The input, technical comments and general support of this programme by Dr RIT (Bob) Prince is gratefully appreciated.

Sirtrack Wildlife Tracking Solutions: Wildlife Telemetry Consultant Kevin Lay provided invaluable assistance and advice on the platform terminal transmitter programming and data analysis of preliminary results.

Crackpots Marine & Rural Supplies: The harnesses used for the platform terminal transmitters were mostly hand made especially for Australian flatback sea turtles. Many years of research and development have gone into them and we thank Paul Tod for his advice and assistance.

CLS (Collecte Localisation Satellites) & www.seaturtle.org: CLS – Argos Systems is the satellite telemetry used to receive signals from the transmitters. The raw data is received by CLS and then processed by the free STAT software and system operated by seaturtle.org.

The help from Michael Coyne of seaturtle.org in assisting with the set up of the Conservation Volunteers website pages for public viewing is appreciated.

1.10. Further Information & Enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expeditions website www.biosphere-expeditions.org.

Enquires should be addressed to Biosphere Expeditions at the address given below.

2. 2010 nesting activity for the flatback turtle (*Natator depressus*) at Eco Beach Wilderness Retreat, Western Australia

Glenn McFarlane
Marine Species Manager
Conservation Volunteers

2.1. Introduction & background

In 2000, Cyclone Rosita wreaked devastation along the north western Kimberley coastline of Western Australia. The original wilderness retreat, operated by Australian Eco Constructions and located at the bottom of Roebuck Bay south of Broome, was destroyed by the cyclone. Years later at the same location, Eco Beach Wilderness Retreat reopened mid-2009, providing guests and visitors an opportunity to once more connect with the natural environment.

Conservation Volunteers, in developing the Wild Futures national wildlife conservation programme, has a special interest in this region of the Kimberleys. Wild Futures makes a measurable difference to the future of many of Australia's most treasured animals including the Australian flatback sea turtle (*Natator depressus*), which nests on beaches in the Broome region. In addition to the Eco Beach Sea Turtle Monitoring Programme, Conservation Volunteers also conducts additional flatback turtle research programmes in the region at Cable Beach and at 80 Mile Beach.

2.2. Eco Beach Sea Turtle Monitoring Programme

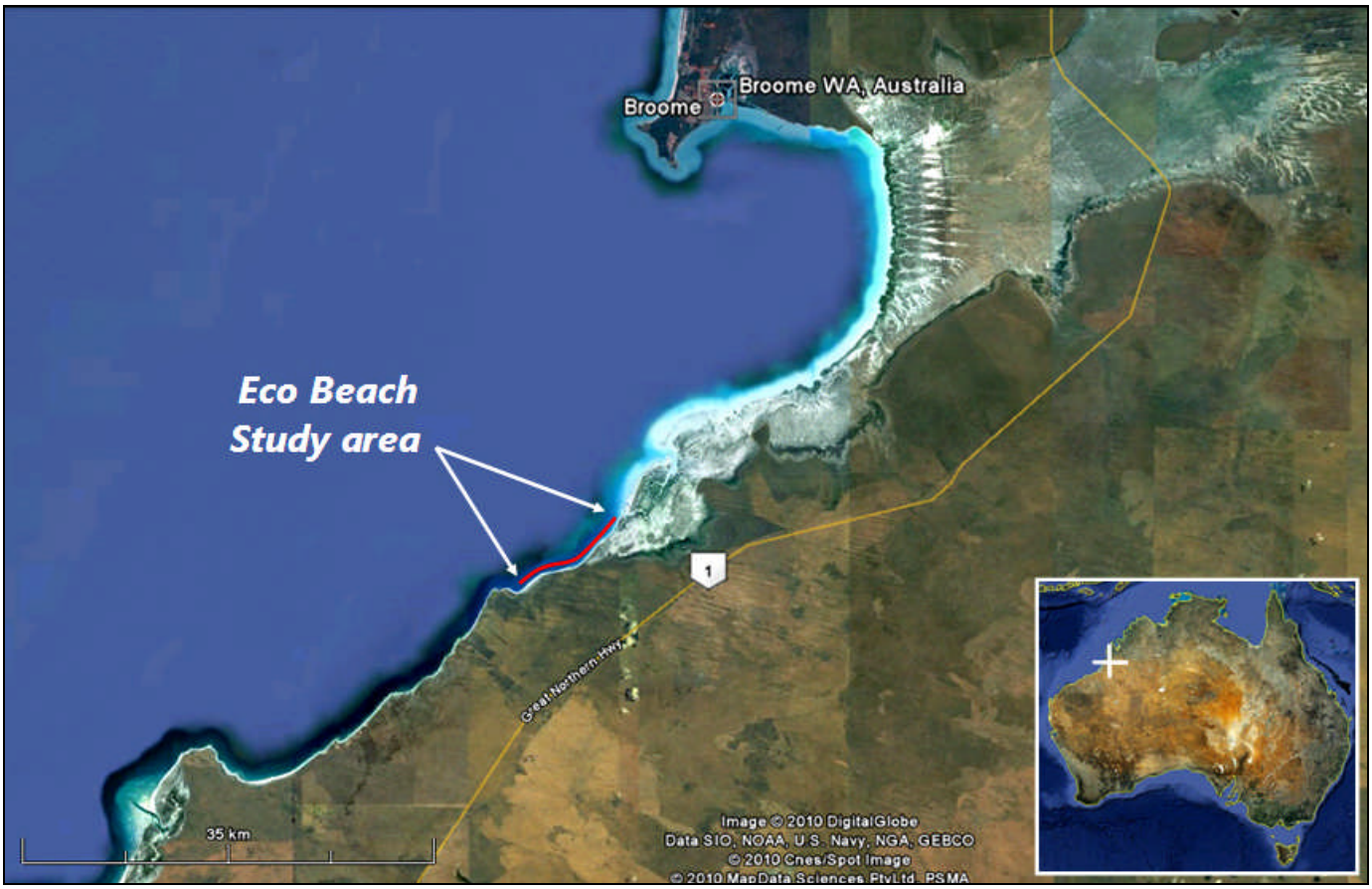


Figure 2.2a. Locality map showing Eco Beach and the survey area. (Source: Google Earth)

While flatback turtles were known to nest along the 12 km of beach heading north from Eco Beach Wilderness Retreat (now referred to in this report as the resort for mapping purposes), no known annual or consecutive recording of nesting turtles had occurred until the commencement of the Conservation Volunteers programme in October 2008. Anecdotal evidence from the resort Managing Director Karl Plunkett and staff together with past track counts by Dr RIT (Bob) Prince of the Department of Environment and Conservation WA, provided the basis for Conservation Volunteers to establish this annual monitoring programme.

While the flatback turtle (*Natator depressus*) is the prime nesting species and hence the focus of the programme, green turtles (*Chelonia mydas*) may also nest on Eco Beach although to this point none have been encountered. Other species such as hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and olive ridley turtles (*Lepidochelys olivacea*) are also known to inhabit these waters.

The Eco Beach Sea Turtle Monitoring Programme for 2010 consisted of three parts:

- A 10-day preparation project[1] during October recorded morning track and nests counts from the night before, plus conducted an annual marine debris survey of the beach.

- The main 40-night tagging component commenced early November and included nest and beach temperature monitoring, hatchling emergence and the deployment of Platform Terminal Transmitters (PTT) to track migratory routes of nesting turtles.

- The 27-day hatchling component[2] consisted of morning surveys to record any late season nesting activity, monitor levels of nest predation and to exhume each nest after hatching to gain a result.

[1] This report focuses on the main 40-night tag and recapture programme. There were 13 flatback nests and 15 false crawls (no eggs deposited) recorded by the Conservation Volunteers preparation project team and the Harvey's from 14/10/10 to 7/11/10.

[2] Key findings of the hatchling component are included in this report in the Results section. A total of 5 nests and 22 false crawls were recorded following the main 40-night tagging component with the last nesting activity on 6th January 2011.

An excellent overall snapshot of the 2010 nesting season was achieved with the assistance of resort naturalists Dave and Fiona Harvey, who recorded early nesting activity between attending Conservation Volunteers research teams.

Community education of guests, visitors and staff is a key feature of this Conservation Volunteers Wild Futures programme and will remain a focus in future years.

2.3. Methods

Survey Area

A 12 km section of beach heading north from the resort to Yardoogarra Creek (locally known as Jack's Creek and also in this report for mapping purposes) was the survey area for this programme. The resort is located approximately 130 km southeast of Broome and near to Cape Villaret. The geographic position of Eco Beach is Latitude 18º19.767'S and Longitude 122º04.939'E.

This survey area located at the bottom of Roebuck Bay is rich in invertebrate fauna found throughout the mudflats, which in turn is fed by the expansive Roebuck Plain. The mudflats give way further south to a long coastal beach running to Cape Villaret and beyond. The study area and Roebuck Bay are renowned for the migration of Arctic shorebirds.

The gradient of Eco Beach is generally flat with a high tidal range in excess of 11 m throughout the year and 10 m during the turtle nesting season. The beach and survey area was geographically divided into three sectors for the programme; (a) Resort, (b) Cliffs, (c) Jack's Creek (see Figure 2.3a below).

(a) Sector: Resort

This first sector extends from the Resort to Cliffs South (a distance of 6 km). The sector has a small low lying dune area adjoining the beach highlighted by a large, sweeping curved coastline. The dunes are sparse in vegetation with soft, sandstone-like low rock structures interspersed. Nesting activity occurs from the high tide mark (which varies greatly) to the occasional nest past the dune amongst the sand and soft rock material.

(b) Sector: Cliffs

The middle beach sector is from Cliffs South to Cliffs North (a distance of 2.5 km). This straight section of beach butts up against what is mostly vertical rocks and cliff faces to a height of 5 m. There is no consistent suitable nesting area where sand meets rock, although nests and false crawls (no eggs deposited) have been recorded annually in this sector. Occasionally a small sand dune up to 2 m against the cliffs appears throughout the year where nesting activity is restricted.

(c) Sector: Jack's Creek

The final sector is from Cliffs North to just before the entrance to Jack's Creek (a distance of 3.5 km). This is a slightly curved section of beach bordering low dunes and a floodplain, which opens to the sea just north of where the Cliffs sector ends. Locally known as Jack's Creek, this inlet and mangrove area is a popular destination for resort guests and Broome locals for the purpose of Mangrove Jack and Barramundi fishing. The majority of nesting takes place between the high tide mark and the fore dune. The vegetation covered dune area past the fore dune is small and unsuitable for nesting activity. In most places these narrow dunes adjoin the low lying flood plain.

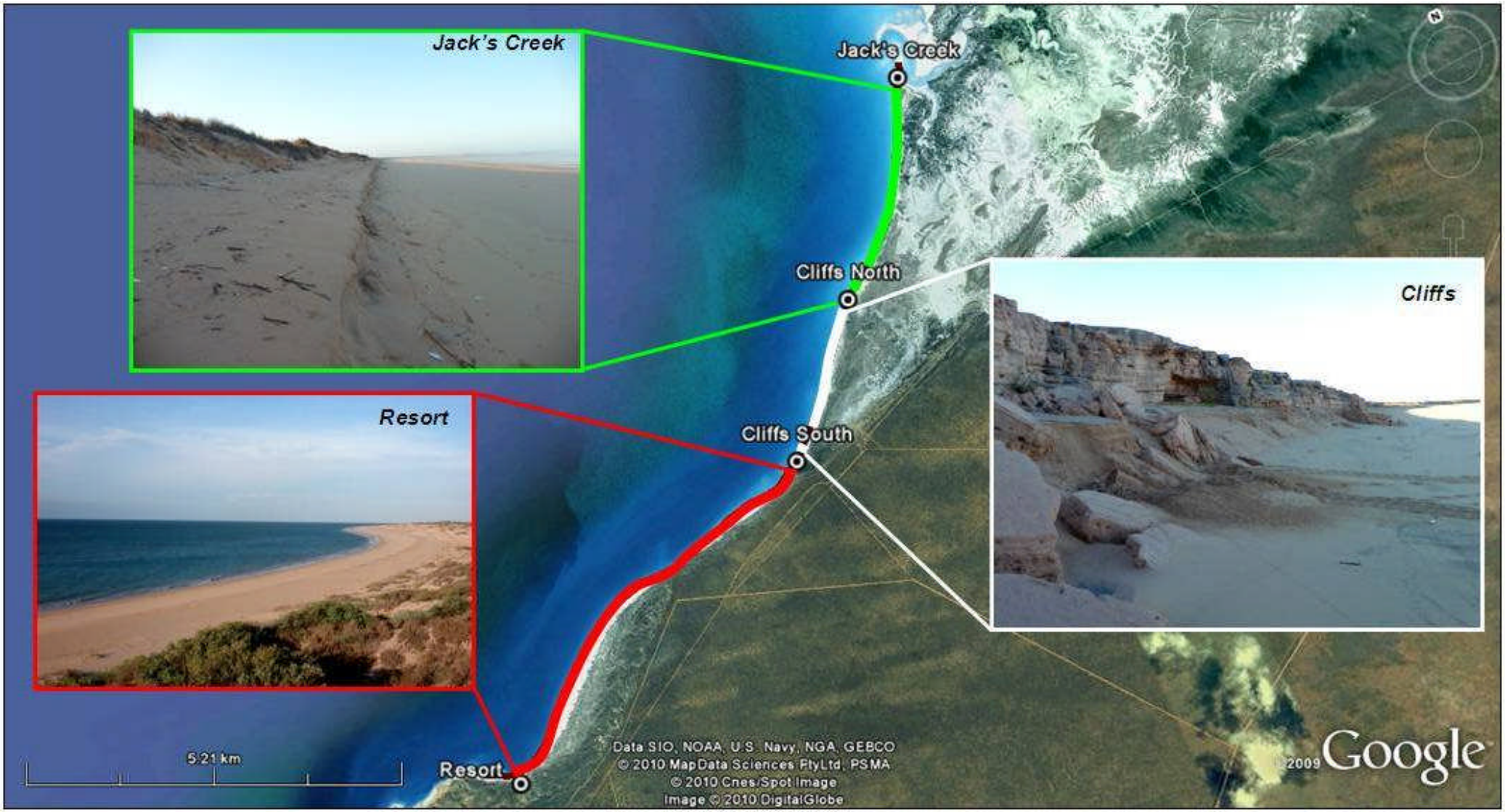


Figure 1.3a. Survey area showing patrol sectors (base map: Map Source / Google Earth).

Patrol days, times and locations

Nightly patrols were conducted from Monday 8 November to Saturday 18 December 2010 which concluded the programme with the standard morning survey. The patrol times varied progressing approximately an hour later each night following the high tide. The length of the patrols varied based on how many turtles were encountered on a sector, but averaged around three hours each night.

Two back to back patrols departed on foot from the Resort sector with one patrol camped out overnight at the Jack's Creek sector. The Cliffs sector was never patrolled at night due to a lower level of nesting activity and unsuitable nesting areas where water meets cliffs. Each day commencing at sunrise, the Jack's Creek sector team completed a morning survey of the entire beach during their return to the resort.

This morning survey, conducted for each of the 40 nights, recorded:

Nest and false crawl activity after the patrols had finished
Hatchling emergence
Interference by predators
Injured and stranded turtles

In turtle time, the actual date recorded on the data sheets (and used in data analysis for this report) commenced at midday continuing through the night to the following midday.

Table 2.3a. Nightly patrols by sector.

Date:	8/11	9/11	10/11	11/11	12/11	13/11	14/11	15/11	16/11
Resort – patrol 1									
Resort – patrol 2									
Jack's Creek	[1]	[1]							
	17/11	18/11	19/11	20/11	21/11	22/11	23/11	24/11	25/11
Resort – patrol 1									
Resort – patrol 2									
Jack's Creek	[2]					[1]	[1]	[1]	[1]
	26/11	27/11	28/11	29/11	30/11	1/12	2/12	3/12	4/12
Resort – patrol 1									
Resort – patrol 2									
Jack's Creek									
	5/12	6/12	7/12	8/12	9/12	10/12	11/12	12/12	13/12
Resort – patrol 1									
Resort – patrol 2									
Jack's Creek	[1]	[1]	[1]	[1]					
	14/12	15/12	16/12	17/12					
Resort – patrol 1									
Resort – patrol 2									
Jack's Creek									

Table Key:

Grey shading indicates a completed patrol
[1] No patrol at Jack's Creek as tides over 9.20m washed over the camping area and the majority of the patrol beach
[2] No patrol at Jack's Creek due to the combined deployment of PTTs on the Resort sector

Tidal variations

An extensive moon and tidal chart was created for the entire nesting and hatching season from 18 October 2010 to 13 February 2011. This was to enable the patrols and later data analysis to gauge the likely survival of a successful nest based on the wide tidal variations.

Like much of this Kimberley coastline of Australia, where spring and neap tides can be extreme, tide variations can affect the nesting success on Eco Beach. The higher spring tides occur around each monthly New Moon and Full Moon phase, with neap tides taking place around the First Quarter and Third Quarter moon phases.

Animal handling protocols

Engagement with turtles by staff and volunteers during the programme was in accordance with the WA Department of Environment and Conservation (DEC) license to take fauna for scientific purposes held by Conservation Volunteers and was supported by the following documentation:

- DEC protocols for turtle flipper tagging programmes
- DEC Animal Ethics Standard Operating Procedures
- Western Australia Marine Turtle Project Protocols
- Australian code of practice for the care and use of animals for scientific purposes
- IUCN / SSC Marine Turtle Specialist Group; Research and Management Techniques for the Conservation of Sea Turtles

In accordance with most international protocols and to reduce the level of human impact on the natural nesting process when on patrol:

- Staff and volunteers remained behind the head of the turtle, quiet and low except for the restraint of the turtle for flipper tagging and DNA sampling upon her return to the water
- Tags were kept clean and a topical antiseptic such as Betadine was used to sterilise flippers for tagging and DNA sampling
- Surgical gloves were worn when handling turtles, hatchlings and eggs
- No insecticides, perfumes or highly-scented creams were used on patrol
- No flash photography (some photos were taken for educational purposes during the deployment of the PTTs, but kept to a minimum)

Use of light

To reduce the level of impact and disturbance to the nesting process, all lights had a red filter. It is generally believed that sea turtles on land are near-sighted and their degree of vision is limited. However, the use of red filters, as opposed to a white light, is less distractive to nesting turtles and hatchlings.

Short wavelength lights such as pure yellow or red, are less disruptive to nesting and hatching sea turtles than sources that emit a substantial amount of short wavelength light e.g. violet, blue, green or any source that appears whitish or golden (Witherington, 1999).

Minimal light was used at all times for the following reasons:

- Light use is a visual distraction to the patrol members when a light, especially a white light, is turned on when walking the beach
- Light is a distraction to turtles attempting to nest
- Hatchlings can become disorientated by light when making their way to the sea

Data sheets

The 2010 nesting season saw the introduction Statewide of a new tagging data sheet to coincide with the new Western Australian Marine Turtle Research and Monitoring (WAMTRAM) tagging database.

Research Assistants (nightly patrol leaders) and the volunteers also recorded additional information necessary for this turtle programme with a complete list of data noted in Table 2.3b below.

Table 1.3b. Data sheet fields and their significance

DEC tagging data sheet	
Beach	**Location of the monitoring**
Date	**Date the patrol commenced**
Time (24 hour clock)	**Time the patrol located a turtle or nesting activity**
Species	**Which species of turtle located**
Remigrant tag number - left / right	**Flipper tag numbers already in a turtle**
New tag number - left / right	**New tags (or tag) inserted by the patrol**
Tag location / barnacled / fixed / scars	**To help gauge the tag duration and status**
PIT tag – present / location / number	**Passive Integrated Transponder for identification**
CCL (total length and to any notch)	**Measuring the Curved Carapace (shell) Length**
CCW	**Measuring the Curved Carapace Width**
Tagger / Measurer	**Cross check of personnel if required**
Turtle activity when tagged	**Action e.g. digging nest, laying eggs, returning to water**
Beach position	**Location e.g. below high water, above high water, in dune**
Latitude	**To locate nesting activity with GPS**
Longitude	**To locate nesting activity with GPS**
Clutch completed - yes / no / unsure	**Visual confirmation of eggs being deposited**
Egg count	**Statistical purposes**
Injuries checked – yes / no	**Statistical purposes**
Body part (mark damage location)	**To help gauge the health of the turtle**
Damage – minor / major / deformity	**To help gauge the health of the turtle**
Flipper damage (mark damage location)	**To help gauge the health of the turtle**
Comments	**Any additional observations noted**
Additional Conservation Volunteers data	
Code	**Allocated Nest or False Crawl code**
Number of body pits	**To gauge unsuccessful nesting attempts in the dry sand**
Track width	**Statistical purposes and to estimate reencountered tracks**
Turtle seen: Yes / No	**To gauge the success of the patrols, help determine activity**
Nest depth	**To gauge sand erosion or accretion upon exhumation**
Nest width	**Statistical purposes, correlation to nest depth, track width**
DNA number	**Vial number for genetic analysis of flipper tissue**
Data logger	**Nest temperature data logger to assist sex ratio determination**
Egg size / weight	**Statistical purposes**
Hatchling size / weight	**Statistical purposes**
Triangulation	**Diagrammatic details of the nest entrance**

A separate standardised data sheet was used to record mortality and strandings with the information provided to DEC.

Conservation Volunteers exhumation sheets were used to record the fate of each nest marked during the programme.

Tagging

External tags were inserted into the front flippers of all untagged turtles. The self locking titanium tags do not corrode or irritate the skin or flesh of the turtle. The tags used on the programme during 2010 were purchased from Stockbrands with a DEC numerical range of WA83701 to WA83875 and 25 turtles were tagged.

Wearing surgical gloves, Research Assistants first inspected the turtle for existing tags or scars. Existing tags were cleaned of barnacles and algae and checked for skin growth or restrictions. Prior to tag insertion, the numbers were recorded on the data sheet, tags individually prepared and the area of the flipper sterilised on both sides. The lowest numbered tag was inserted first into the trailing edge of the left flipper, centre of the first scale out from the axilla (the armpit). The same position and process was used for right side flipper tagging.

Figure 2.3b. Pliers (left) and titanium tag in situ (right).

DNA sampling

As no previous tagging or DNA sampling had been undertaken on flatback turtles in this part of WA prior to the commencement of this programme, it was essential that suitable samples of skin were collected for genetic analysis.

Sampling was done during 2010 at the request of the Institute for Applied Ecology, Faculty of Applied Science at the University of Canberra. DNA samples were taken from all encountered nesting flatbacks and from one dead hatchling.

After the nesting or false crawl processes were complete, a small area of skin was sterilised on a rear flipper of each turtle and a sample approximately 4 mm x 4 mm was removed and placed in a vial containing a preservative solution. The affected area was checked for any bleeding and the turtle released.

A total of 27 DNA samples were taken from *Natator depressus* including 2008 and 2009 remigrant flatbacks which were nesting at a one or two year interval. The two turtles on which PTTs were deployed have also been sampled.

Biometrics

Each turtle encountered was measured when covering the nest after the egg laying process was complete or when returning to the sea. Measurements were taken three times to ensure correct statistical information. Only the length and width of the carapace (shell) was measured in centimeters, not the overall length of the turtle (see Figure 2.3c). Longitudinal measurements were taken from a central point of the carapace near the head to the middle of the notch found at the end of the carapace (CCL: curved carapace length). The widest point of the carapace was also recorded (CCW: curved carapace width).

Figure 2.3c. Measuring the CCW (left) and CCL (right).

A body inspection of each turtle was conducted to record any scars or pieces missing from all four flippers, presence of any barnacles or parasites, any body or shell deformations and also to note the successful excretion of salt as fluid from the eyes.

Additional measurements and data were taken such as the track width of the front flippers, the nest depth and width, location of the nest relative to the water, whether it was a new or remigrant tagging and the number of body pits per nesting attempt.

Nest marking

During the 2008 programme, successful nests were only recorded using GPS. However, in 2009 and 2010 all nests were marked with a bamboo stake and tag 1 m behind the nest entrance.

Once the turtle had finished nesting, volunteers triangulated the nest entrance. As GPS accuracy is to within a 2 m radius, each nest was triangulated using two natural or placed markers and the actual nest entrance as reference points. Measurements using a 50 m tape and compass bearings (see Figure 2.3d below) were also part of the triangulation method to locate the exact location of the nest entrance for exhumation after the hatching process was complete.

Figure 2.3d. Volunteers triangulating a Jack's Creek sector nest

Data loggers

Temperature data loggers were deployed in four flatback nests during the incubation period, plus two additional loggers have been permanently buried at either end of the nesting beach.

In each of the four nests, two DS1922L Thermochron iButtons (High Resolution 8kb / ±0.01°C) were attached to a cord at set intervals and lowered into the nest as the turtle commenced the egg laying process. No disturbance to the turtle or interruption to the egg laying process was observed.

The first iButton was placed at the bottom of the nest and the second iButton located 25 cm further up the cord, which was then laid on the sand surface to allow the turtle to cover and camouflage the nest. The cord was then buried in a small sand channel and attached to a false marker next to the bamboo nest marker and tag. This eliminated the possibility of the bamboo nest marker being removed by external forces during incubation and damaging the nest. All eight temperature data loggers (two per nest) were recovered during the exhumation process (see Figure 2.3e). The data loggers were programmed to record hourly nest temperatures.

Fig 2.3e. Removal of data loggers during exhumation.

The purpose of the iButton data loggers located in nests was to gather data relative to successful embryo development and to indicate whether a nest has produced all males, all females, or a split of the sexes.

As a characteristic of TSD (Temperature-dependent Sex Determination), the pivotal temperature of turtle eggs is the constant incubation temperature that produces equal numbers of males and females. The pivotal temperature during the middle period of incubation determines the sex of the hatchlings and the subsequent male / female ratio of the nest. Limited studies in this field have been published for flatback turtles, although the pivotal sex temperature has been noted at 29.3ºC (Limpus, 1995).

Warmer nest temperatures produce predominantly females while cooler temperatures result in more males. The pivotal temperature for each species of marine turtle varies slightly, not only by the number of degrees, but also by geographical regions around the world where a turtle species nests. The survey area has recorded only flatback turtles nesting during the first three years of the programme. A definitive pivotal temperature for this species is yet to be determined.

The two additional single data loggers were deployed at either end of the survey area as part of a long term study by Conservation Volunteers to monitor any changes in climate at this nesting beach. One DS1922L Thermochron iButton was buried in the main Resort sector nesting area at a depth of 70cm. The same process was repeated at the main Jack's Creek nesting area.

Platform Terminal Transmitters (PTTs)

Two PTTs were deployed during the programme. KiwiSat 101 transmitters from Sirtrack Limited were used (see Figure 2.3f), tracked through the Argos system and displayed on www.seaturtle.org for public viewing.

Each pre-programmed PTT contains lithium cells, which power the transmitter to emit a VHF signal to the nearest Argos satellite when the turtle surfaces to breathe. This occurs when the small antenna on the PTT comes in contact with the air. With software updating the location of a tracked animal daily, a range of data can be obtained depending on the type of transmitter and the sensors required.

One of the main gains from deploying PTTs on nesting sea turtles is to track migratory movements from nesting to foraging to mating grounds as the life cycle of the turtle progresses. Effective tracking can lead to the effective management of turtle stocks, which can often cross international waters.

Figure 2.3f. KiwiSat 101 transmitters with test antenna (foreground).

The conventional method of gluing transmitters to hard-shelled turtles using epoxy resin will fail on flatback turtles as they, similarly to leatherback turtles (*Dermochelys coriacea*), have a carapace covered by a soft and easily abraded skin (Sperling, 2004). Two specially made harnesses were used for the Eco Beach transmitter deployments (see Figure 2.3g). The first step was to epoxy glue each PTT to a base plate.

Figure 2.3g. PTT harness and base plate.

Once the PTT was glued to the base plate and allowed to set for 24 hours, the transmitter was then tested before attachment to the turtle soon afterwards.

The flatback turtle was allowed to complete the nesting process as staff and volunteers prepared the harness by taping it into position on an upturned 68 litre Nally Australia plastic storage bin (see Figure 2.3h). The harness consisted of a central round metal ring, which was located underneath the turtle on the plastron with six seatbelt-type webbing straps leaving the ring and passing around the front and rear flippers, as well as both sides of the turtle.

The turtle was quickly restrained and lifted on top of the plastic box and the central harness ring. Straps were threaded through the base plate and adjusted with velcro and metal clips to secure it in place (see Figure 2.3h).

Figure 2.3h. Attaching the harness (left) and strap positioning (right).

Each flipper was checked for a complete free range of movement before final adjustments were made to the harness, the transmitter activated and tested and then the turtle released (see Figure 2.3i).

Staff and volunteers were able to complete a PTT attachment and deployment in just nine minutes.

Figure 2.3i. Turtle no.1 Lucy Jack (left) and no. 2 Miss Kimberley (right).

The transmitter longevity depends on a number of factors including the repetition pulse rate pre-programmed into the PTT, battery life, biofouling of sensors, loss of the PTT from the carapace or the death of the turtle e.g. through natural causes, hunting, fishing industry bycatch, or the environment which the turtle inhabits, e.g. open water or rocky reefs.

The type and gauge of metal used in the harness ring is designed to corrode in salt water and coincide with the expected transmitter internal battery depletion. The harness then falls off the turtle and sinks, preventing further transmissions.

2.4. Results

Nest and false crawl activity

217 data registrations (65 nests and 152 false crawls) were recorded during the tagging component of the programme (see Figure 2.4a) from 8 November to 17 December 2010 and all were from flatback sea turtles.

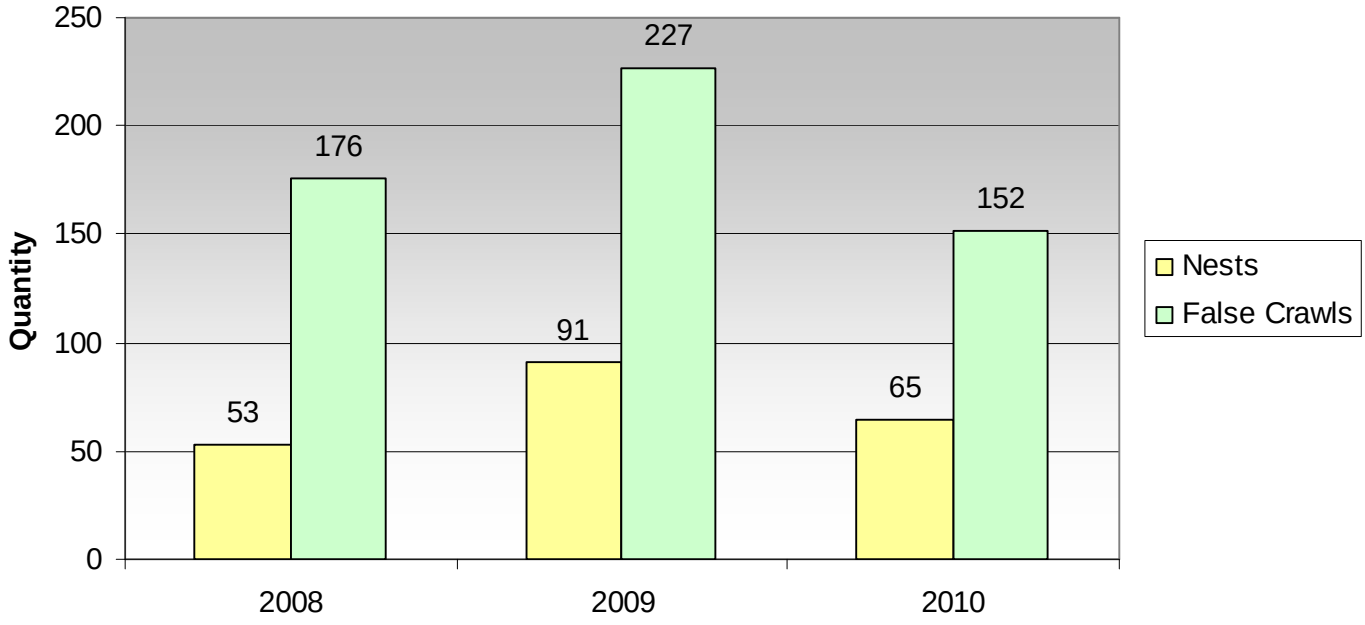


Figure 2.4a. Nesting acitivity.

Before and after this 40-night tagging survey, 15 more nests and 40 false crawls were recorded to complete the entire season. Nesting activity at the beach commenced on 14 October 2010, which was 25 nights later than in 2009.

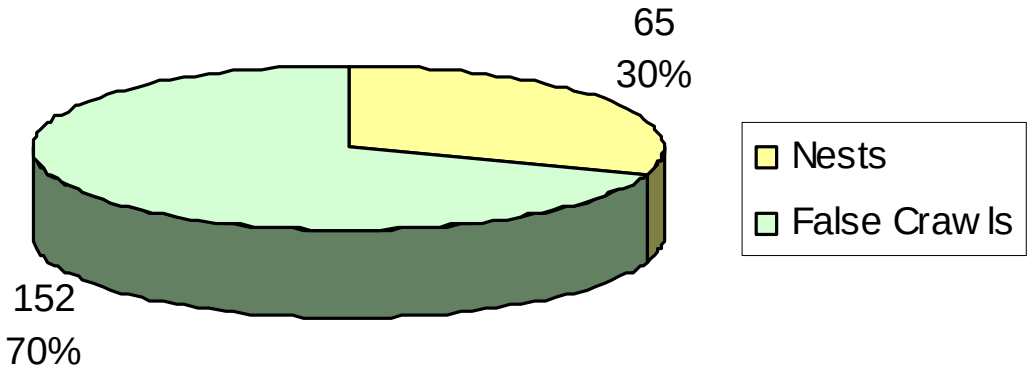


Figure 2.4b. Nesting activity 2010.

The level of activity for the first three years of the monitoring programme is compared in Figure 2.4b above and one would expect to this point different turtles nesting each year. This, however, was not necessarily the case and is explained in the section on remigrant turtles below.

The ratio of false crawls to nests was 3.3 to 1 in 2008 compared to a slightly lower ratio of 2.5 to 1 in 2009. This figure dropped again, but only minimally during the 2010 nesting season to 2.4 false crawls to each successful nesting. Flatbacks in this region choose to nest at the end of the dry season when rainfall is minimal and often when the last good rains were observed some eight months earlier. Increased moisture in the nesting areas prior to season commencement means the turtles are able to have the nest chamber hold in the dry sand, which is constantly buffeted by harsh and dry winds.

As part of the nesting process a turtle clears an area of sand of all debris and begins recessing herself slightly below the beach level. This is called the body pit. The number of body pits was recorded for each nesting attempt (see table 2.4a) as an indicator of annual nesting conditions. During the 2010 programme, the turtles averaged 1.2 body pits each visit to the beach.

Table 2.4a. Frequency of body pits

Number of body pits	*0*	*1*	*2*	*3*	*4*	*5*	*6*
Number of times	**44**	**108**	**41**	**18**	**2**	**0**	**2**

A false crawl takes two forms; where the turtle exits the water and makes no attempt to nest, or where single or multiple body pits or nest chambers are made without depositing eggs.

Due to dry sand, many turtles were observed abandoning collapsing egg chambers and moving closer to the high water mark each time. This pattern generally continued until the turtle found more moist sand suitable for the nest shape to hold and then deposited the eggs.

Location of nesting activity

Activity was scattered along the entire 12 km of the survey area (see Figure 2.4c below) and mirrored previous years.

47% of the 65 nests were centralised in one distinct area between 3 km and 4 km from the actual resort. Nesting on the normally plentiful Jack's Creek sector differed from a past concentration in the most northerly 800 m of the sector. This was due to exposed rock replacing the small nesting dune after tropical cyclone Lawrence passed through the area on 19 December 2009.

The locations of the 152 false crawls were fairly even across the survey area (see Figure 2.4d below). For the first time in the programme, attempted nests were found towards the southern end of the Jack's Creek sector.

Figure 2.4c. Distribution of nests – 2010.

Figure 2.4d. Distribution of false crawls – 2010.

Nesting activity per sector

During the 2010 monitoring period, the Resort sector distance of 6 km yielded 42 nests and 51 false crawls. The Cliffs sector of 2.5 km recorded 6 nests and 28 false crawls, while the Jack's Creek sector of 3. 5km recorded 17 nests and 73 false crawls (see Figures 2.4e & f below).

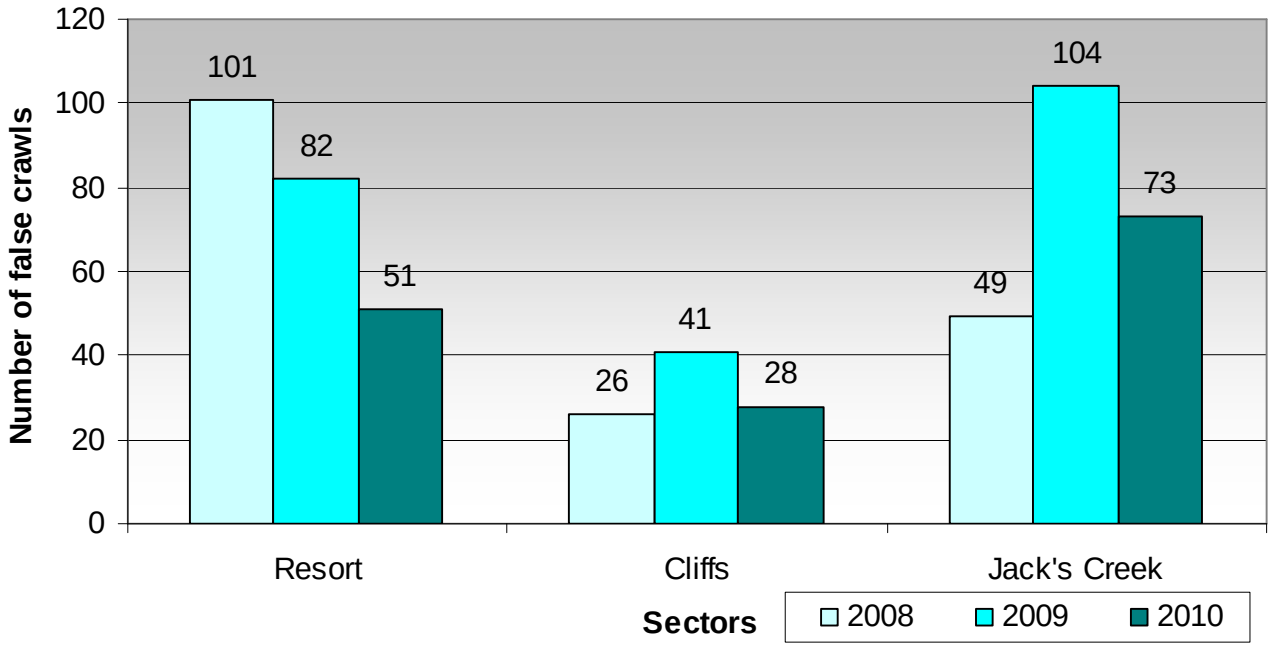


Figure 2.4e. Annual trends of false crawls per sector.

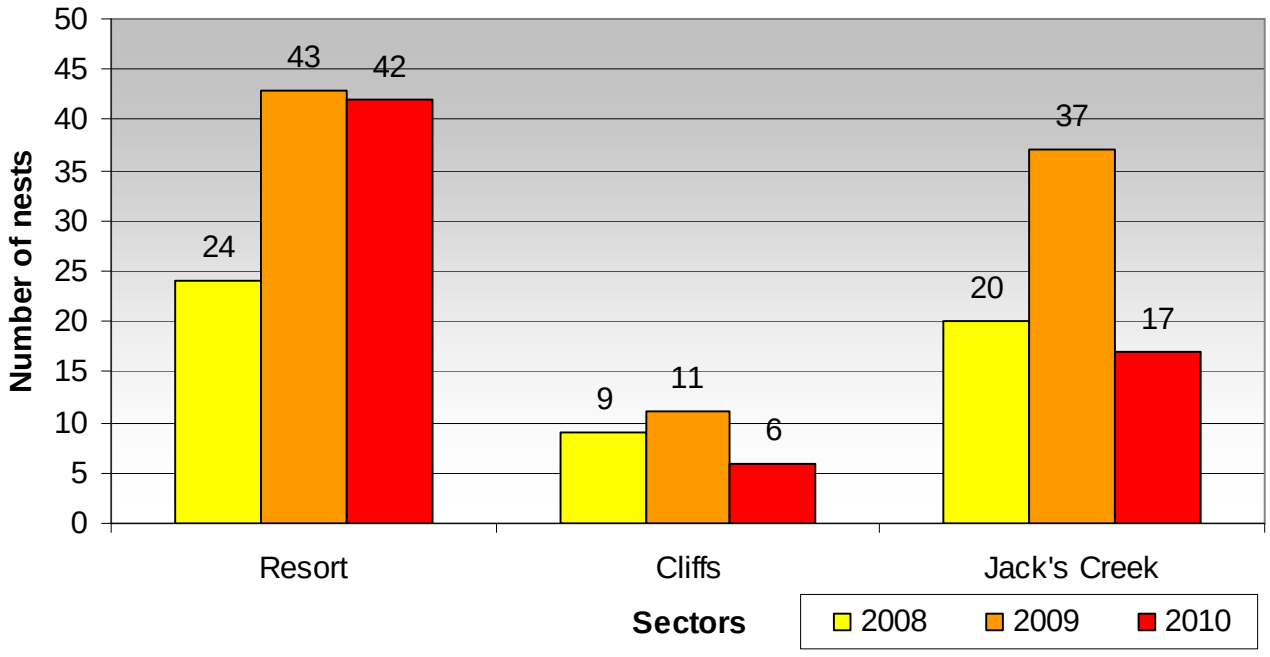


Figure 2.4f. Annual trends of nests per sector.

No one knows exactly why a turtle chooses a particular place to exit the water, make her way up a beach, find a suitable nesting site to make a body pit and then dig the nest to deposit the eggs. Visually there appeared to be little topographic difference between subsectors within the defined survey area of the beach deemed suitable for nesting. The effects of cyclone Lawrence at the conclusion of the 2009 nesting season did result in a higher number of false crawls and fewer nests by comparison with previous years on the Jack's Creek sector for 2010. Nesting activity on this sector was more spread out than in past years with a higher level of false crawl activity nearer the Cliffs North marker. A long-term and in-depth study of nesting activity per sector is outside the scope of this report. It should also be remembered that in the majority of cases the survey area has different turtles nesting each year.

The ratio between the numbers of nests against false crawls on many sea turtle projects would see a greater number favouring nests, for example at the flatback nesting location of nearby Cable Beach in Broome, which Conservation Volunteers also monitors. But this trend has not been the case at Eco Beach during the first three monitoring years, most likely due to the harsh winds and drier sand condition during this time of year when the flatbacks are nesting. The number of false crawls in 2010 outweighed the number of nests by more than 2 to 1.

Location of the nests relative to the sea

Turtles generally nest at different locations each time they return to a beach. At Eco Beach, some favour nesting nearer the vegetation, some on the high tide sandbank and others at the high tide mark. A turtle may also nest at a combination of locations throughout the season.

Categories on the new DEC tagging datasheet were modified slightly from those of previous datasheets used on the programme. Nest location results relative to the sea for the 2010 season indicated the turtles favoured the part of the beach located on the front edge of the spinifex (see Figure 2.4g).

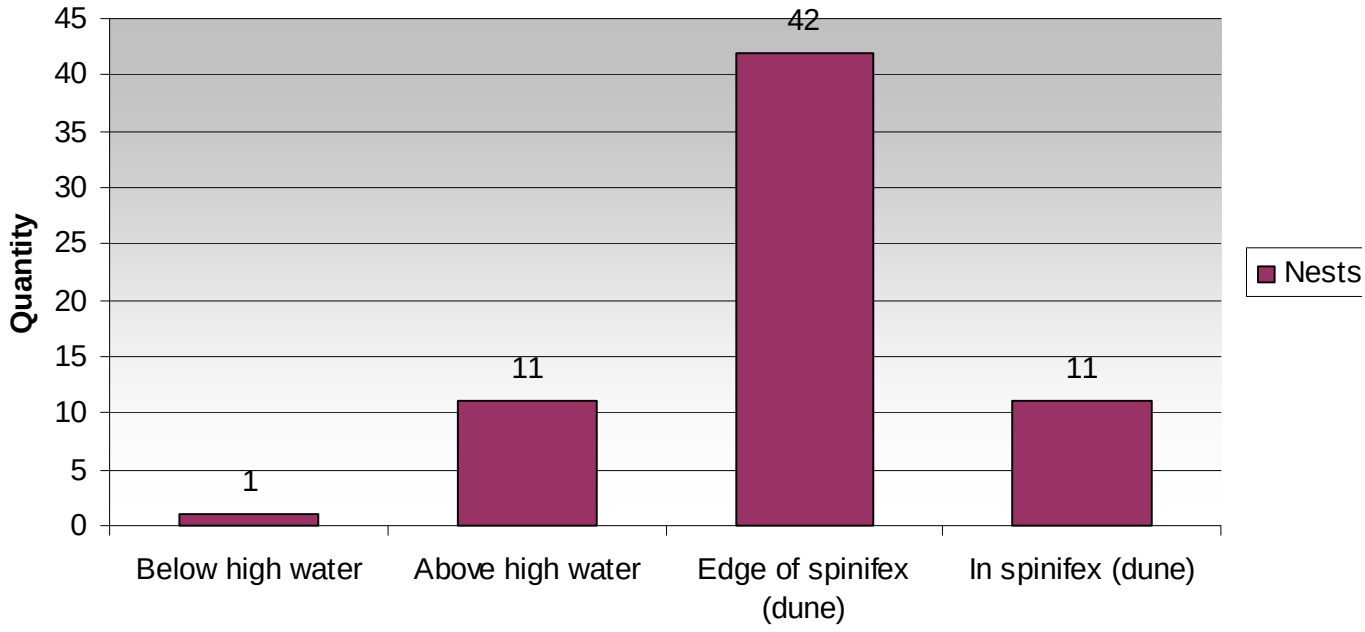


Figure 2.4g. Location of nests relative to the sea.

As observed in 2008 and 2009, a significant number of turtles during the 2010 season tried to nest in the sparse vegetation and dune system, but moved closer towards the water after each abandoned attempt, to enable the nest chamber to hold in the dry sand. Monthly spring tides in excess of 10 m during the complete nesting and hatchling season meant many nests were ultimately washed away as turtles nested closer to the nightly high tide mark throughout the course of monthly tidal variations.

The graph of Figure 2.4g does not tell the complete story of nest locations, as the dynamics of Eco Beach across the 12 km of the survey area varies greatly. Many parts of the Resort sector do not have any vegetation or dune, with sand giving way to long stretches of fragile rock plateaus. The Cliffs sector has mostly waves hitting cliff faces and Jack's Creek sector has a combination of narrow vegetation, dune and rocks for a nesting area.

Number of eggs

Visual egg counts were made of 26 nesting turtles without disturbance to the process or removal of the eggs from the nest. Of the total 1,212 eggs counted only two were identified as infertile being significantly smaller in size and a different shape.

Due to the fragility of nest chambers because of dry sand conditions and the susceptibility of flatbacks to disturbance, no attempt was made during this project to remove a sample of 10 eggs for measurement and weighing. The average number of eggs deposited per nest was 47 (50 in 2008 and 46 in 2009), with a range of 30 to 61.

Turtle biometrics

These results represent factors relating to the physiology of nesting Eco Beach flatbacks.

Nest depth and width

The average nest depth was 45 cm (n=20) with the average width 19 cm (n=19).

Due to the fragility of the nest environment and because the large carapace of a flatback often restricts access to the nest, depth measurements could not always be taken. The depth measurement was taken from the bottom of the nest chamber at the rear, to underneath the rear of the carapace behind the cloaca of the turtle. Width was taken measuring across the widest point of a healthy rear flipper.

Table 2.2b. Nest depths and widths (cm).

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Depth	**40**	**50**	**41**	**50**	**56**	**46**	**44**	**42**	**40**	**36**	**40**	**50**	**42.5**	**59**	**44**	**43**	**47**	**40.5**	**41**	**49**	**-**
Width	**22**	**-**	**23**	**22**	**22**	**15**	**16.5**	**22**	**15**	**15**	**16**	**19.5**	**24**	**18.5**	**25**	**16**	**15**	**-**	**15**	**22**	**15**

There was not a strong biometric correlation between the depth of the nest and the width of the rear flipper used to dig the nest ($R^2 = 0.0492$).

Curved Carapace Length

Each time a patrol located a turtle, even if previously encountered, the same set of measurements were taken. The curved carapace length (CCL) was recorded using a flexible fiberglass measuring tape. A total of 42 individual flatbacks were measured during the programme with many measured on multiple occasions.

Two CCL measurements were taken as per the new DEC tagging datasheet; a measurement to the longest point of the carapace, and a measurement to the central end notch of the carapace. Results given here represent measurements to the notch (note: four individuals did not have a carapace notch)

The average CCL was 87.7cm (sd = 2.18) with a range of 81.2cm to 92.3cm (see Figure 2.4h).

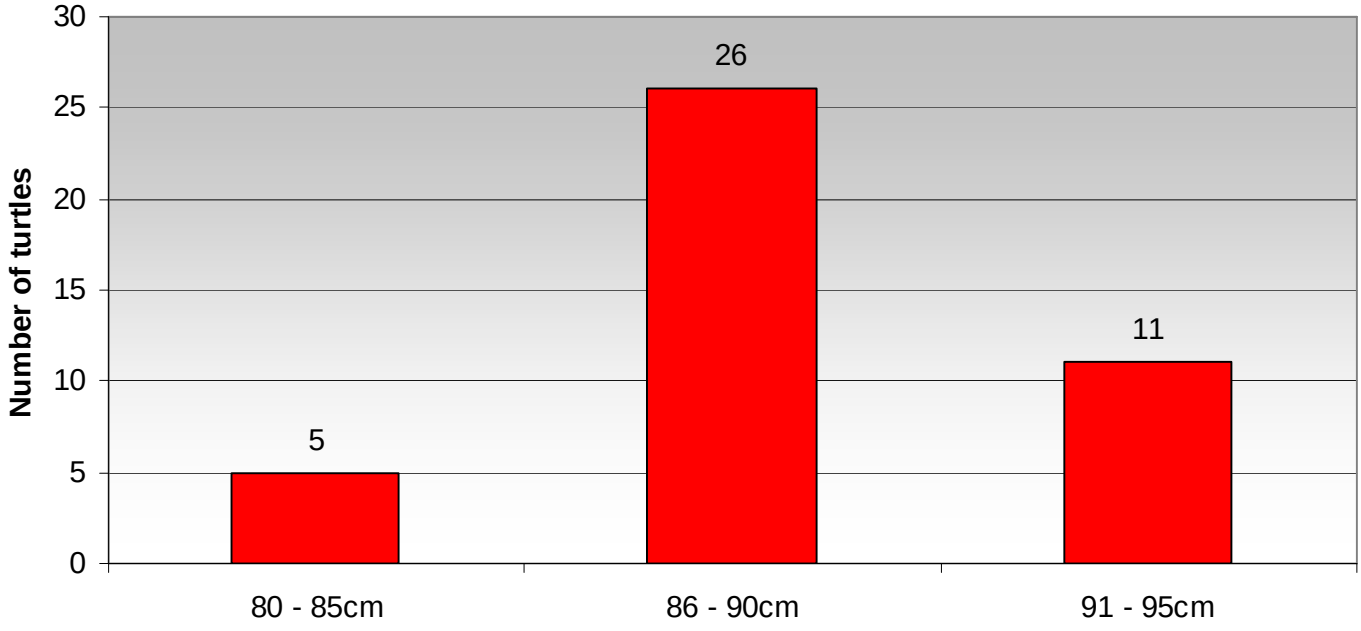


Figure 2.4h. CCL measurements for 2010 Eco Beach flatbacks.

Curved Carapace Width

The average curved carapace width (CCW) was 73.3 cm (sd = 2.46) with a range of 65.8 cm to 77.5 cm (see Figure 2.4i).

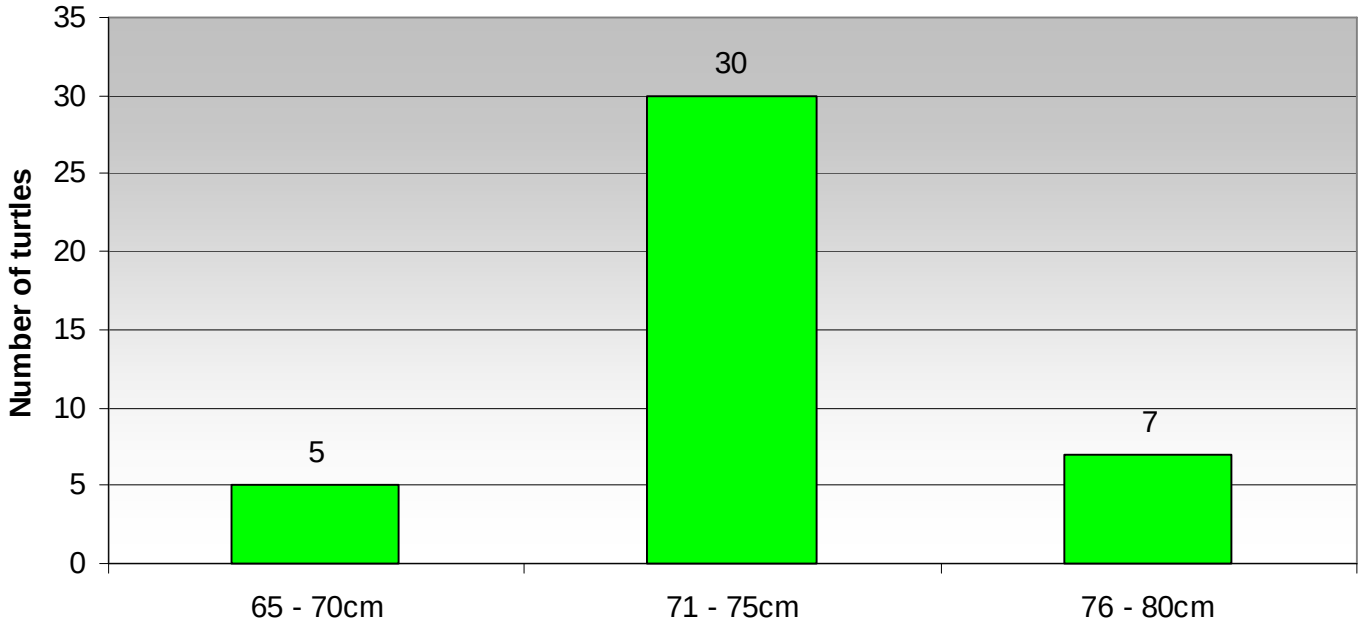


Figure 2.4i. CCW measurements for 2010 Eco Beach flatbacks.

The 42 flatbacks measured during 2010 did not show a strong relationship between CCL and CCW (see Figure 2.4j).

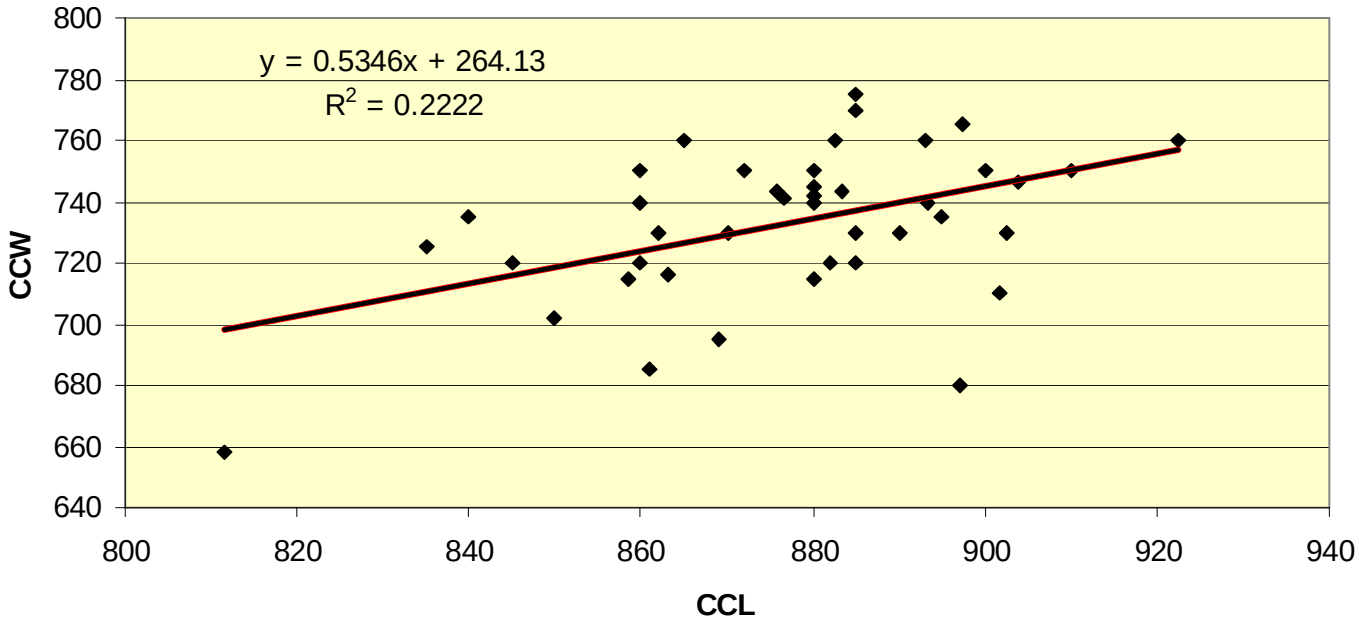


Figure 2.4j. Relationship between CCL and CCW for 2010 Eco Beach flatbacks.

Track width

Turtle track measurements were taken on flat sand from the widest points of the front flippers for 206 of the 217 data registrations. This helped at the time to estimate the number of individual turtles that may have visited the beach or were due to return for each of the 40 nights of monitoring. Some turtles were observed on the beach at least twice during the same patrol and may have, for example, false crawled on the first sighting and then nested on the second.

206 track width measurements were recorded from turtles seen on patrol for nests and false crawls, plus turtle activity recorded on the morning survey where the turtle was not seen. The average track width was 96 cm (sd = 8.43) with a range of 76 cm – 119 cm.

Of the 42 turtles where CCL, CCW and track width were recorded, there was a poor relationship between track width and CCL (R^2 = 0.0309) or track width and CCW (R^2 = 0.0005).

Inspection of turtles

Observations of the flippers, the head (including the eyes), the carapace and the general body structure were taken by the patrols to gain an overall picture of the external health of the turtle.

A turtle may have pieces missing from the front and rear flippers which could be the result of mating wounds or attacks by fish such as barracuda and shark. Carapace scratch marks may be due to mating scars or the turtle inhabiting a particular type of marine environment, for example, a reef or rock protrusions. Inspections were carried out for all 42 individuals with 27 turtles recorded as having damage. Most damage to the flippers was categorised as minor cuts. No fibropapilloma tumors were identified. Overall, the Eco Beach stock appears externally to be relatively healthy (see Table 2.4c).

Table 2.4c. Body damage.

*Flippers **						*Carapace **	
Front left	*Front right*	*Rear left*	*Rear right*	*Tag scars*	*Tags barnacled*	*Edge notches*	*Severe deformity*
1	***6***	***2***	***7***	***2***	***10***	***9***	***1***

* Denotes the subcategory frequency of damage as viewed by standing behind the turtle

Nesting trends

Nesting intervals

Tagged turtles were encountered numerous times on the beach sometimes first as a false crawl and then later completing a nest. Often turtles were seen false crawling but not nesting within a night or two, so it was assumed they nested successfully after the initial encounter and were not seen, or nested outside the survey area.

Five individual flatbacks were visually recorded as completing multiple consecutive nests during the 40 night monitoring programme. One additional flatback was observed nesting twice but with a 25 night interval. The average interclutch interval for observed flatbacks nesting at Eco Beach during 2010 was 11 nights (see Table 2.4d below).

Table 2.4d. Interclutch intervals for 2010 Eco Beach flatbacks

Tag numbers (Left)	(Right)	Date	Time	Body pits	Clutch count
WA38198	WA38199	8/11/10	2048	2	54
WA38198	WA38199	20/11/10	2230	1	
Interval:		11 nights			
WA83789	WA83793	19/11/10	1915	1	
WA83789	WA83793	30/11/10	2200	1	53
Interval:		11 nights			
WA83756	WA83798	27/11/10	2250	2	49
WA83756	WA83798	7/12/10	2118	1	44
Interval:		10 nights			
WA83791	WA83760	1/12/10	2010	2	59
WA83791	WA83760	12/12/10	0100	2	48
Interval:		11 nights			
WA83821	WA83822	1/12/10	1745	1	48
WA83821	WA83822	12/12/10	0006	2	43
Nights since seen nesting:		11 nights			
WA83864	WA83860	11/11/10	2330	1	48
WA83864	WA83860	6/12/10	0000	1	
Nights since seen nesting:		25 nights			

All six turtles returned to nest each time on the Resort sector with only one turtle having a significant distance between nests (see table 2.4e on the right). It should be remembered that the nesting beach is 12 km in length.

Table 2.4e. Distances between interseasonal nests.

Tag numbers (Left)	(Right)	Sector	Distance between nests (metres)
WA38198	**WA38199**	**Resort**	**615**
WA83789	**WA83793**	**Resort**	**412**
WA83756	**WA83798**	**Resort**	**291**
WA83791	**WA83760**	**Resort**	**140**
WA83821	**WA83822**	**Resort**	**220**
WA83864	**WA83860**	**Resort**	**2,500**

Remigrant turtles

Nesting turtles are generally classed as either neophytes or remigrants.

A neophyte turtle is one which is in its first reproductive season. This is very difficult to distinguish without an internal laparoscopy to determine first-time breeding capabilities. For tag and release programmes, the term is used for females with no tags and that have not previously been recorded nesting at that location. The female may be smaller in size, be clean of flipper or body marks and scars and have no previous tags or indication of tagging. Once tagged and seen repeatedly nesting within the same season, the turtle is then referred to as a renesting or interseasonal turtle.

Remigrant turtles are those which have a tagging history of two or more seasons recorded at the same programme or at multiple programme locations.

Published documentation referencing the nesting cycle for flatbacks in Western Australia is limited and incomplete. While flatbacks are regarded as being able to nest at two year intervals as recorded at projects in QLD, NT and WA, 15 to 30% of WA flatbacks have a remigrant interval of one year (personal communication, Dr RIT Prince, February 2010).

Tagged turtles at Eco Beach were encountered returning on many occasions during the 40 nights of monitoring, with combinations of completed nests and false crawls. Due to the length of the nesting beach (12 km) and the Cliffs sector not being patrolled, there were many identified nests where the turtle was not seen. It is anticipated that she will return to nest within two nights of first false crawling. Many tagged turtles have been sighted annually on one occasion only and logic dictates that these turtles had migrated back to the beach for the sole purpose of nesting. These points should be considered when analysing the data below which reference only repeated visual confirmations of egg depositing per turtle, such that overall remigrant numbers are likely to be much higher than stated here.

33% of previously tagged flatbacks nesting during the 2010 season were tagged and had nested in 2009.

16% were tagged and had also nested during the 2008 season (refer figure 2.4k below).

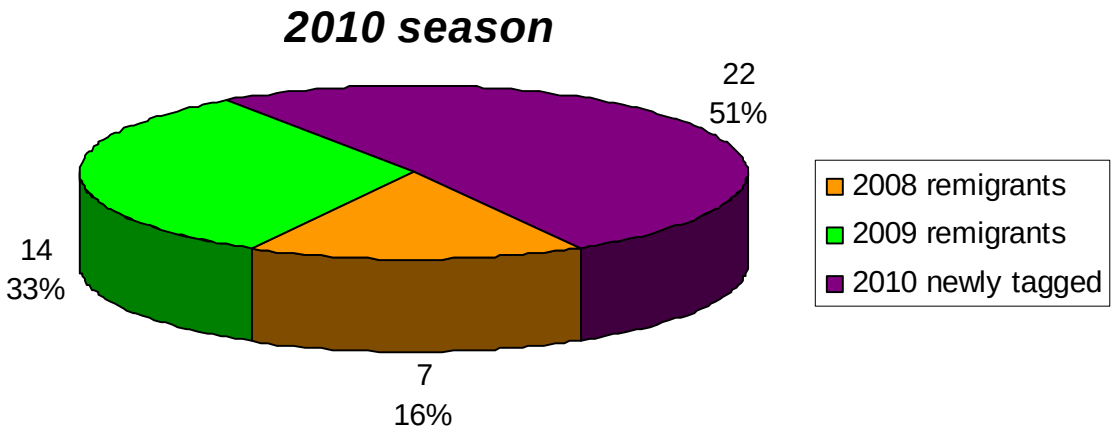


Figure 2.4k. Tagged nesters at Eco Beach in 2010.

Table 2.4f. When have the 2008 turtles returned?

Number of tagged turtles in 2008	2008 turtles as remigrants in 2009 (one year cycle)	2008 turtles as remigrants in 2010 (two year cycle)	2008 turtles as remigrants each year (annual cycle)
29	6 (21%)	7 (24%)	2 (7%)

Table 2.4g. When have the 2009 turtles returned?

Number of tagged turtles in 2009	2009 turtles as remigrants in 2010 (one year cycle)
42	33%

While still in the early years of this Eco Beach dataset, it is too soon to distinguish definitive cyclic remigrant trends. However, it is notable that during the first three years of monitoring, 20 of the 93 individuals seen have returned to the nesting beach at an interval of one year. It will be interesting to follow trends over a longer period of time for the two observed turtles from 2008 which in the first three years have returned to Eco Beach annually.

Nesting peak

Monitoring for 40 nights enabled more than one full moon and monthly tide cycle for any correlative nesting observations to be made. Spring and neap tides at this beach vary greatly over a month with 6.13 m for a neap high tide and 9.92 m for a spring high tide as examples from the 2010 monitoring period. Two First Quarter and one Full Moon, Last Quarter and New Moon phases were observed during the 40 nights.

Nightly nesting activity during the monitoring period peaked at 15 data sheets on 1/12/10 which was two nights after the solitary Last Quarter moon phase (see Figure 2.4l).

Nesting activity was lowest on 14 and 16 November, which correlated with the lowest recorded high tide (a neap tide) and a First Quarter moon phase (see Figure 2.4l).

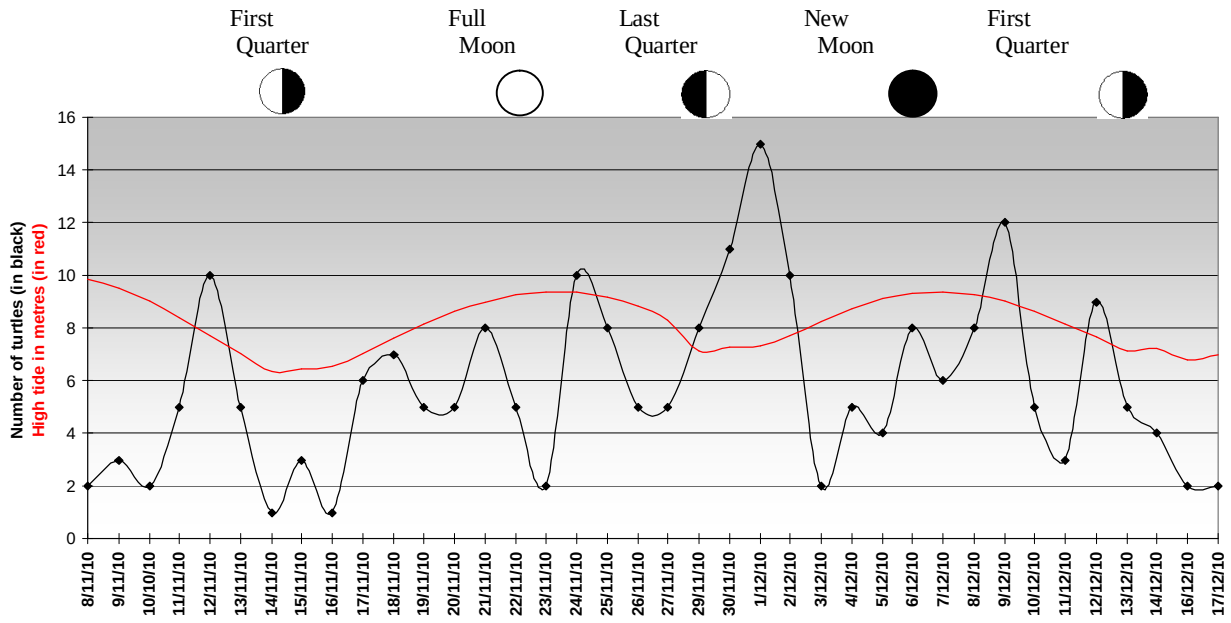


Figure 2.4l. Nesting activity over 40 nights relative to moon and tide.

Outside the scope of this report, a deeper analysis of tidal fluctuations and moon phases relative to nesting activity at Eco Beach is being conducted. However, it is worth noting the main nesting periods for the first three years of the programme as indicated in Table 2.4h. These results signify main nesting periods taken from annual three night averages of nesting activity.

Table 2.4h. Eco Beach main nesting periods 2008 to 2010.

Year	Number of data registrations	Criteria*	Main nesting period dates	Number of consecutive nights
2008	229	8 nights	29th November to 2nd December 4th to 8th December 15th to 17th December	4 5 3
2009	318	10 nights	9th to 19th November 5th to 10th December 13th to 15th December	11 6 3
2010	217	8 nights	27th November to 3rd December 7th to 10th December	7 4

** Equal to or greater than, for the number of turtles per night taken from a three night average*

Temperature data loggers

Thermochron DS1922L iButtons (High Resolution, ±0.01ºC) were deployed at the survey area from 1 to 5 December 2010 in four nests. Two permanent beach data loggers have been in place since 10 December 2009.

Nest data loggers

Eight loggers were placed in nests (two per nest) at set depths with the bottom logger at the lowest point of egg placement and the top logger 25 cm higher. Each turtle's nest depth dictated at what beach depths the loggers recorded hourly temperatures (see Table 2.4i).

Three nests were located on the Resort sector and one nest on the Jack's Creek sector. Although more nest loggers were desired at the Jack's Creek sector, turtles at the time did not nest at locations, which would have survived subsequent high tides during incubation.

Table 2.4i. Nest and data logger results (Celsius) for the 2010 Eco Beach season

Nest code	Date in	Date out	Number of days logged	Nest depth at the time	Nest depth at exhumation	Minimum temp.	Maximum temp.	Average temp.	Std. Dev.	Hatch success rate
DL1 top	5/12/10	29/1/11	55			29.20	33.57	32.26	1.00	80%
DL1 bottom				44cm	57cm	29.75	33.62	32.33	0.88	
DL2 top	2/12/10	29/1/11	58			00.00 *	00.00	00.00	0.00	Unknown
DL2 bottom				50cm	64cm	00.00 *	00.00	00.00	0.00	
DL3 top	4/12/10	21/1/11	48			30.49	34.67	33.13	0.95	100%
DL3 bottom				59cm	59cm	30.82	34.87	33.28	0.84	
DL4 top	1/12/10	21/1/11	51			28.47	34.27	32.78	1.16	96%
DL4 bottom				40cm	81cm	30.64	34.38	32.96	0.77	

* Nest predated with recorded logger temperatures of between 27.03 and 52.11

All nest data loggers, with the exception of DL2 (top and bottom), where the nest was predated, were consistent in their paired recordings. Unlike 2009 where all loggers recorded the same coolest and warmest day, 2010 results varied with five dates across the incubation periods noted as the coolest and two dates as the warmest.

Sex determination of Eco Beach hatchlings

As a characteristic of TSD (Temperature-dependent Sex Determination), the pivotal temperature of turtle eggs is the constant incubation temperature that produces equal numbers of males and females. The pivotal temperature during the middle period of incubation determines the sex of the hatchlings and the subsequent male / female ratio of the nest.

Limited studies in this field have been published for flatback turtles, although the pivotal sex temperature has been noted at 29.3ºC (Limpus, 1995). Warmer nest temperatures produce predominantly females while cooler temperatures result in more males. The pivotal temperature for each species of marine turtle varies slightly, not only by the number of degrees, but also by geographical regions around the world where a turtle species nests. The survey area has only recorded flatback turtles nesting during the first three years of the programme. A definitive pivotal temperature for this species is yet to be determined.

Sea turtle eggs rarely develop at temperatures over 34ºC (Miller, 1997), yet repeating 2009 results, Eco Beach loggers recorded constant temperatures at or above this mark on multiple occasions for extended periods. This includes during the pivotal temperature period which has resulted in high hatch rates. Table 2.4j shows the percentage of total logged time for 2010 where the temperature reached and exceeded 34ºC.

Table 2.4j. Percentage of logged nest time at or above 34ºC for the 2010 Eco Beach season

Nest code	Number of days logged	Nest depth at the time	Nest depth at exhumation	% of time at or above 34 ºC	Hatch success rate
DL3 top	48	59cms	59cms	12%	100%
DL3 bottom				12%	
DL4 top	51	40cms	81cms	4%	96%
DL4 bottom				5%	

The results from the nest loggers were consistent for both 2009 and 2010 seasons, averaging between 32.23ºC and 33.64 ºC during the expected pivotal incubation period.

An analysis of nest temperature data and the known nest hatch success rates for the two seasons shows that embryo development continued to occur when sand temperatures reached and exceeded 34ºC. Temperatures annually were very high during the 48 to 51 days that loggers were activated, including during the pivotal temperature period, suggesting a strong female-biased sex ratio. Annual nest logger results of high temperatures were consistent with those of the two permanent beach data loggers.

Beach temperature data loggers

A logger at both ends of the survey area buried at 70 cm has been in place since 10 December 2009. As per the nest loggers, they are set to record hourly sand temperatures for the battery life lasting some years as part of a long term study to record any changes in climate.

The initial Jack's Creek logger was washed away by cyclone Laurence on 20 December 2009 whilst the Resort sector logger failed for a five month period during 2010. Both replacement loggers in place and activated during the 2010 nesting season recorded temperatures consistent with those of the nest loggers for the same period with a range of 28.20ºC to 34.17ºC.

As with correlating nesting occurrence with tide and moon phases, an in-depth study of beach and TSD nest temperatures is outside the scope of this report.

Fate of the nests

For the first time in the programme's history, staff and volunteers remained on site after the 40-night tagging component, conducting a morning survey to monitor hatchling emergence and to exhume all nests. This occurred until Eco Beach Wilderness Retreat closed on 10 January 2011 and was followed by five weekend trips to exhume hatched nests for the previous seven days. The hatchling component of the programme concluded on 13 February 2011, two days after the final nest had naturally hatched.

Beach dynamics

As with 2008 and 2009 results, some 2010 season nests were always subject to erosion and being washed away by impending higher spring tides during incubation. With almost half of the Jack's Creek nesting sector washed away by tropical cyclone Laurence on 19 December 2009, the narrow foredune system gave way to exposed rock and the beach dune system has not returned to date. Successful nest locations during 2010 moved further south down this beach sector yet the overall number of nests on Jack's Creek sector dropped by 54% compared to 2009 figures.

Exhumations

Complete exhumations were conducted on 47 of the 65 nests (see Figure 2.4m below) and were categorised as:

Exhumed – A completed nest result.

Hatched and predated – Incomplete result due to signs of predation and egg shells located inside and outside of the nest with known egg numbers not tallying.

Total predation – No result and nest destruction.

Washed away – Tidal influences removed the nest.

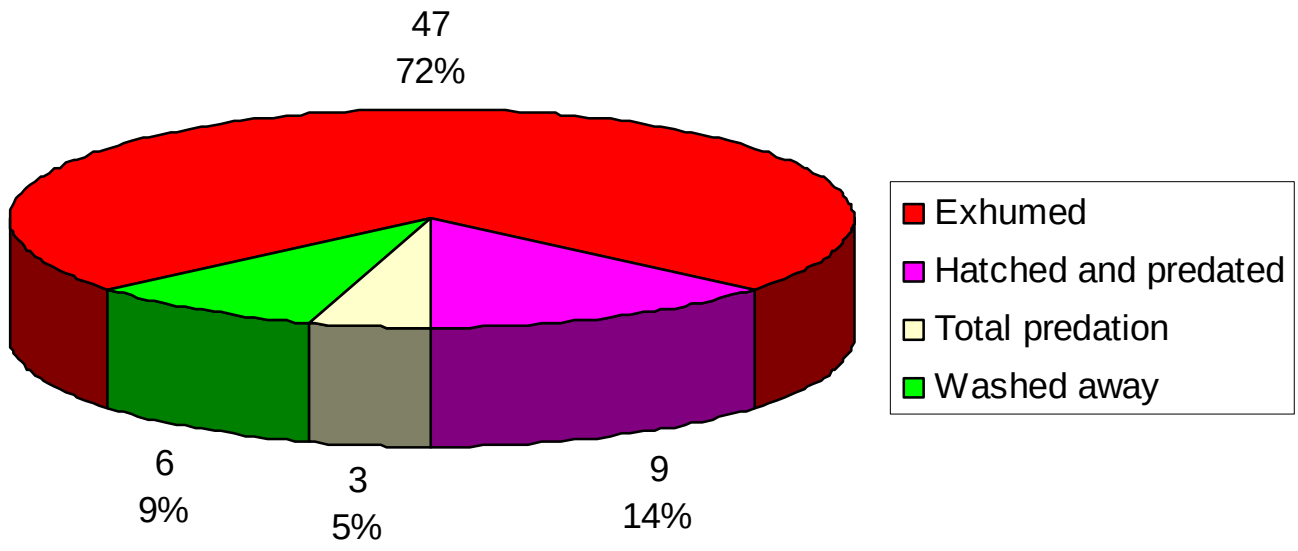
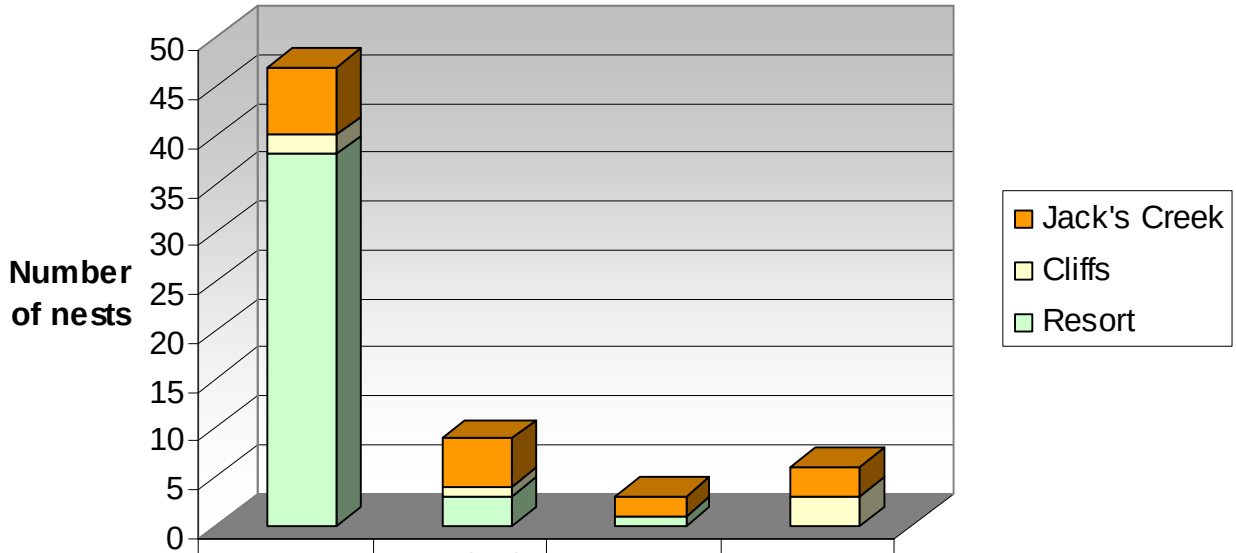


Figure 2.4m. Nest fate.

As with past years, predation by native predators such as large sand goannas (*Varanus* spp.) and canine (*Canis* spp.) was centralised on the Jack's Creek sector and in 2010 accounted for 58% of all predated nests. Beach sector results as per exhumation categories are shown in Figure 2.4n.



	Exhumed	Hatched and predated	Total predation	Washed away
Jack's Creek	7	5	2	3
Cliffs	2	1	0	3
Resort	38	3	1	0

Figure 2.4n. Nest fate by sector.

The hatch success rate of exhumed nests at Eco Beach for 2010 remained high with an average of 87%. Hatch success percentages ranged from a low of 5% (n=1) to a high of 100% (n=14) with the results indicated in Figure 2.4o below.

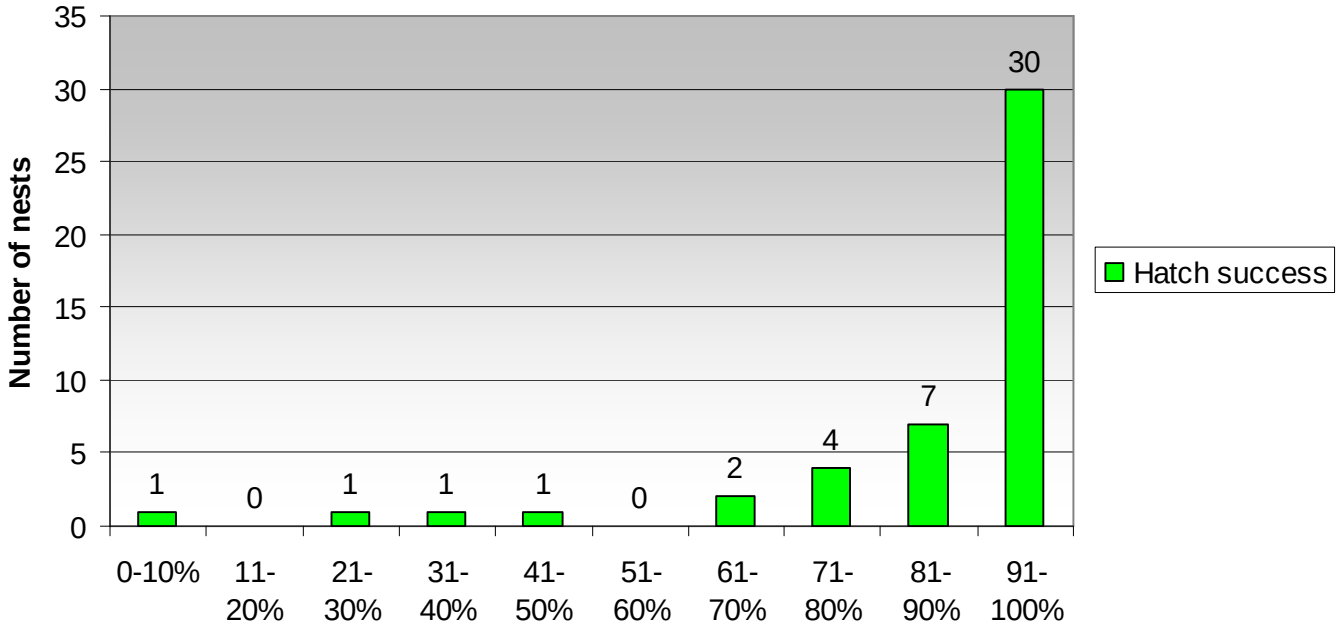


Figure 2.4o. Nest hatch success rate.

The average incubation period was 48 nights (n=28) and as was the case in 2008 and 2009, eggs with no embryo development accounted for the majority of eggs opened. The results for the 47 complete exhumations and individual egg findings are summarised in Table 2.4k.

Table 2.4k. Nest exhumation results.

No development	Stage 1	Stage 2	Stage 3	Stage 4	Maggots	Fungus	Bacteria	Ants	Crab	Roots
163	29	12	46	28	1	29	32	0	25	17

Explanation of embryonic stages:
No development – No embryonic development was found in the egg.
Stage 1 – Where the embryo (including the bloodline and eyes) was up to 25% of the egg mass.
Stage 2 – Where the embryo was between 25% and 50% of the egg mass.
Stage 3 – Where the embryo was between 50% and 75% of the egg mass.
Stage 4 – Where the embryo was between 75% and 100% of the egg mass yet the hatchling remained dead in the shell.

24 developed hatchlings were found dead in nests and one hatchling found dead outside a nest.

The average nest depth at exhumation (from beach level to the chamber bottom) was 66 cm (n=53) and included nests listed as Hatched and predated.

Strandings and mortalities

One Western Australia Government Marine Wildlife Stranding and Mortality Report was completed during the programme.

A 28 cm (CCL) immature female hawksbill turtle (*Eretmochelys imbricata*) was washed up and found dead on the Jack's Creek sector on 20 November 2010.

Platform Terminal Transmitters

Two more Kiwisat101 Platform Terminal Transmitters (PTT) were deployed during the programme in November and December 2010 to complement the two from the 2009 nesting season. A full study on migratory paths for these four past and future Eco Beach deployments is outside the scope of this report. However, an indication of this most recent tracking is given in Figure 2.4p with individual turtle details listed in Table 2.4l.

Table 2.4l. 2010 Eco Beach PTT turtles.

Name	Deployment date	Left tag number	Right tag number	Year first flipper tagged	Curved Carapace Length
Lucy Jack	17/11/10	WA83870	WA52493	2008	86.3cm
Miss Kimberley	16/12/10	WA83742	WA83811	2009	87cm

Lucy Jack was the first PTT to be deployed and she was located false crawling on the Jack's Creek sector at 17.30 in the afternoon. She was not sighted again on the beach. Her PTT transmitted for only 82 days and she travelled 1,240 km mostly in circles while continuing to nest and then starting her foraging (feeding) phase. Lucy Jack was last tracked 38 km northwest of Eco Beach starting to leave a foraging area.

The second PTT was deployed after Miss Kimberley nested on the Resort sector and at the time of writing the telemetry continues to transmit after 194 days and 20,919 km. She was last located off Adele Island (see Figure 2.4p below).

All tracked turtles from this programme can be followed by visiting www.seaturtle.org and searching the tracking section for *CVA Eco Beach, Western Australia – Flatback Monitoring Programme.*

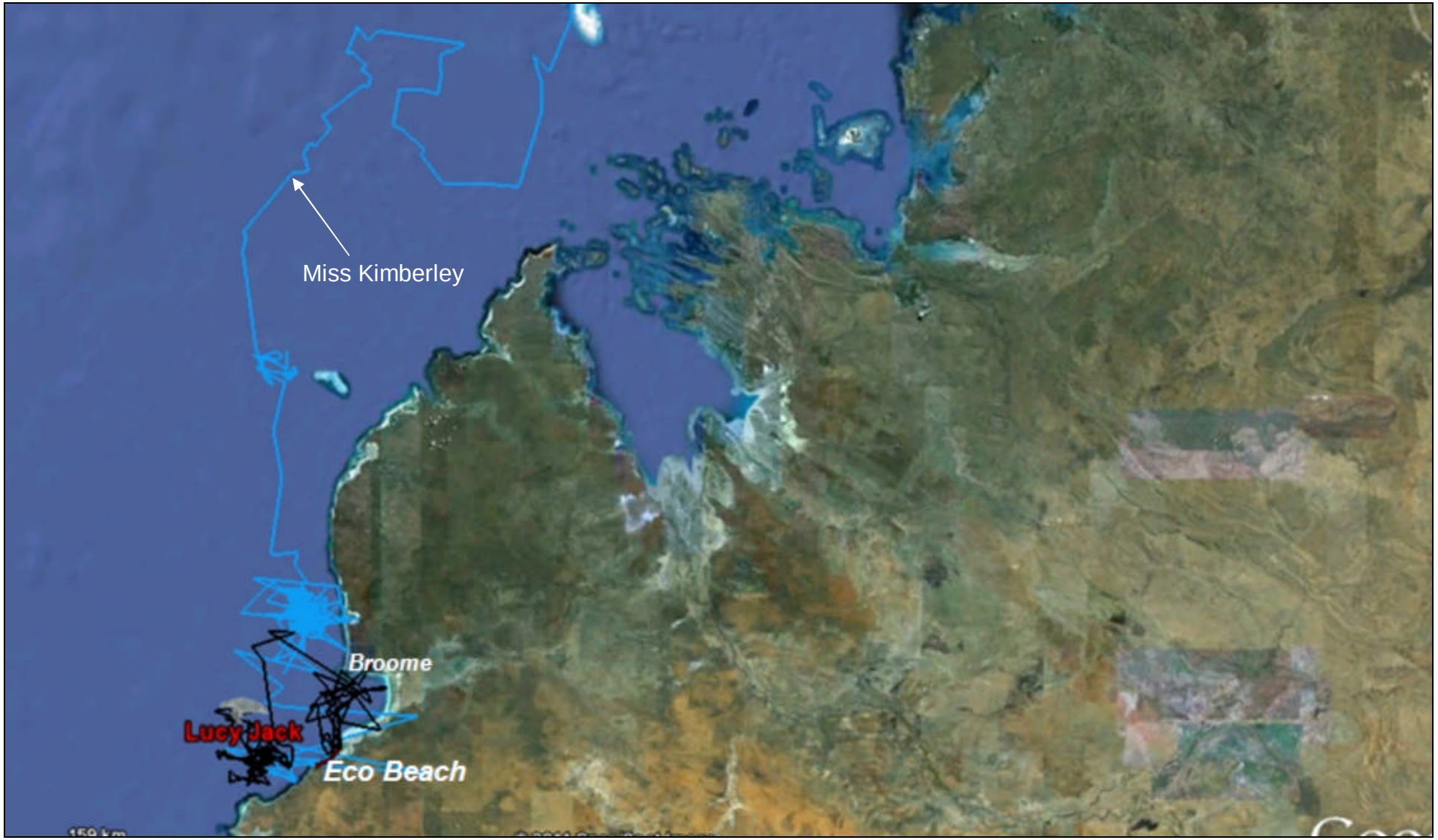


Figure 2.4p. Satellite tracking of two 2010 season Eco Beach flatbacks to 30 June 2011. Source: seaturtle.org STAT / Google Earth.

2.5. Summary of Findings

2010 nesting activity for flatback turtles (*Natator depressus*) at Eco Beach, Western Australia

Total distance of the survey area		12 km
Total number of records (nests and false crawls)		217
Number of nests		65
Number of false crawls		152
Nesting activity by other species		0
Number of turtles tagged during the program		22
Number of remigrant females from other programs		0
Number of remigrant females from previous years		7 from 2008 14 from 2009
Number of individual turtles seen		42
Interclutch interval (number of nights)		11
Number of turtles observed nesting more than once		6
Average carapace length (CCL):		87.7 cm
	Maximum	92.3 cm
	Minimum	81.2 cm
Average carapace width (CCW):		73.3 cm
	Maximum	77.5 cm
	Minimum	65.8 cm
Average track width:		96 cm
	Maximum	117 cm
	Minimum	76 cm
Average number of body pits per turtle:		1.2
	Maximum	6
	Minimum	0
Average number of eggs per nest		47
Average depth of nest (to nest bottom)		45 cm
Location of nests by sector:	Resort	42
	Cliffs	6
	Jack's Creek	17
Location of false crawls by sector:	Resort	51
	Cliffs	28
	Jack's Creek	73
Number of predated nests		12
Number of predated nests by sector:	Resort	4
	Cliffs	1
	Jack's Creek	7
Average hatch success rate of exhumed nests		87%
Favoured moon phase for nesting activity		Last Quarter
Main nesting period		27 Nov - 3 Dec
Lowest temperature recorded by a nest data logger		28.47ºC
Highest temperature recorded by a nest data logger * 52.11 from an eroded nest		34.87 ºC *
Number of Platform Terminal Transmitters deployed		2

2.6. Recommendations

Loss of nests

The monitoring programme during 2010 recorded an increase in volunteer numbers and a slight decrease in nesting activity. It is recommended that conservation and research actions continue for 2011.

As in 2008 and 2009, the main causes of nest loss during 2010 were natural predation and erosion of the nesting area. Loss of nests due to predators remains strong and warrants further study and conservation measures. High spring tides from early November 2010 to early February 2011 (higher than those previously seen at the survey area) eroded nests during the incubation period thus preventing embryo development.

Volunteers and staff participating on the patrols were fully aware at the time of monitoring that many observed nests would soon be washed away by impending higher tides, as turtles nested too close to that night's high tide mark. A low percentage of turtles nested higher up in the small dune/vegetation section of the beach.

With a desired outcome of more flatback (*Natator depressus*) hatchlings making it to the sea, then the following recommendation should be considered:

Immediate relocation of nests soon to be washed away, to a point above the monthly spring high tide marks during the incubation period of 55 days (tide charts are extensively used on the programme). The original nest measurements would be used at a location higher up the beach. Only nests where the turtle was observed depositing the eggs would be relocated and not nests identified by the morning survey, as embryo development may soon commence. No rotation of eggs should take place during relocation and they should be placed in the new nest in the same order in which they were removed.

Tracking nesting turtles

Initial satellite tracking of Eco Beach flatbacks during 2009 and 2010 proved successful, giving researchers an insight into movements and regional foraging grounds. It is recommended that this form of tracking continues with a greater number of PTTs deployed in the coming years. Advanced sensor and location telemetry is desired to correctly determine if Eco Beach flatbacks are also nesting on Cable Beach in Broome during the season.

DNA sampling and analysis should also continue to help identify whether the Eco Beach nesting flatbacks are a separate genetic stock or part of a larger and more widespread turtle stock.

2.7. References

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Miller, J.D. 1997. Reproduction in sea turtles. In The Biology of Sea Turtles. (Lutz, P.L. and Musick, J.A. eds). CRC Press, Boca Raton, Boston, London, New York, Washington, D.C. pp. 51-81.

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Witherington, Blair E. 1999. 'Reducing Threats To Nesting Habitat.' Research and Management Techniques for the Conservation of Sea Turtles. K.L. Eckert, K.A. Bjorndal, F.A. Abreu-Grobois, M. Donnelly (Eds). IUCN/SCC Marine Turtle Specialist Group Publication No.4, 1999

3. Expedition leaders' diary: Western Australia 2010 by Matthias Hammer and Wren McLean

This diary is for the Biosphere Expeditions part (from 8 to 22 November 2010) of the monitoring programme

21 October

Hello everyone and welcome to the first diary entry for Biosphere Expeditions' first ever Western Australia turtle expedition. My name is Dr. Matthias Hammer, founder & Executive Director of Biosphere Expeditions, and I will also be your expedition leader on slot 1 of this project, training Wren McLean, who will take over from me for slot 2. You will also meet Glenn McFarlane, our expedition scientist, and Tony, his sidekick ;)

It's a pretty early entry for the diary, because I am about to leave for Australia tomorrow, spending a week in Melbourne & Sydney, going to the office in Melbourne, having meetings and doing some media work, before hitting Broome about a week ahead of slot 1 to get everything prepared.

I'll write once or twice from Australia to tell you how preparations are going, but for now just a quick message that my mobile phone number during the expedition will be +61 (437) 389363. Remember that this is for emergency purposes only (such as being late for assembly, for example).

I'll see you all at 08.00 at the Mercure Inn Continental Hotel in Broome in due course!

Best wishes

Matthias

P.S. This diary is now also on www.biosphere-expeditions.org/diaries and excerpts of it are also on www.facebook.com/pages/Biosphere-Expeditions/132594724471, so please feel free to pass this on to your families & friends for updates on what we are up to.

31 October

I've spent a week in Melbourne seeing our Biosphere office staff, giving press interviews (a couple of which are on our Facebook site www.facebook.com/pages/Biosphere-Expeditions/132594724471), attending our drinks reception in St Kilda, etc. Yesterday I arrived at Broome and it's hot (35 C) and humid with the temperatures set to go one way only - up ;) I'll spend the next week meeting local partners, buying equipment and setting up, ready for the arrival of slot 1 on 8 November. The view from just outside the assembly point alone is pretty impressive, so not a bad place to be for the next few days. There's a video up on Facebook too.

3 November

We're almost ready for you here in Broome. Most of the shopping done and only one more parcel to arrive, as well as Glenn, the scientist. Talking about shopping, if you are worrying about things on your dossier kit list such as headlamps with a red filter, etc., then worry no more as http://www.kimberleycamping.com.au/ has everything you may want, including those headlamps with the red filter. They are even open on Sundays from 09:00 to 13:00, so you can do your last minute shopping there.

Otherwise another hard Biosphere Expeditions day with a visit to Cable Beach
(see http://www.facebook.com/pages/Biosphere-Expeditions/132594724471).

See you soon

Matthias

7 November

The whole staff team has now arrived at Eco Beach at and we're getting ready for the arrival of the first team. Tony & Glenn had their tent strewn with tags, tapes, bamboo poles, markers, backpacks, etc. and Wren & I set up with a computer, printer & lots of paperwork. Skies are iridescent blue, Eco Beach is a beautiful base, it's hot and humid, but there was a good breeze around blowing away the sand flies ;) Long may it last!

8 November

Slot 1 has arrived safely and all were impressed with the research site and the base. No wonder - it's such a beautiful place in picture book surroundings. The first day was packed with briefings on safety, how to restrain, measure, handle, sample, count, spot, and anything else you can think of, turtles. The first beach patrol just headed out into the dark of the night and we'll be on shifts through the night, because darkness and high tides is what the turtles like when coming onto the beach to nest. Wish us luck and more soon.

10 November

We're in the groove now and things are running smoothly. We now have three patrol groups doing shifts on the beach during the night and early morning and two of those groups have come across and handled turtles. The third group have been unlucky so far, but their time will come! Unusually we've also had a couple of turtles come up on the beach to nest during the heat of the day, which are cloudless with blue skies and temperatures in the high 30s centigrade. Thankfully there's usually a breeze about.

12 November

After a few slow nights on the beach, and just as half our team departed for an afternoon trip to a neighboring Aboriginal community art centre, our first untagged turtle emerged in broad daylight, directly opposite base and proceeded to nest!

Luckily one of our patrol teams was on the case and were able to observe and process the turtle as well as keep other inexperienced onlookers from disturbing her. A total of 47 eggs were laid and we now have another gal added to our database of Eco Beach Flatbacks. Sensibly she chose to nest the shade of one of the sun shelters provided for guests on the beach.

We have been most surprised at the amount of daytime nesting behavior which is not what we would have predicted. As the 'Data Deficient' classification for Australian flatback turtles suggests we still have a lot to learn about these ancient creatures.

Have a look at the Facebook entry with a patrol member counting eggs - http://www.facebook.com/pages/Biosphere-Expeditions/132594724471.

17 November

After a couple of quiet nights on the beach, the pressure was on to locate a turtle to deploy our satellite transmitter.

Heading back to catch dinner before patrols started, we spotted the all important turtle of the night, Lucy-Jack sniffing around for her nesting site. Relieved to have the turtle we needed for the job, we radioed back to base from further up the beach whilst some of us kept an eye on her. Luckily the equipment and crew we needed were ready to rock and we didn't need to restrain her long before they were on site.

She had lost one tag over the last couple of years since we had seen her last, so she needed some processing before fitting her new harness with satellite transmitter attached. She remained calm and the whole process was completed in 15 min or so. Lots of happy feelings and high fives followed as we saw her off into the sea. The latest update is that she has travelled around 9 km in the Eco Beach Bay.

18 November

Patrol 1 was leaving to drive to Jack's Creek and came across its first turtle in the golden light of sunset. She was digging a body pit on the edge of the dunes. The patrol spent some time watching her sandblasting antics, noted she was tagged and took some beautiful photos. Then soon after, encountered their second turtle emerging from the surf in the twilight. They stopped the car and observed her for a while then, deeming by her behavior that she would be there for some time, decided to put up their tents at our campsite only 200 m or so before coming back to process her.

One of us had her head strategically positioned near her rear end ready for an egg count as she neared the end of her egg chambering. For mysterious turtle reasons, she then stopped digging and started filling it in again.

She proceeded to dig two more body pits and each time filled it back in. By that time the group had stayed with her for 2 hours and the patrol leader called the decision to move on to patrol the rest of the beach. The group tagged and processed her and interestingly this did not perturb her from continuing her nesting attempts and she was still faffing around in the dunes trying to find a suitable spot an hour later when the patrol returned to camp.

22 November

The early high tides and full moon this week gave us some fortunate chances to view and photograph turtles in the light. We had to be extra cautious not to disturb nesting turtles under the bright moonlight. All team members had intimate and memorable moments with our ancient turtle friends and most of them witnessed the nesting process. Most of the turtles we encountered have been re-migrants, meaning they have already been tagged whilst nesting over the previous two years of the project.

Our calf muscles were feeling pretty buff this morning as team 2 calculated the many km we have walked up and down Eco Beach. Good vibes all round as team 2 waved goodbye this morning, thanks so much for being so much fun. And thank you everyone for making this expedition a success! Safe travels home and please stay in touch and don't forget to share your pictures via www.biosphere-expeditions.org/pictureshare.

Best wishes

Wren McLean
Expedition leader