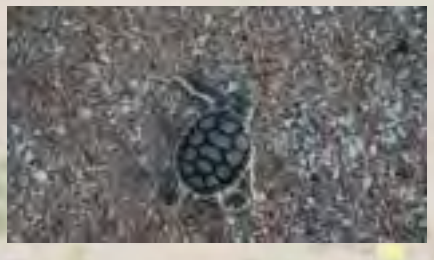

Monitoring Nesting Flatback Sea Turtles - West Island, Sir Edward Pellew Islands

SW Gulf of Carpentaria

WARNING: This document may contain images of deceased Aboriginal people

LIANTHAWIRRIYARRA SEA RANGER UNIT

MABUNJI ABORIGINAL RESOURCE CENTRE

This project was primarily conducted by li-Anthawirriyarra rangers, including the following people:

Ranger Coordinators
2015 – Current Fiona Keighran
2013 – 2014 Ray Ulinovich
2010 – 2012 Chris Francis
2007 – 2010 Steven Johnson
2002 – 2006 Felicity Chapman

Senior Advisors to rangers
Graham Friday, Leonard Norman

Senior Rangers
Damien Pracy, David Barrett

Current Rangers
Shaun Evans, Sebastian Evans, Steven Simon, Cedric John, Matthias Hammer, Levina Johnston, Christopher Barrett, Gaylene Te Hatu (Admin), Troyce Mawson

Casual staff – Antonio Johnson, Harriet Johnston, Gavin Dhurrkay, Stephen Barrett

Previous Rangers
Allan Charlie, Eric Mullholland, Jonathon Miller, Richard Dixon

Amy Brown (admin)
Anthony Johnston
Adrianne Friday (admin)
Cameron Dixon
Clem Goodman
Clinton Madson
Cody Miller
Conrad Rory
Corrine Coombes (admin)
David Harvey
David Keighran (barge operator)
Joanne Miller
Jody Evans (admin)
Kendrick Douglas
Kurtly Harvey
Lanceton Norman
Leanne Norman (deceased)
Lester Timothy
Lloyd Dixon
Nathalia Dixon
Nicholas Fitzpatrick
Ronnie Miller
Samuel Evans
Sean Fitzpatrick
Sheyene Anderson
Stanley Allen JNR
Terrence Mawson
Treh Mawson
Thomas Simon

This report was prepared by Scott Whiting, Andrea Whiting, Fiona Keighran, Damien Pracy and Graham Friday.

Questions regarding using the report should be directed to:

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The recommended citation for this report is:
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ACKNOWLEDGEMENTS

ACKNOWLEDGEMENT OF COUNTRY AND FAMILY

West Island was the location of much of the information contained in this report and these activities would not have been possible without the support and assistance from the Simon family. This project recognises the special contribution to Shirley Simon and the late Tom Simon. Over the years many traditional owners have been highly supportive of the turtle research and monitoring including Sammy Evans, the late Steve Johnston and the late Archie Johnston.

ACKNOWLEDGEMENT OF PARTNERS AND PEOPLE

- WWF and Charles Darwin Charles Darwin University conducted some early surveys in 2000 and 2001 – Mark Hamann, Tony Dore.
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- NRETAS supported the project through science and funding between 2006 and 2011. Scott Whiting, Karen Edyvane.
- The local Borroloola Parks and Wildlife Office have been very supportive over many years– Ben Senge and Shaun Evans.
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- 2003/65 Turtle and Dugong Monitoring and Management around the Sir Edward Pellew Islands. The project was made possible by the Interim Natural Heritage Trust in the Northern Territory.
- Traditional Owners: Steve Johnston, Archie Johnston, Johnny Johnston, Tom Simon, Tom Friday, Warren Timothy, Leonard Norman, Dinah Norman, Annie Isaac, Rosie Noble, Jemima Miller, Samuel Evans, Billy Miller, Barry John, Josephine Timothy, Kathy Jupiter, Wylo McKinnon.
- Greg and Dianne Quayle of Black Rock Landing provided valuable logistical and other support providing transport and catering to Traditional Owners, scientists, rangers and volunteers during short and extended field trips over many years.
- Monash University supported the turtle camp concept and provided students and cultural support John Bradley.
- Tracking maps were provided by seaturtle.org.
- Flipper tags were supplied by Department of Environment and Science, Qld.

CURRENT LI-ANTHAWIRRIYARRA SEA RANGERS INVOLVED IN THE TURTLE MONITORING

Fiona Keighran

Damien Pracy

Shaun Evans

Gaylene Te Hatu (Admin)

David Barrett

Steven Simon

Sebastian Evans

Levina Johnston

Matthias Hammer

Cedric John

Christopher Barrett

Troyce Mawson

PREVIOUS LI-ANTHAWIRRIYARRA SEA RANGERS INVOLVED IN THE TURTLE MONITORING

Thomas Simon

Allan Charlie

Graham Friday

Jonathon Miller

Stephen Johnson

Chris Francis

Nicholas Fitzpatrick

Anthony Johnston

Stanley Allen JNR

Lester Timothy Leonard & Lanceton Norman Maxine Keighran

PREVIOUS LI-ANTHAWIRRIYARRA SEA RANGERS CONT.

Felicity Chapman

Joanne Miller

Kurtly Harvey

Kendrick Douglas

David Harvey

Cody Miller

Sea Rangers & NT Park Rangers with Scott Whiting (Scientist)

Sean Fitzpatrick

Graham holding a turtle

Leonard Norman

SUMMARY

- The long-term monitoring of flatback turtles at West Island over 16 consecutive years is an enormous achievement by the ranger unit.
- West Island during the September/October period supports predominantly flatback turtles with some green and olive ridley turtles.
- The numbers of flatbacks during this period has remained relatively constant with an average of **7.4 clutches laid per night or 8.5 tracks per night.**
- The trend of nesting flatback turtles over 16 years **appears stable** with moderate confidence.
- Analysis of mark-recapture tag data would provide more confidence, but this cannot be achieved until issues tag loss are resolved.
- Flipper tag loss is high, as is the case with other flatback turtle populations. This is caused by the soft tissues of flatback turtles compared to other species and the high barnacle load the tags acquire within their foraging grounds.
- **Flipper tag and microchip (PIT) tag loss (tagged and not seen again) is high.**
- The reason for PIT tags not being detected again could be from several factors:
    - Turtles using a suite of beaches over their nesting life.
    - Turtles are nesting on West Island early in their nesting life but moving to other beaches later.
    - Not enough scanners on the beach so PIT tags are not being recorded.
    - PIT tags have migrated deeper into the body and may require more powerful scanners.
    - PIT tags are expelled before the skin surface heals.
- Genetic analysis has been completed and shows that the West Island population is within the same genetics stock as Bare Sand Island and Field Island near Darwin and those rookeries on Cape York (FitzSimmons et al. 2020).
- **Nesting success (the proportion of turtles that successfully lay) is high:** 87.5%
- **Hatching success and emergence success from non-marked nests is high:** 87.0% and 81.2% respectively.
- In general, the rookery seems stable over time in terms of adult females and hatchling production.
- **The Turtle Camp has provided many community benefits** through opportunities to deliver many activities for the community including cross generational exchange of knowledge, men's health camp, and language workshops.

CONTENTS

1. GENERAL INTRODUCTION

For the Yanyuwa people in the Borroloola region sea turtles are highly culturally significant through lore, ceremony, dance, song, stories, art and food. This importance is articulated in the Sea Country Plan (Bradley and Yanyuwa families 2007) and demonstrated through Yanyuwa long term traditional custodianship of turtles (Bradley 1997) and more recently through the commitment of the li-Anthawirriyarra Sea Ranger Program (http://www.mabunji.com.au/site/li-anthawirriyarra-sea-ranger-unit/).

The importance of the turtles in this region for the Northern Territory and for Australia is recognised though a turtle survey report (Chatto and Baker 2007) and through the Recovery Plan for Marine Turtles in northern Australia (Commonwealth of Australia 2017). The turtles in the area are highly connected to other locations in Australia and overseas. Resident green turtles at Borroloola are connected to nesting beaches at Cobourg Peninsula, Gove Peninsula, Great Barrier Reef, Torres Strait and Western Australia (Dethmers et al. 2006, Kennett et al. 2004) with resident hawksbill turtles are connected to beaches at Groote Eylandt (Hoenner et al. 2016) and olive ridley turtles are connected to the Tiwi Islands (Whiting et al 2006). Nesting flatbacks at West Island travel at least as far as the Tiwi Islands.

The sheer numbers of turtles in the area were brought to the attention of a wider audience by cyclone Kathy in 1984 when the tidal surge washed hundreds of turtles and dugongs ashore (Limpus and Reed 1985, Marsh 1989). Green turtle foraging was also investigated by Hamann et al. (2006a)

From various sources including preliminary surveys and aerial surveys (Chatto and Baker 2006) and beach-based surveys (Hamann et al. 2006b) Borroloola is recognised to have significant green turtle nesting at Vanderlin Island with dispersed nesting across several islands. Unquantified nesting remains for hawksbill nesting at Pierce and Urquhart Islands. Flatback nesting occurs on various islands including West Island, North Island and Skull Island with some nesting on the mainland near Fat Fellows Creek.

This report summarises the last 20 years of turtle monitoring within the region.

Sea turtles are highly culturally significant for Yanuwa people

2. STUDY SITE

The study area is focused on West Island, but also includes various islands in the Sir Edward Pellew Island group. The Sir Edward Pellew Islands are in the southwest corner of the Gulf of Carpentaria (Figure 1) and include eight main islands comprising of West Island, Black Craggy Island, Southwest Island, Centre Island, North Island, Watson Island, Skull Island and Vanderlin Island. Borroloola is the nearest service centre and is located 60 km inland and borders the banks of the McArthur River.

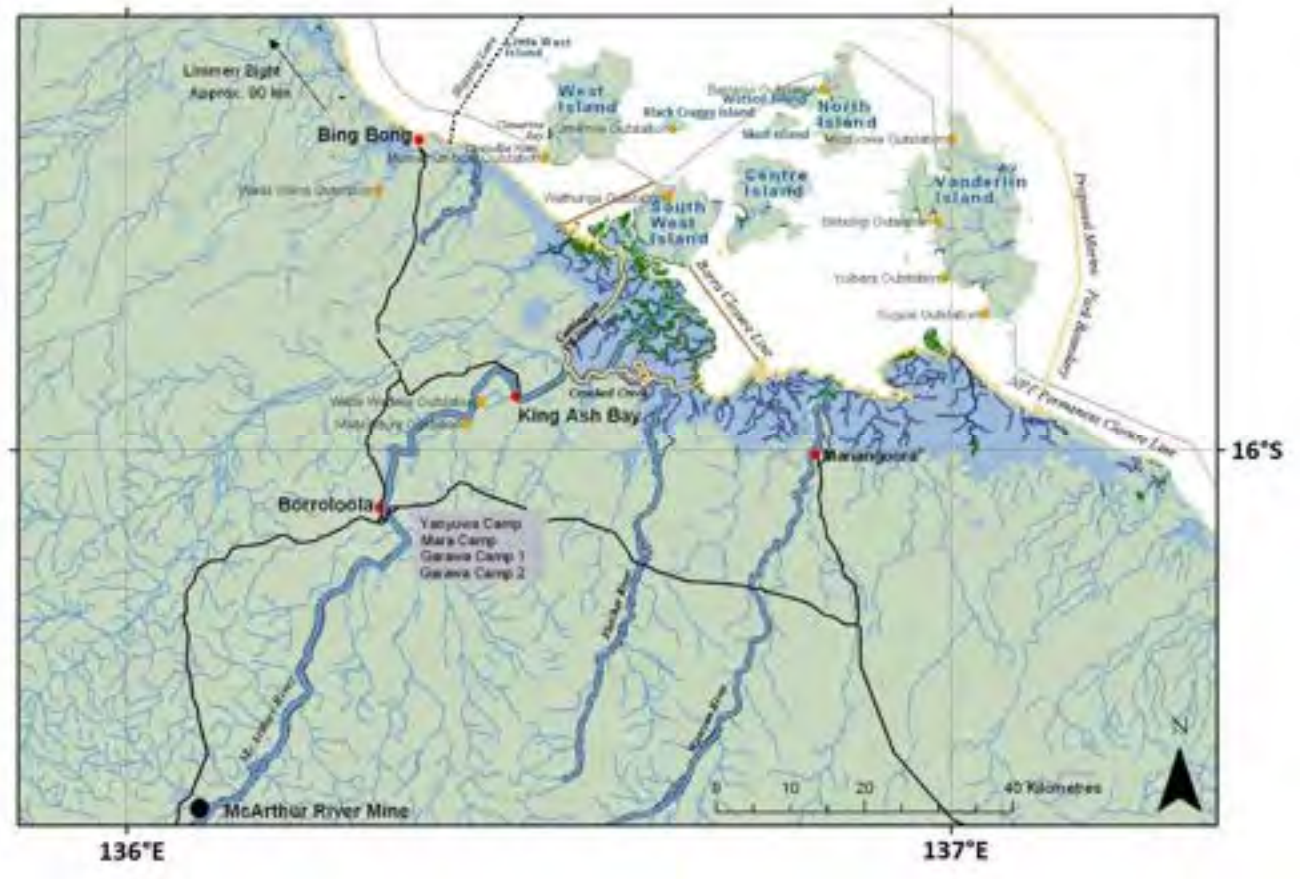


Figure 1. Location of the Sir Edward Pellew Islands. Map reproduced from WWF.

3. SEASONALITY & DISTRIBUTION OF NESTING TURTLES

MAIN AIMS

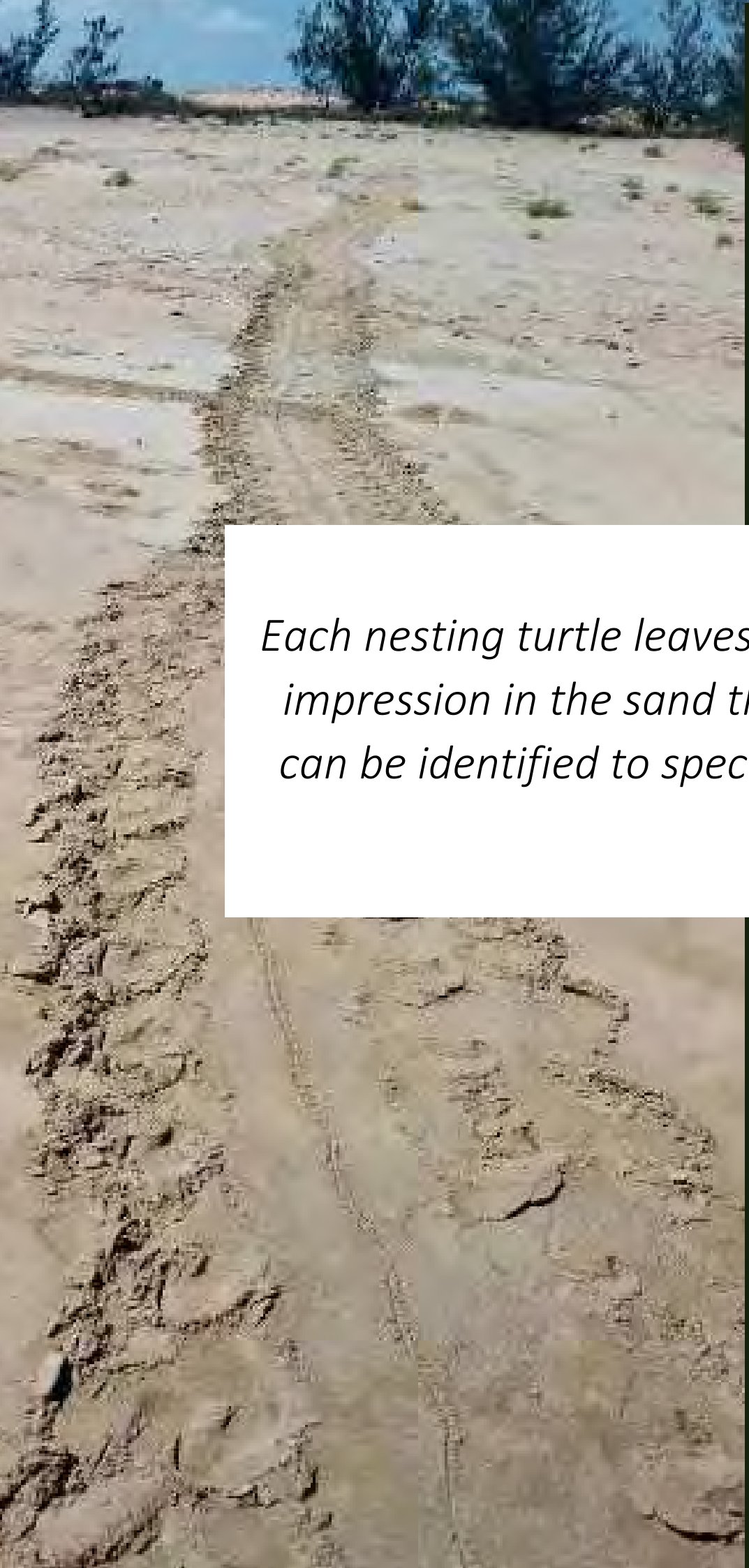
- To identify the seasonality and peak nesting of nesting for each species on key islands.
- Results to be used to plan on-ground tagging program.
- Train personnel and build local capacity.

METHODS

Based on the initial discussions with the Traditional Owners this project identified five beaches on five islands that were significant to sea turtle nesting. The beaches surveyed by the li-Anthawirriyarra Sea Rangers included: Paradice Bay, North Island; Beach 1, Skull Island; Beach 1, Watson Island; Investigator Bay, Vanderlin Island and North Beach, West Island.

The li-Anthawirriyarra Sea Rangers conducted beach surveys of these beaches throughout the year during 2004 and 2005 at monthly intervals. Each beach had a start and end point that was recorded using a GPS.

Tracks were differentiated to species and recorded as either fresh or old tracks. Fresh tracks were those from the previous night and old tracks were those that were older than one night.



Each nesting turtle leaves an impression in the sand that can be identified to species.

MONTHLY TRACK COUNTS ON MULTIPLE ISLANDS IN 2004-2005

RESULTS

Monthly surveys showed that both green and flatback turtles nested on the islands (Figure 4 and Figure 5). Hawksbills are known to nest of other islands not included in this survey (Chatto and Baker 2006). Flatback turtle nesting was most abundant on West Island where peak nesting appears to occur between September and October (Figure 4). Most nesting appears to occur between September and December with low density nesting occurring between March and August.

Green turtles appear to nest later in the season and were more common at North, Skull and Vanderlin islands.

Figure 2 li-Anthawirriyarra rangers recording a dead turtle during a beach survey.

Figure 3 Felicity Chapman (li-Anthawirriyarra ranger), Archie Johnston (Traditional Owner) and Scott Whiting (Scientist) counting turtles tracks on Vanderlin Island

Flatback turtle nesting

Note – the scale is the same for all graphs, except North Beach, West Island

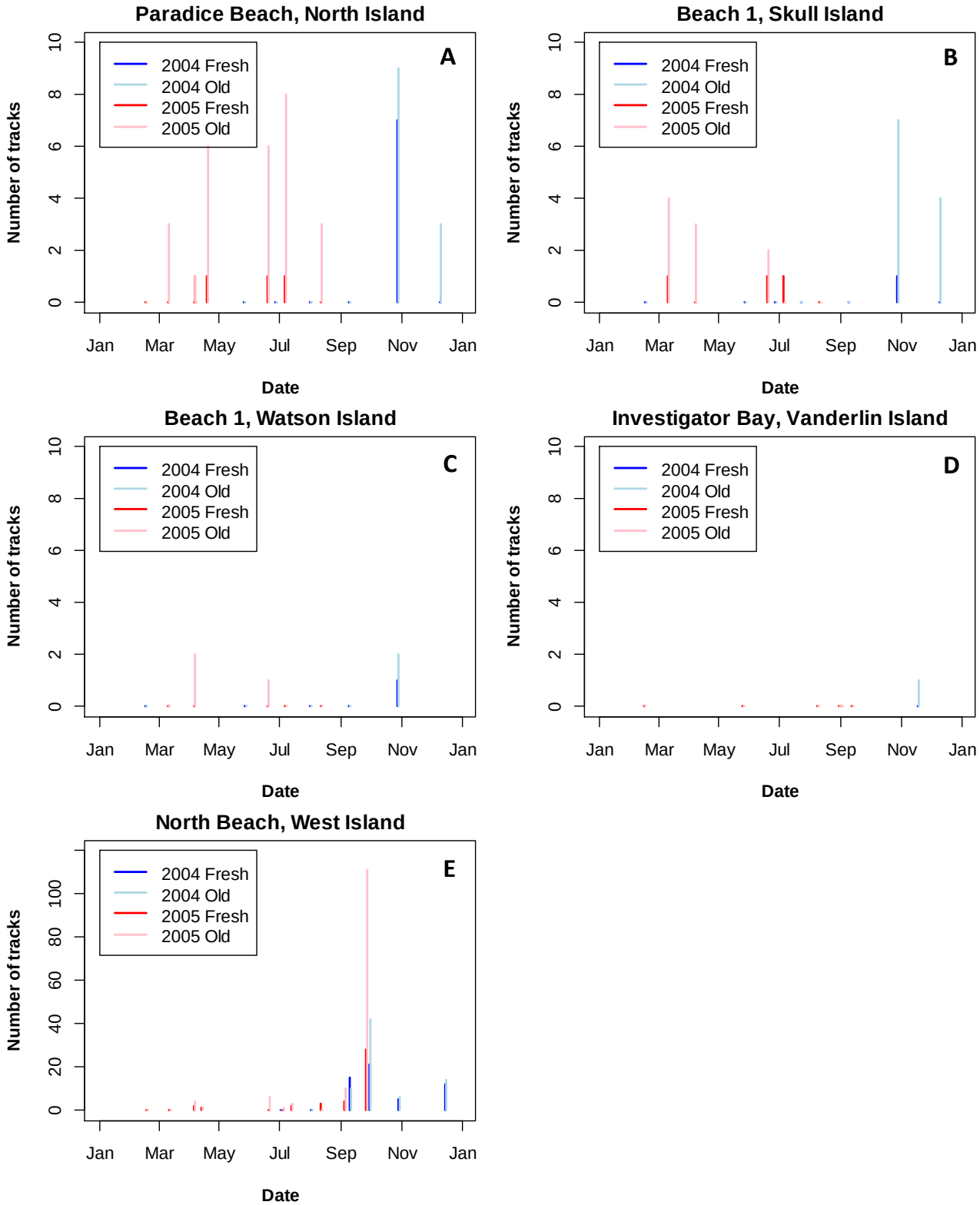


Figure 4. Nesting track counts for flatback turtles at a) Paradice Bay, North Island; b) Beach 1, Skull Island; c) Beach 1, Watson Island; d) Investigator Bay, Vanderlin Island and e) North Beach, West Island.

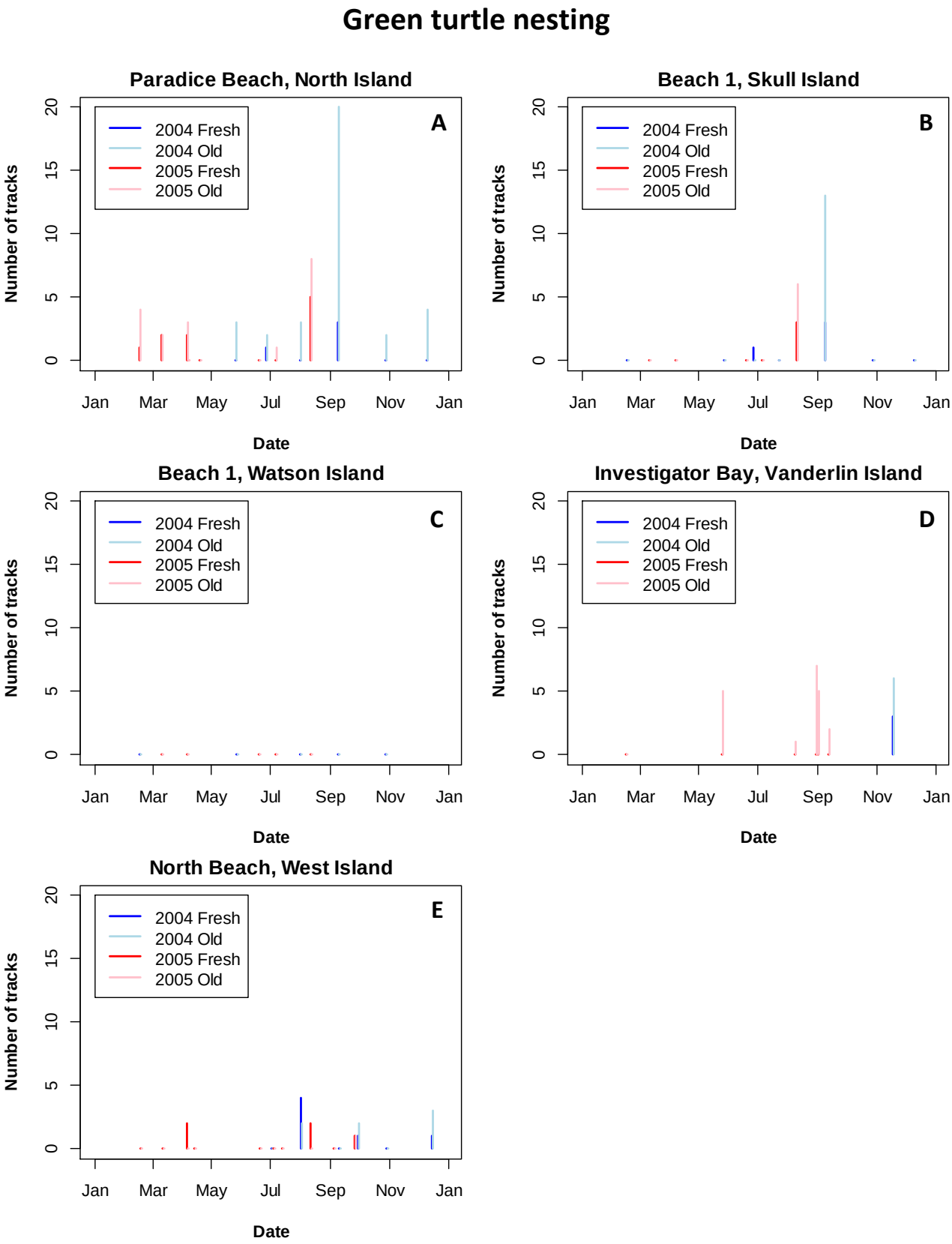


Figure 5. Nesting track counts for green turtles at a) Paradice Bay, North Island; b) Beach 1, Skull Island; c) Beach 1, Watson Island; d) Investigator Bay, Vanderlin Island and e) North Beach, West Island.

DISCUSSION

The monthly surveys provided information on seasonality of nesting for each species. Some remaining knowledge gaps could be filled through additional surveys and would add value to understanding sea turtle nesting distribution across the islands.

1. Visits to Urquhart and Pierce islands during October and again in December would provide an understanding of the extent of hawksbill nesting. If possible, this could include camping for one or two nights and include skin sampling for genetics.
2. Visits to Investigator Bay at north Vanderlin Island over several nights in December or January to understand the density of nesting green turtles. Visits would also allow assessment of predation – goannas, pigs.
3. Aerial surveys could be used periodically (every 5 to 10 years) to detect any changing in nesting distribution.
4. Visits to the mainland beaches (or aerial surveys) south of Fat Fellows Creek in October, December and January.

5. TURTLE CAMP – WEST ISLAND FLATBACK MONITORING

Turtle camp began in 2004 following a year of monthly surveys on several islands to determine nesting distribution across the islands and throughout the year. From this information it was decided to attempt to do annual monitoring of flatback turtles on West Island. North Beach on West Island became the location of "Turtle Camp."

Between 2004 and 2019 surveys were mostly conducted over a two-week period.

Survey length ranged from 6 to 14 days and centred at the end of September and start of October.

Initially these surveys were supported by WWF and the NT Department of Natural Resources Environment and the Arts (NRETAS) (now Department of Environment and Natural Resources) and through grants from the Commonwealth Government. Prior to 2004, an aerial survey provided information on nesting distribution and shorter surveys at West Island were conducted by Charles Darwin University in 2001 (Hamann et al. 2006).

Turtle Camp became a community event, enjoyed by many people and became a focal point for other community activities.

The benefits of this camp have gone beyond turtle monitoring and have included:

- A planned annual event for people to gather on country.
- Cross generational exchange of information
- Shared experiences
- School and youth education and training
- Ranger training

More formally the camp has provided a venue for:

- Reinvigorating language
- Dance and song
- Men's health
- Coxswain training
- Business enterprise- eco tourism
- Scientific monitoring
- School field trips
- University student projects
- Training in scientific methods
- Sea turtle education
- Visiting guests

Turtle Camp in the early days prior to a solid roof.

PEOPLE AND FAMILIES

The camp could not have been conducted without the initial and continued support of the Yanyuwa families and especially the Simon family who are the custodians of West Island. Several generations of the Simon family have supported this project and their hospitality shown to everyone on the island has been exceptional.

We pay our respects to the late Tom Simon who was instrumental in establishing this camp and was engaged with science and conservation projects from the early 1990s.

ANNUAL NIGHT-TIME SURVEYS (16 YEARS)

The Sir Edward Pellew Islands are important for nesting and resident turtles.

AIMS

- To understand whether the flatback population on West Island is stable or going up or down.
- To use two methods to estimate annual relative abundance: 1) turtles and tracks counted and 2) marking turtles with tags.

METHODS

North Beach at West Island was surveyed for an intensive period between late September and early October between 2004 and 2019 (and continuing) on Sector 1 of West Island (Figure 6). This research was designed to provide training to Sea Rangers, facilitate community involvement, gather scientific data on the nesting population and provide the framework for ongoing long-term monitoring. Turtles were allowed to complete their nesting activities before they were processed. Each turtle was tagged on each of the front flippers with individually numbered titanium tags (Limpus 1992), the curved carapace length (ccl) measured (Limpus *et al.* 1983 and 1984) and some turtles were weighed using a 100 kg (+/-0.5kg) hanging balance. Since 2008 Passive Integrated Transponder (PIT) tags (also known as microchips) were also applied as flatbacks lose flipper tags more often that other species. Detailed methods are similar to those described in the Western Australian Field Guide (Fossette et al 2018).

Total tracks per night were calculated as the sum of new tagged turtles, recaptured turtles and those missed by researchers as evident by their track in the sand. All turtles recorded by researchers were crossed off by making a line in the sand across the track, to avoid double counting and ensure that all tracks/turtles had been recorded.

A morning survey was conducted to record any turtles that may have been missed from the night before.

The survey area was the western half (Sector 1, Figure 7) of North Beach, with only rare sightings of turtle track on the eastern half of the beach (Sector 2) which was surveyed weekly.

Figure 6. Map of North Beach, West Island. The numbers represent sectors of the Beach. Most nesting occurred in Sector 1 and was patrolled each night. Sector 2 was patrolled each week with generally only one track each week.

Figure 7 Tagging a female flatback turtle after nesting.

Figure 8 li-Anthawirriyarra and Parks and Wildlife rangers with an olive ridley turtle ready to be tagged.

Figure 9 Li-Anthawirriyarra and Parks and Wildlife Rangers with a female flatback turtle after tagging.

Figure 11: Measuring the curved carapace length of a turtle.

Figure 12 *Measuring the curved carapace width of a turtle.*

Figure 10 Li-Anthawirriyarra and Parks and Wildlife Rangers with a female flatback turtle after tagging and DNA sampling.

RESULTS

Flatback Turtles – Tagging

A total of 635 individual nesting turtles have been tagged at West Island, comprising 600 flatback turtles, 32 green turtles and 3 olive ridley turtles. One male flatback turtle was also tagged near West Island after it was captured floating.

Since intensive surveys began in 2004, nightly surveys have been conducted for between 6 and 14 nights during a similar two-week period in Sep/Oct for a total of 188 days. In 2017 a 9-day survey was conducted outside this period in November (Table 1).

Flatback turtles were seen an average of 1.6 times each (SD=1.1, N=655, Figure 13), with one turtle being seen over seven seasons spanning 15 years (Figure 14 and Figure 15).

Approximately two thirds of the turtles tagged at West Island have not been seen again (65%, Figure 16). A large percentage of both tag types were not recorded again, with 78.7% of flipper tags applied not seen again and 78.6% of the PIT tags applied not recorded again. Of all the turtles tagged at West Island, 58.7% have had a PIT tag inserted and 71.8% of turtles seen since 2008 have had PIT tags inserted. Some PIT tags are still being read from their first application 11 years ago (Figure 17) and some turtles are carrying three PIT tags (Figure 18). Based on a 14-day sampling approach, the number of recaptured turtles (carry either tag type) may not reach more than 50% (Figure 19). In other study areas where tagging effort is extended to four or more weeks, recapture percentage approaches 85%. Mark recapture analysis for this project will be presented in a subsequent report.

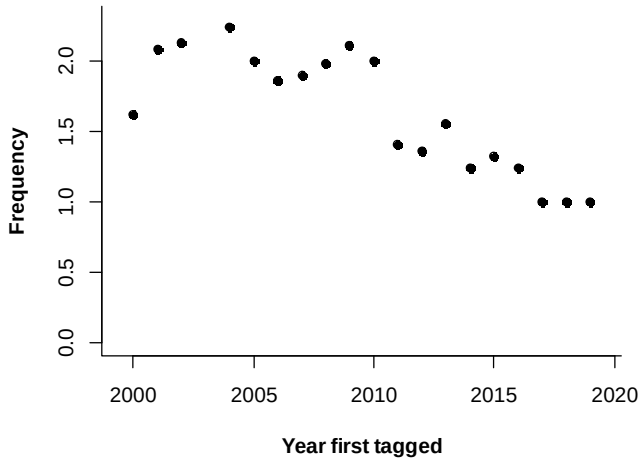


Figure 13. The number of times resighted after initial tagging year. For example between 2000 and 2005 turtles are seenn on average two times.

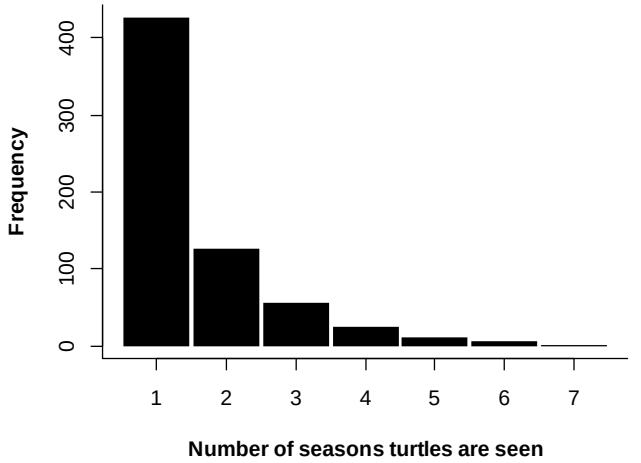


Figure 14. The number of seasons that a turtle is seen. For example, over 400 turtles were seen only once, about 50 turtles were seen 3 times and only 1 turtles was seen seven times.

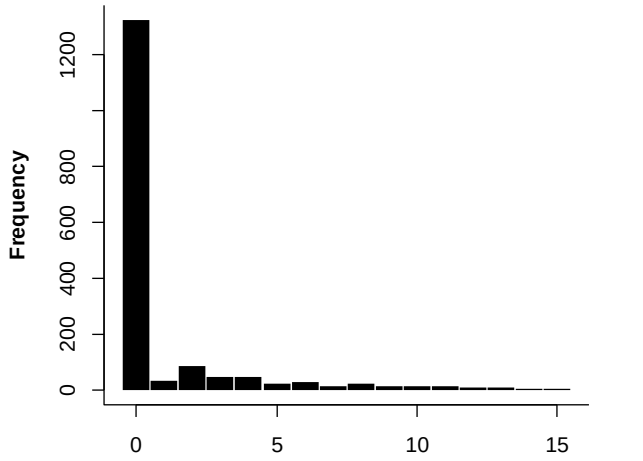


Figure 15. The number of years that a flipper tag remains and is seen.

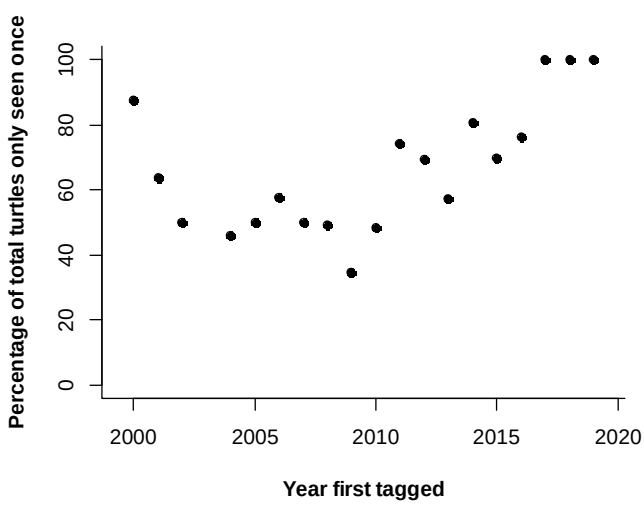


Figure 16. Percentage of turtles only tagged once and not seen again. This includes those that have lost their tag, died, or moved away.

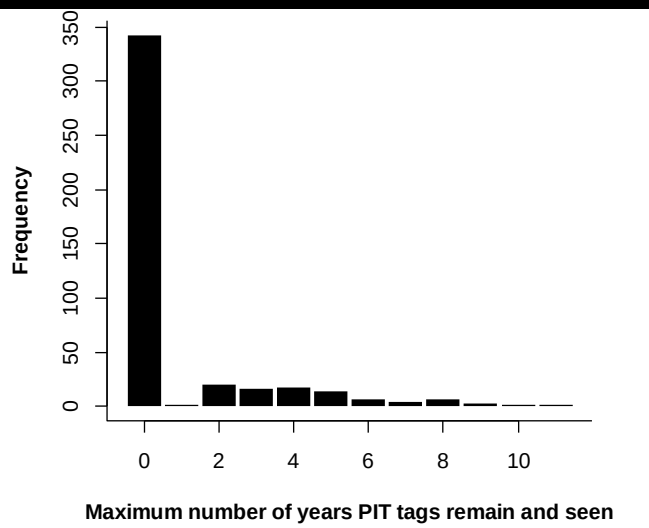


Figure 17. The number of years that PIT tags remain and are seen.

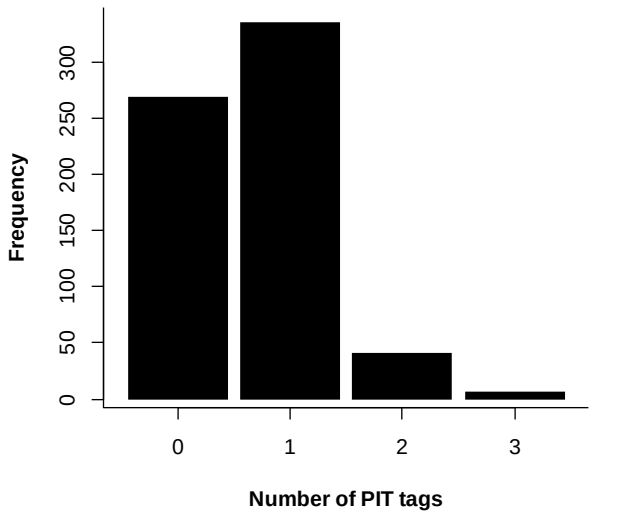


Figure 18. Number of turtles carrying 0,1,2 or 3 PIT tags.

This project has successfully merged science and community benefit

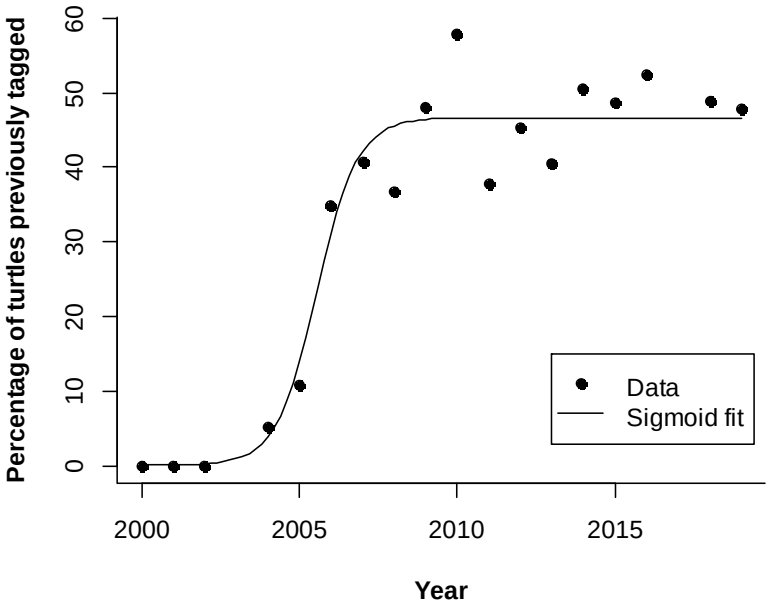


Figure 19. The percentage of recaptures. Percentage of turtles previously tagged, shows a sigmoid function approaching an asymptote of 46.6%. The equation of the sigmoid function is PercentagePreviouslyTagged= 46.65/(1+exp(-1.5423*(Year-2005.6))). Increasing this persentage would require increase survey days or increase the percentage of turtles processed within the 14 days.

When turtles were seen more than once, they were seen at an average interval of 3.1 years (SD= 1.8, N= 409). The maximum time between seeing a turtle and the turtle still holding a PIT or flipper tag was 11 years (Figure 20). This indicates that individual turtles can be missed by researchers over multiple breeding seasons or that turtles may be using a wider range of beaches.

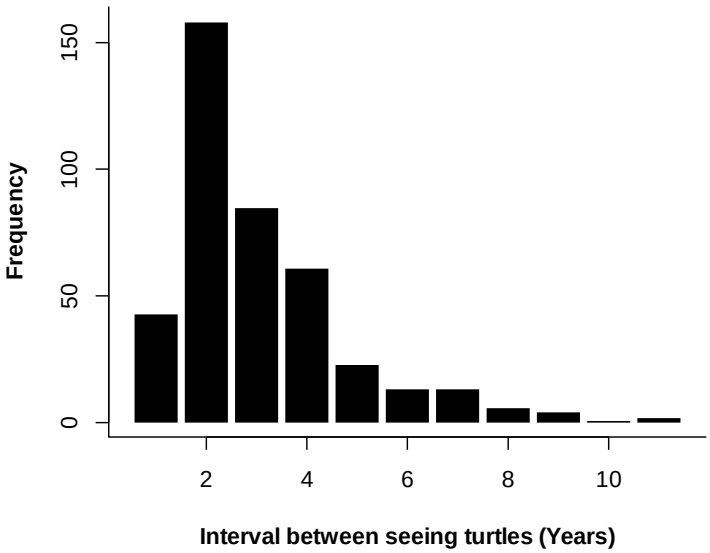


Figure 20. The interval between captures of turtles.

Flatback Turtle index – Track counts

Track counts were plotted for annual survey periods in Sep /Oct spanning 16 years and appear to show a stable nesting population of flatback turtles with an average nesting abundance of 7.4 clutches per night and 8.5 tracks per night during the standard survey period (Figure 21). The 2017 period was missed due to delay in permits for that year.

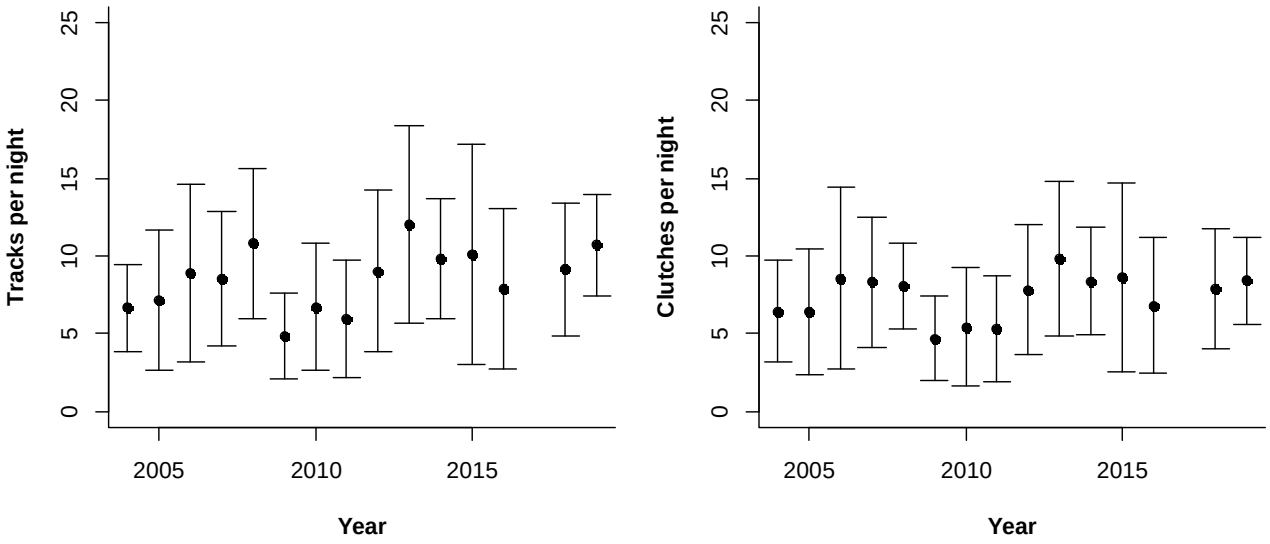


Figure 21. Average and Standard deviation of tracks per night and clutches per night for flatback turtles nesting on West Island.

Table 1. Dates of surveys and number of new and recaptured turtles tagged on West Island.

Year	Dates of survey	Duration (days)	Flatbacks			Green		Olive ridley	
			New	Recap (Tags)	Recap (Tag scars)	New	Recap	New	Recap
2000	23 Oct 2000	1	8	0	0	0	0	0	0
2001	20 Aug; 10-12 Sep; 25,26,27 and 29 Oct	8	11	0	0	4	0	0	0
2002	9 – 15 Sept	7	22	0	0	0	1	0	0
2003	-	0	-	-	-	-	-	-	-
2004	28 Sep – 7 Oct	10	37	2	0	2	0	0	0
2005	27 Sep – 9 Oct	13	49	6	1	0	0	1	0
2006	25 Sep – 8 Oct	14	44	24	1	1	0	0	0
2007	15 Oct – 20 Oct	6	17	13	2	0	0	0	0
2008	27 Sep – 10 Oct	14	47	32	8	2	1	0	0
2009	27 Sep – 9 Oct	13	20	24	6	0	0	0	0
2010	27 Sep – 9 Oct	13	25	37	2	5	0	1	0
2011	26 Sep – 8 Oct	13	35	23	3	1	1	0	0
2012	23 Sep – 6 Oct	14	53	44	0	0	0	1	1
2013	20 Sep – 5 Oct	16	45	36	8	2	0	0	0
2014	22 Sep – 5 Oct	14	38	41	2	5	1	0	0
2015	20 Sep – 1 Oct	12	40	39	1	0	0	0	0
2016	26 Sep – 5 Oct	10	20	22	0	2	5	0	0
2017	14 Nov – 22 Nov*	9	1	0	0	6	1	0	0
2018	24 Sep – 6 Oct	13	43	42	1	0	0	0	0
2019	23 Sep – 5 Oct	13	45	42	1	2	2	0	0
Total		**213**	**600**	**427**	**36**	**32**	**12**	**3**	**1**

**2017 survey was outside standard survey period as permits were not received in time.*

Nesting success is the proportion of clutches laid to the number of nesting attempts. Nesting success was high, with an average of 87.5% (sd=7.0, range= 75.0-98.0%, N= 15 years, Figure 22). There was a statistically significant decline in nesting success (r^2= 0.29, P=0.04) with a linear equation of Nesting Success= -0.8068*Year + 1710.1 (Figure 22).

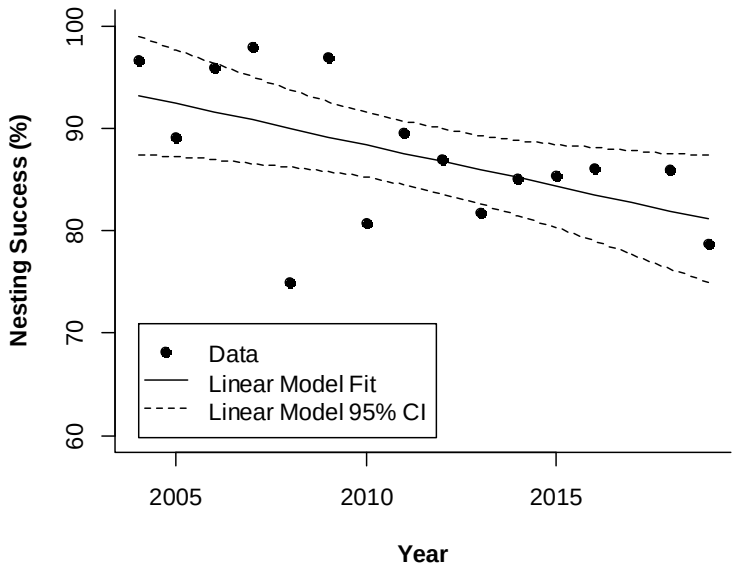


Figure 22. Nesting success of flatback turtles coming ashore to nest at West Island.

Sampling coverage – The Percentage of Turtles Processed

This metric measures how many turtles are processed from the total number of turtles that emerge on to the beach.

The percentage of turtles processed ranged from between 60 and 90% each year. The higher the proportion of turtles processed increases the chance of the mark recapture methodology being successful.

Approximately 72% of all flatback nesting emergences are seen (mean=72.3%, SD= 9.0, range=60-88.3%, Figure 23) and there has been no significant change since surveys began in 2004 ($t_{(1,13)}$= 0.69, P= 0.50). The percentage of turtles seen is also not dependent on the number of turtles coming ashore that year ($t_{(1,13)}$= -0.714, P=0.49) or the number of turtles coming ashore each night (e.g., 2006-2010, $t_{(1,59)}$= -0.244, P=0.81).

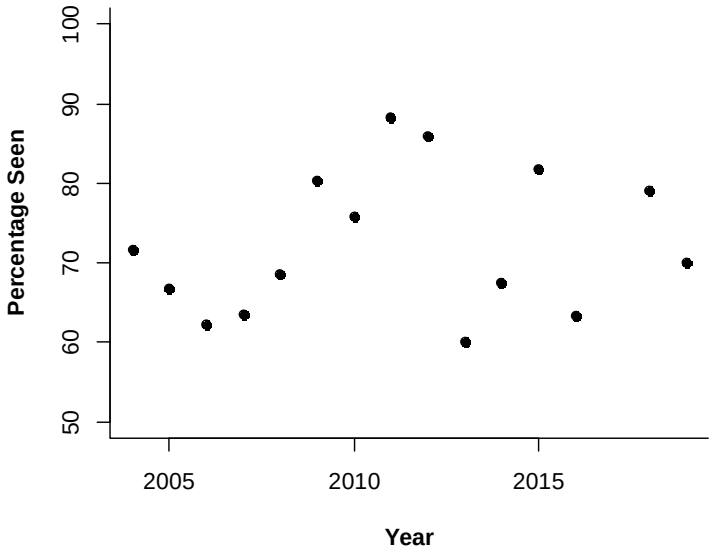


Figure 23. Percentage of all flatback turtles ashore that are seen and have tags recorded.

The proportion seen is usually impacted by the:

- number of experienced researchers on the beach
- timing of surveys during the night – on the beach for the correct period
- the number of survey teams on the beach
- if the turtle nesting is spread out or clumped along the beach

Flatback Turtles – Morphometrics

Nesting adults

Flatback turtles had a mean Curved Carapace Length (CCL) of 87.3 cm (SD=2.8, range= 77-95, N=620) and a mean Curved Carapace Width (CCW) of 71.9 cm (SD= 3.2, range= 58.5-82.5, N=593) when calculated using the mean measurement for each turtle (Figure 24 and Figure 25).

The size of flatback turtles at West Island is similar to flatback turtles nesting at other locations in the NT, at Mundabullangana Station WA and Crab Island, Qld but are smaller than flatback turtles nesting in southern Queensland (mean between 93.2 and 94cm CCL, Limpus 2007).

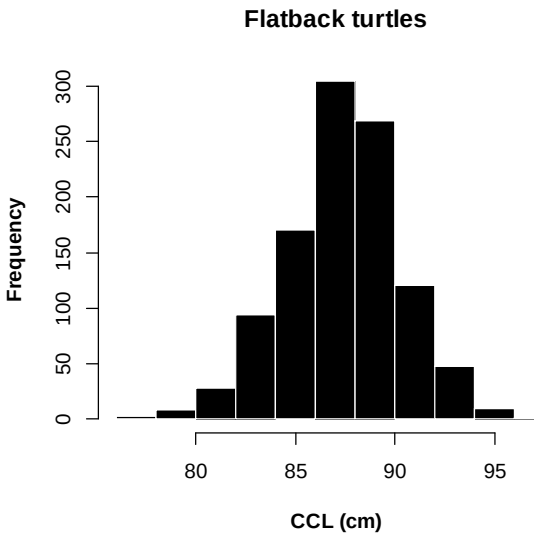


Figure 24. Size frequency of curved carapace length (CCL) for flatback turtles using all measurements recorded

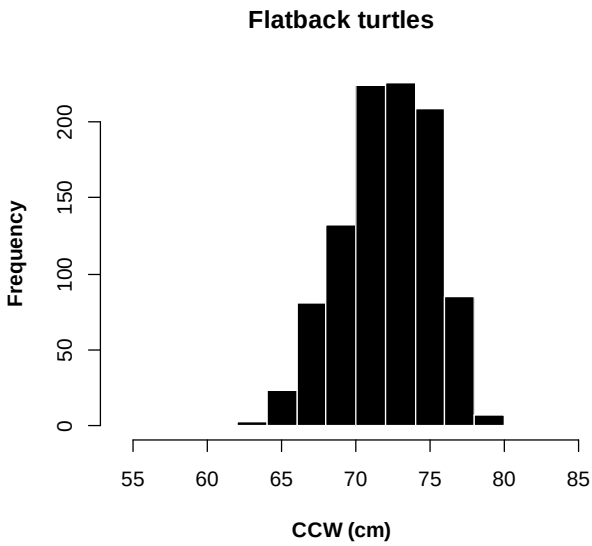


Figure 25. Size frequency of curved carapace width (CCW) for flatback turtles using all measurements recorded

Table 2. More detailed measurements for four flatback turtles tagged in 2006. CCL= curved carapace length, CCW= curved carapace length, WT= weight, TP= tail length to plastron, TC= tail length to carapace, TV= tail length to vent/cloaca, HL= head width, HW= head length, SCL= straight carapace length, SCW= straight carapace width, PL= plastron length.

Primary Tag	Date	CCL	CCW	WT	TP	TC	TV	HL	HW	SCL	SCW	PL
K58543	27/09/2006	79.9	66.5	51.5	16.4	4.5	5.4	19.3	12.5	76.5	63.5	61.6
K58417	27/09/2006	85.4	71.0	70	20.8	6.0	4.9	22.0	14.1	87.3	69.2	70.6
K58545	27/09/2006	88.0	73.4	71	23.2	7.3	6.0	19.9	68.4	84.5	68.4	68.4
K58501	28/09/2006	91.4	75.0	77	22.2	5.6	5.0	20.6	14.4	86.7	70.5	68.6
Mean		86.2	71.5	67.4	20.7	5.9	5.3	20.4	27.4	83.8	67.9	67.3
SD		4.9	3.7	11.0	3.0	1.2	0.5	1.2	27.4	5.0	3.1	3.9

Clutch and Egg measurements

Turtles were selected at random and eggs were removed, counted and measured within 2 hours of oviposition (egg laying). A random selection of ten eggs had the sand brushed off and the maximum and minimum diameter of the eggs was measured using callipers (+/- 0.01cm). Egg mass was measured using a jeweller's balance (0.1g).

Table 3. Egg measurements for flatback turtles when measured shortly after oviposition.

Parameter	Mean	SD	Range	Sample Size (n)
Eggs per clutch	53.0	8.4	40-74	22
Egg Diameter (mean) (cm)	4.95	0.21	4.16-5.97	250 (25 clutches)
Egg Mass (g)	64.2	7.1	37-78.8	240 (24 clutches)
Depth of nest top (cm)	42.0	8.1	22-52	24
Depth of nest bottom (cm)	61.1	9.4	45-84	24

Green Turtles - Tagging

Green turtles were not the focus of this study at West Island with the survey period missing the peak of green turtle nesting which occurs later in the year. However, 32 green turtles were tagged at West Island during this period.

Green Turtles - Morphometrics

Green turtles had a mean Curved Carapace Length (CCL) of 103.3 cm (SD=4.1, range= 97.0-111.6, N=30) and a mean Curved Carapace Width (CCW) of 92.8 cm (SD= 4.2, range= 84.6 – 100.2, N=25) when calculated using the mean measurement for each turtle (Figure 26 and Figure 27).

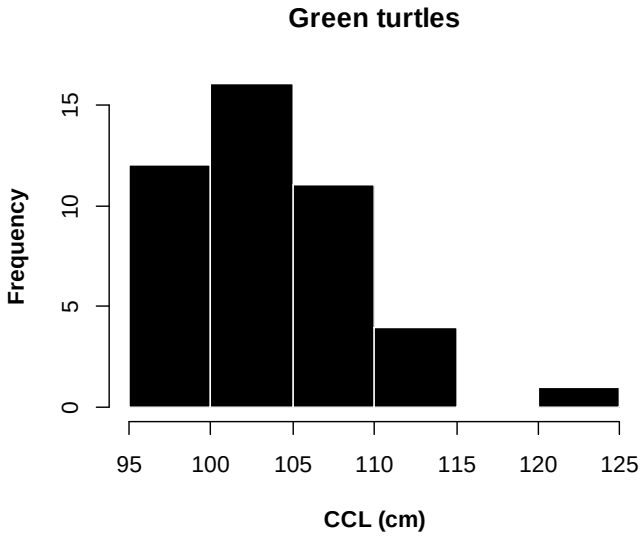


Figure 26. Size frequency of curved carapace length (CCL) for green turtles using all measurements recorded.

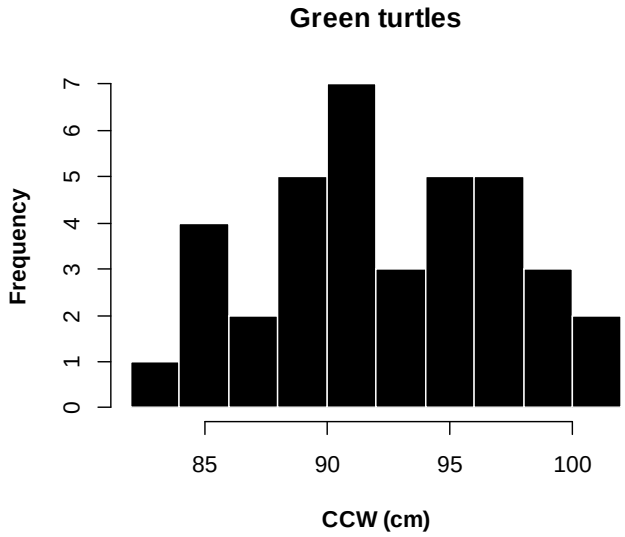


Figure 27. Size frequency of curved carapace width (CCW) for green turtles using all measurements recorded.

Green Turtles – Clutch and Egg Measurements

The clutch and egg measurements are found in Table 4.

Table 4. Egg measurements from one green turtle when measured shortly after oviposition.

Parameter	Mean	SD	Range	Sample Size (n)
Eggs per clutch	118	-	-	1
Egg Diameter (mean) (cm)	4.06	0.04	4.00-4.13	10 (1 clutch)
Egg Mass (g)	39.5	1.4	36.9-40.9	10 (1 clutch)
Depth of nest top (cm)	63	-	-	1
Depth of nest bottom (cm)	86	-	-	1

Green Turtles – Nesting Success (the number of attempts to lay a clutch of eggs)

Hatching success was only determined for one green turtle nest. In 2019, hatching success was 84.2, emergence success was 82.9, clutch size = 76, depth to bottom – 73 cm.

Olive Ridley Turtles – Tagging

Three olive ridley turtles were tagged on West Island in 2005, 2010 and 2012. Of these, one was seen again; she was initially tagged in 2010 and recaptured in 2012.

Olive Ridley Turtles – Morphometrics

Adult size

Olive ridley turtles had a mean Curved Carapace Length (CCL) of 70.1 cm (SD=2.7, range= 67.5-73.0, N=3) and a mean Curved Carapace Width (CCW) of 65.0 cm (SD= 3.9, range= 62-69.4, N=3) when calculated using the mean measurement for each turtle.

Egg size and clutch count

Egg metrics are presented in Table 5.

Table 5. Egg measurements for olive ridley turtles when measured shortly after oviposition.

Parameter	Mean	SD	Range	Sample Size (n)
Eggs per clutch	46.5	4.9	43-50	2
Egg Diameter (mean) (cm)	3.79	0.1	3.65-3.99	20 (2 clutches)
Egg Mass (g)	29.4	1.7	26.3-32.2	20 (2 clutches)
Depth of nest top (cm)	43	2.8	41-45	2
Depth of nest bottom (cm)	48	2.8	46-50	2

Olive Ridley Turtles – Nesting Success (the number of attempts to lay a clutch of eggs)

Hatching success was not calculated for any olive ridley nests.

Figure 28. Counting eggs.

Figure 29. Counting eggs.

Figure 30. Measuring the depth to the bottom of the nest.

Figure 31. Measuring eggs.

FLATBACK TURTLES – HATCHING SUCCESS

AIMS

To determine the hatchling and emergence success of clutches of eggs that had recently hatched.

METHODS

Nest contents was assessed for hatching and emergence success (Figure 32 - Figure 34). Hatching success was calculated as the number of empty shells (hatched) as a percentage of the clutch count (Miller 1999). Emergence success is the number of hatchings that leave the nest and was calculated as the number of empty shells minus the dead and live hatchlings left in the nest as a percentage of the total clutch count (Miller 1999). Predation was surveyed by species of turtle and type of predator or destructive influence (e.g. tides).

Nests were located from tracks in the sand (Figure 35) and opportunistically excavated. No nests were marked at the time of nesting and excavated at hatching. Emergence success may be lower than other studies where excavations are only conducted three days after first hatchlings emerge.

RESULTS

The results are presented in Table 6

Table 6. Hatching success, Emergence Success and Clutch counts for flatback turtle nests excavated at West Island.

Year	Hatching success (%)			Emergence success (%)			Clutch Count			N
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	
2005	86.5	12.3	58.8-100	82.3	14.7	49.1-100	52	10	32-75	17
2006	87.7	5.0	83.9-91.5	84.2	8.0	78.6-89.8	57.5	2.1	56-59	2
2007	81.6	3.3	79.1-85.4	74.9	11.1	62.3-83.3	58.7	9.7	48-67	3
2008	86.0	12.9	56.6-98.4	77.8	20.8	62.3-98.4	56.75	4.62	51-62	8
2009	91.6	5.2	75.8-98.0	83.5	7.5	38.5-98.0	51	9.2	33-66	16
2010	88.0	2.4	86.3-89.7	83.3	4.1	80.4-86.2	54.5	4.9	51-58	2
2013	87.5	-	-	87.5	-	-	48	-	-	1
2017	100	0	100-100	95.4	6.4	90.9-100	38	7.1	33-43	2
2019	69.5	20.4	41.8-84.9	67.6	21.1	41.8-84.9	54.5	3.4	51-59	4
Combined	**87.0**	**11.6**	**41.8-100**	**81.2**	**16.6**	**38.5-100**	**52.7**	**8.8**	**32-75**	**55**

Figure 32. Checking hatching success.

Figure 33. Local community members helping dig up a hatched nest to record hatchling success.

Figure 34. Checking hatching success.

Figure 35. Early morning hatchling tracks.

GENETICS

FLATBACK TURTLES

Over the years skin samples collected from flatback turtles from the Sir Edward Pellew Islands have contributed to genetic studies to identify the management units or stocks (groups) with a major study was recently published (FitzSimmons et al. 2020). This study showed seven distinct stocks in Australia with the Sir Edward Pellew Island turtles grouped within the Arafura Sea stock. This is the largest geographical group with rookeries 1200 – 1300 km apart and including all the Northern Territory and northern Queensland populations. This includes nesting rookeries at Fog Bay, Field Island and West Island in the Northern Territory and Flinders Beach, Crab Island and Warul Kawa in northern Queensland (FitzSimmons et al. 2020).

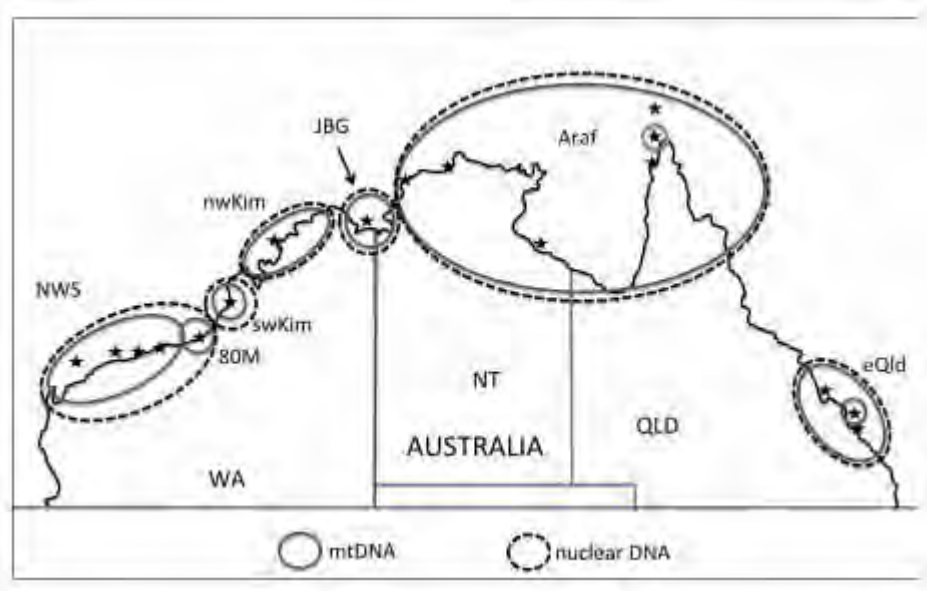


Figure 36. Flatback turtle genetic stocks based on the analyses of 17 rookeries across their range. This figure was used from FitzSimmons et al. 2020 to link the samples collected by the rangers to a direct result.

GREEN TURTLES

In the early years skin samples were taken from nesting green turtles to contribute to national studies. The result of this study showed seven stocks for Australia, with the Sir Edward Pellew Island being included in the Gulf of Carpentaria with rookeries at the Wellesley Islands and Gove.

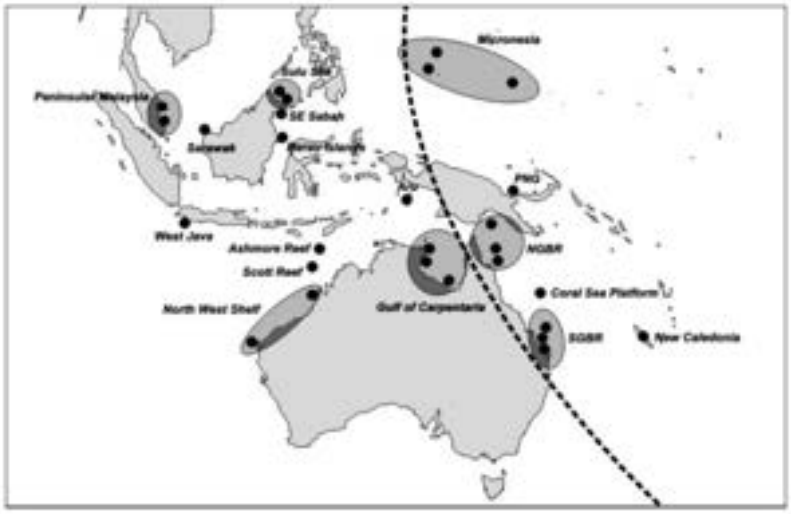


Figure 37. The locations of green turtle stocks in Australia and Southeast Asia. Seven stocks occur in Australia. Source of map: Dethmers et al 2006.

OLIVE RIDLEY TURTLES

Genetic samples were taken from two of the olive ridley turtles seen nesting. Analysis of the samples have not yet been conducted. The Tiwi Islands/McCluer Group and Cape York represent the two defined stocks. The West Island samples sit in between these two sites.

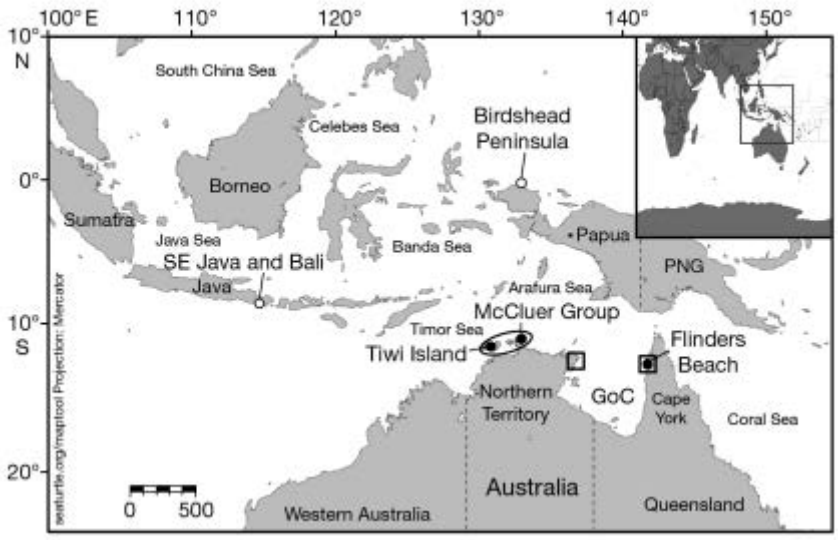


Figure 38. The location of two olive ridley genetic stock in Australia. Source of map: Jensen et al 2013.

SAND TEMPERATURE LOGGERS

In October 2007, two Vemco minilog temperature data loggers were deployed in the sand at 50 cm.

These temperature loggers when installed on the beach to measure sand temperatures at the depth of the turtle nests. This was part of a National Project that installed temperature loggers on many nesting beaches across Australia.

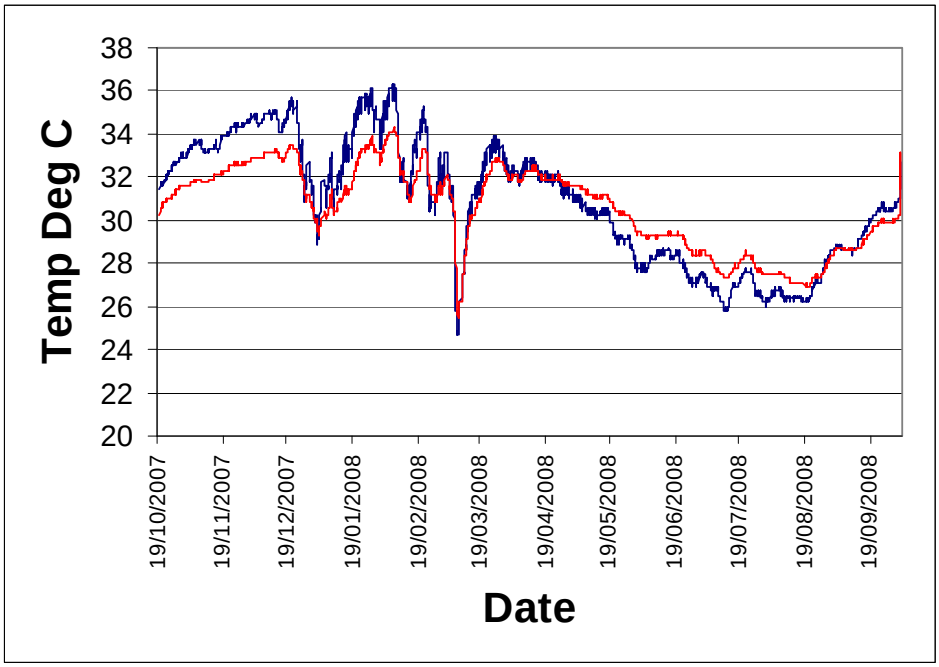


Figure 39 Sand Temperature data from shaded and sunny sites.

6. SATELLITE TRACKING

AIMS

To identify the inter-nesting habitat, migratory paths and foraging grounds of flatback turtles that nest at West Island.

METHODS

At the time of application, attachment methods for flatback turtles were being developed. For hard shelled turtles such as green turtles, a two-part epoxy or fibre glass were proven to be effective., while for flatback turtle a harness system was being trialled (Sperling and Guinea 2004). Based on discussions with traditional owners, they preferred to attach the transmitters with the epoxy and or fibreglass method rather than a constrictive harness.

RESULTS

Experience and evidence have shown that flatback turtles have a carapace that is slippery and does not allow transmitters to remain attached for any length of time.

Four transmitters were applied and were tracked for between 30 and 65 days. Three of the turtles headed north on their migration with one travelling as far as the Tiwi Islands before losing its transmitter.

Terrisita – Satellite Tag Number 17350

This flatback turtle was named "Terrisita" by one of the Traditional Owners of West Island, Thomas Simon after his niece. This turtle was tagged on 29 September 2004, and she measured 84.9 cm curved carapace length and 74 cm in width (Figure 25-26).

Figure 25. Terrisita in the turtle enclosure waiting for the fibreglass to dry.

Figure 26. Terrisita returning to the ocean after nesting and having a satellite transmitter attached.

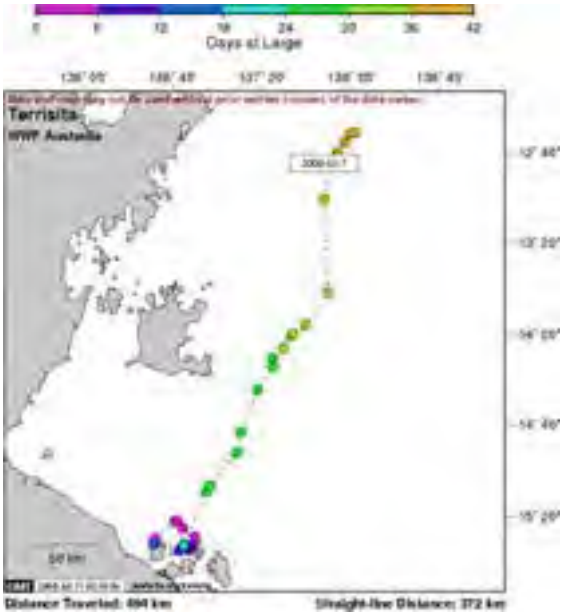


Figure 27. Migratory path of Terrisita

Wundunyuka – Satellite Tag Number 17341

This turtle was named 'Wundunyuka' by the local school. In the local Yanyuwa language it is generic name for sea turtle. The secondary school students looked up this name in the Yanyuwa dictionary which was produced by John Bradley to document the Yanyuwa language. This turtle was tagged on 30 September 2004 and measured 88 cm curved carapace length and 73 cm in width.

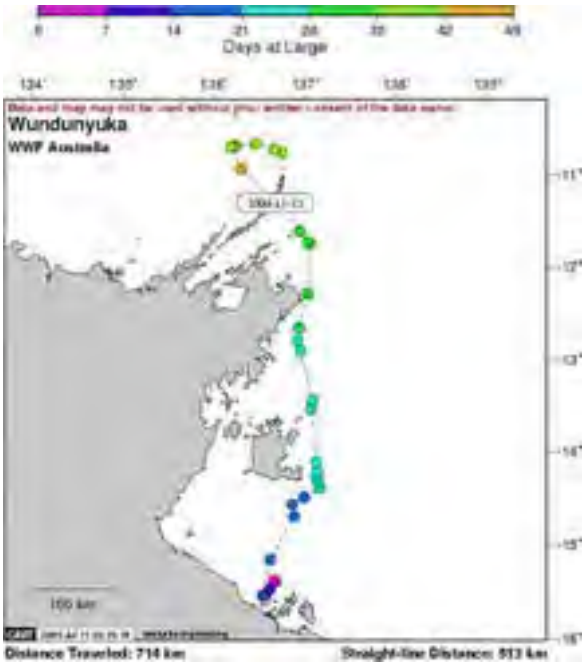
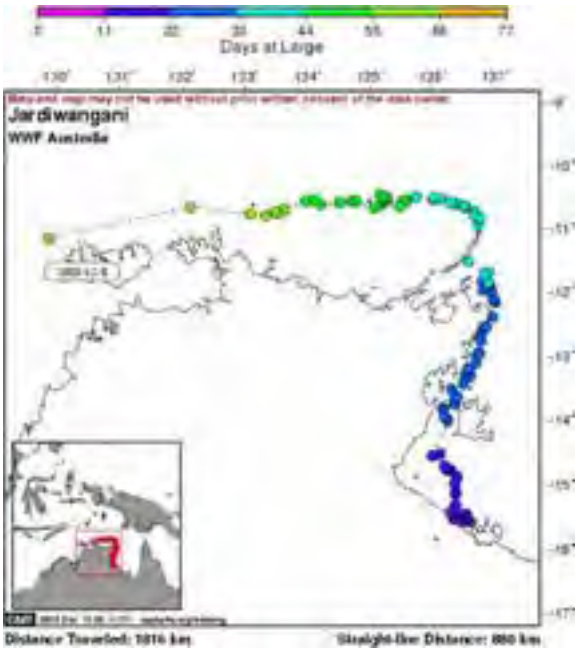


Figure 29. Migratory path of Wununyuka

Jardiwangani – Satellite Tag Number 37755

Senior ladies in the Borroloola community, Dinah Norman, Jemima Miller, Annie Isaacs and Rosie Noble named the turtle Jardiwangarni which means nesting sea turtle in Yanyuwa. West Island is the dreaming place for sea turtle and for this reason this name was chosen. This turtle was tagged on 27 September 2005. The turtle travelled as far as the Tiwi Islands before losing transmissions.



37755

<u>Karrubu – Satellite Tag Number 22638</u>

This turtle was named after a community- wide naming competition in the local township of Borroloola. Over 40 entries were received and six entries were submitted with the same name, "Karrubu". Most entries that were submitted were various deviations meaning flatback turtle in the Yanyuwa language. Two entries referred to it as poisonous to eat. This turtle measured 87.8 cm curved carapace length and was 71.7 cm in width.

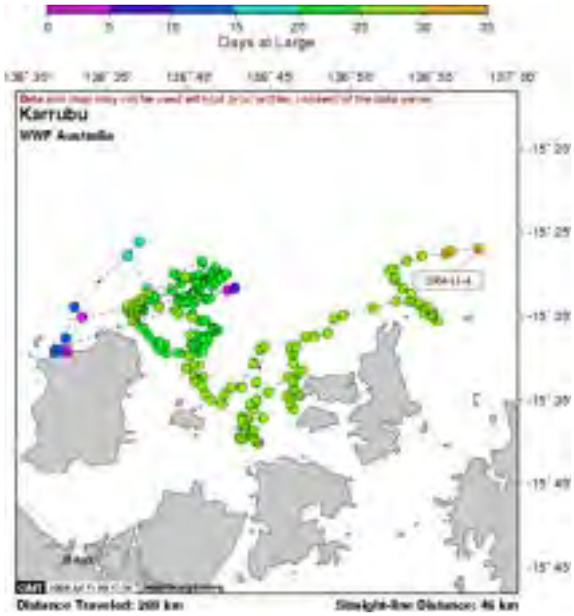


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Figure 32. Migratory path for Karrubu

DISCUSSION

From what we know now, the longer attachment time is achieved through a harness attachment method. However, scientists are working to improve or replace this method as it creates drag through the water, is vulnerable to fouling by algae and invertebrates and can damage the turtle.

7. COMMUNICATION AND EDUCATION

Communication and education were a priority throughout the duration of this project.

Several activities took place to increase awareness of sea turtle conservation in the Borroloola area. These activities are shown in Appendix 1 and included:

- Animations by John Bradley (partly funded through NHT grant to this project)
- Meetings with Traditional Owners
- Camp with TOs and local community members on West Island (Figure 15)
- School talks (primary and secondary) & Powerpoint presentation
- Naming competition for satellite tracked turtles by school and community.
- Powerpoint presentations to the local community
- Stories in newsletters and newspapers
- ABC radio interviews
- Flyers with updated satellite tracking maps
- Satellite Tracking Seaturtle.org
- Presentation to NHT funders – Commonwealth Government- Canberra 12 Dec 2004
- Posters of on-ground activities (Turtle tracking and sick turtle projects with community reporting details) in local schools, fishing clubs and community venues

8. RECOMMENDATIONS

The following general recommendations include:

- To continue this monitoring program as it is one of the longest running programs in northern Australia.
- Continue to periodically check other beaches to ensure that turtles are not shifting to other nesting locations over time.
- Monitor hatching and emergence success.
- Continue to use the program to train new generations of rangers and researchers.
- Use the research site to integrate with other programs and projects to enable the results to be used in a regional context.
- Continue to use PIT tags for marking individuals over decades.

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APPENDIX 1. COMMUNICATION PRODUCTS

The following sections showcase some of the communication products that have come from the turtle camp over its life.

1. SONGLINE ANIMATIONS

BY JOHN BRADLEY – MONASH UNIVERSITY

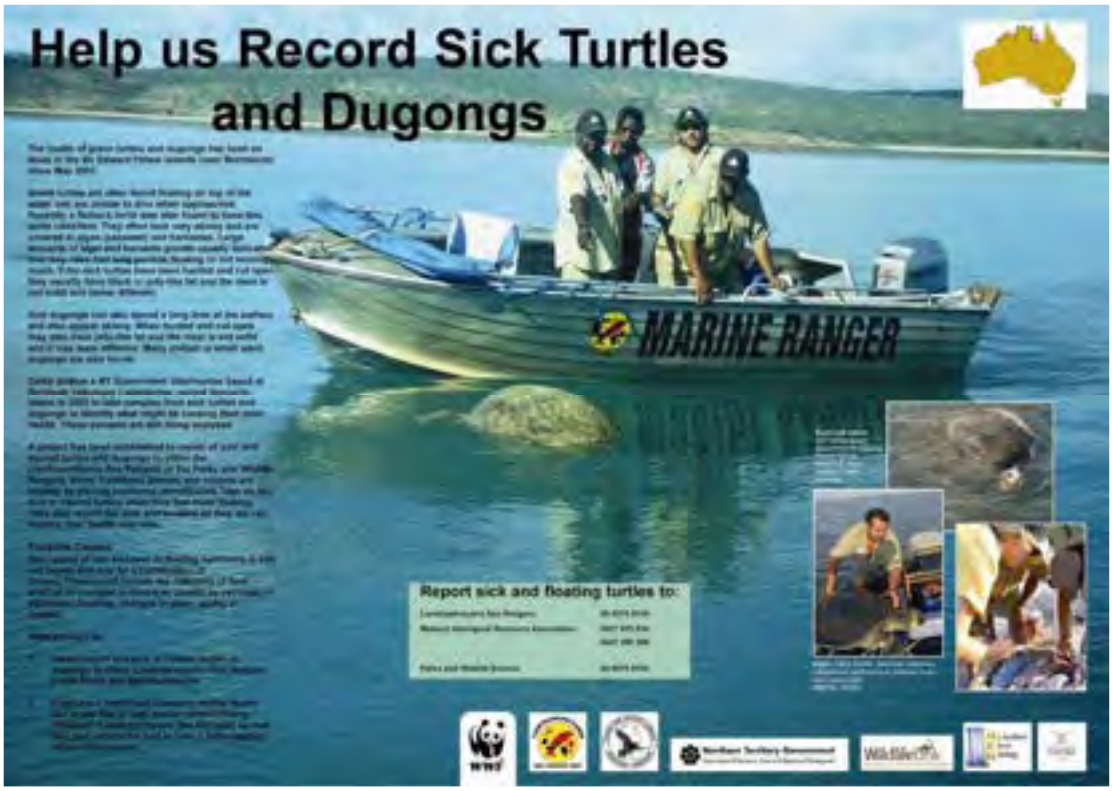
This component was partly funded through project money from Natural Heritage Trust Grant.

See link.

https://www.monash.edu/arts/monash-indigenous-studies/wunungu-awara/animations/the-sea-turtle-and-the-osprey-2011

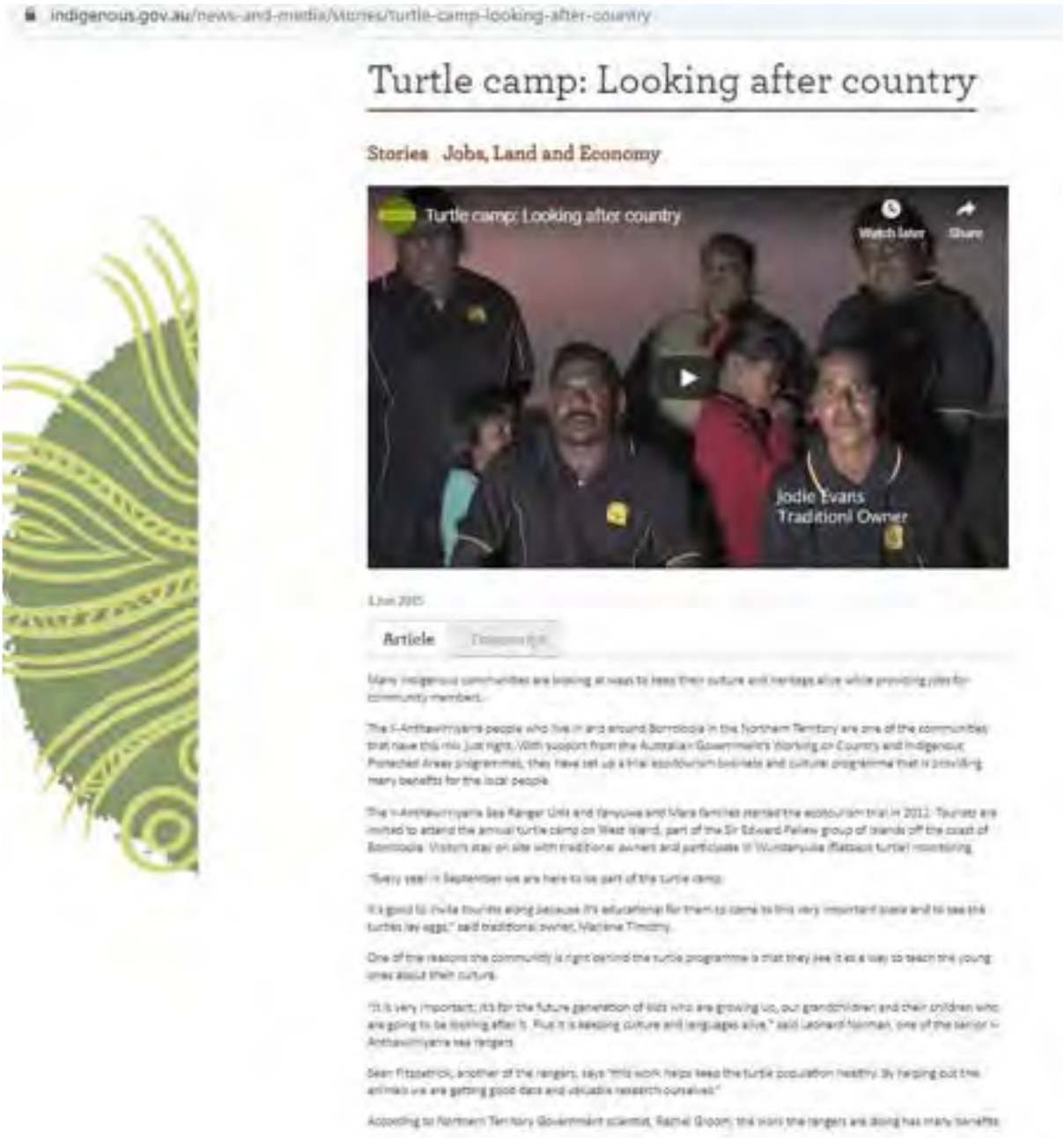
The Sea Turtle and the Osprey (Wundanyuka kulu Jujuju) (2011)

2. POSTERS PRODUCED BY WWF


Help us Record Sick Turtles and Dugongs
MARINE RANGER
Report sick and floating turtles to:

3. NEWS ARTICLE

https://www.indigenous.gov.au/news-and-media/stories/turtle-camp-looking-after-country



indigenous.gov.au/news-and-media/stories/turtle-camp-looking-after-country

Turtle camp: Looking after country

Stories **Jobs, Land and Economy**

1 Jun 2015

Article

Many Indigenous communities are looking at ways to keep their culture and heritage alive while providing jobs for community members.

The Anthawirriyarra people who live in and around Borroloola in the Northern Territory are one of the communities that have this mix just right. With support from the Australian Government's Working on Country and Indigenous Protected Areas programmes, they have set up a trial ecotourism business and culture programme that is providing many benefits for the local people.

The Anthawirriyarra Sea Ranger Unit and Yanyuwa and Mara families started the ecotourism trial in 2012. Tourists are invited to attend the annual turtle camp on West Island, part of the Sir Edward Pellew group of islands off the coast of Borroloola. Visitors stay on site with traditional owners and participate in Wuntanyuka (flatback turtle) monitoring.

"Every year in September we are here to be part of the turtle camp.

It's good to invite tourists along because it's educational for them to come to this very important place and to see the turtles lay eggs," said traditional owner, Marlene Timothy.

One of the reasons the community is right behind the turtle programme is that they see it as a way to teach the young ones about their culture.

"It is very important, it's for the future generation of kids who are growing up, our grandchildren and their children who are going to be looking after it. Plus it is keeping culture and languages alive," said Leonard Norman, one of the senior Anthawirriyarra sea rangers.

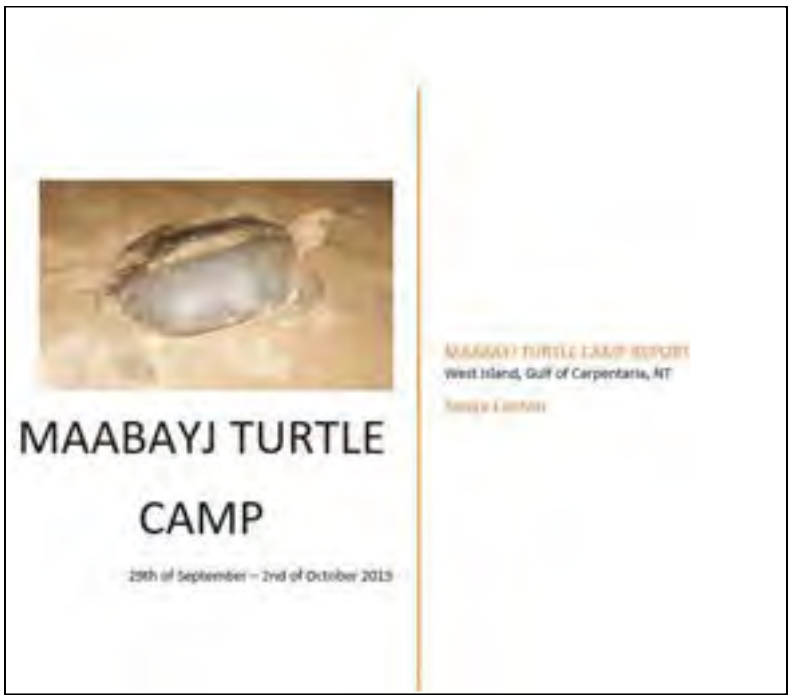
Sean Fitzpatrick, another of the rangers, says "this work helps keep the turtle population healthy. By helping out the animals we are getting good data and valuable research ourselves."

According to Northern Territory Government scientist, Rachel Groom, the work the rangers are doing has many benefits

4. OPPORTUNITY THROUGH SPONSORSHIP

https://www.ethosglobal.org.au/projects/youth-ecology-sponsorship

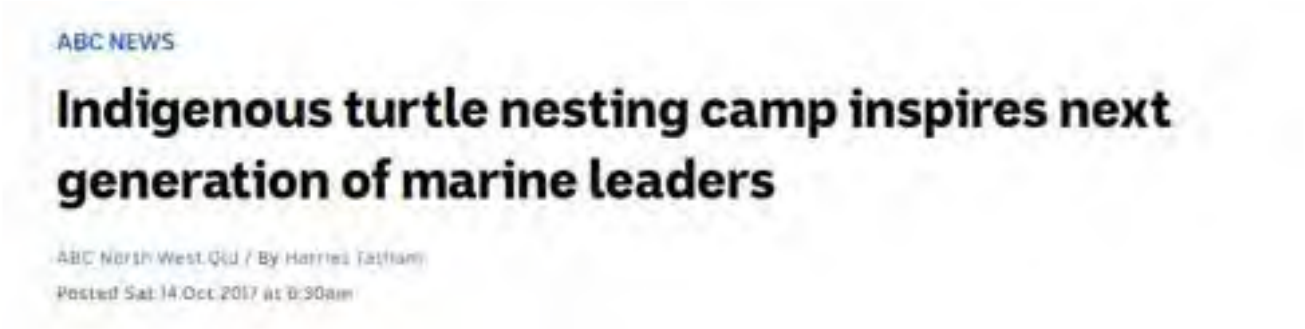
See report by Student.



https://www.ethosglobal.org.au/projects/youth-ecology-sponsorship#blog=175

5. NEWS ARTICLE

https://www.abc.net.au/news/2017-10-14/turtle-nesting-camp-inspires-future-aboriginal-marine-leaders/9022196



ABC NEWS

Indigenous turtle nesting camp inspires next generation of marine leaders

ABC North West QLD / By Harriet Latham

Posted Sat 14 Oct 2017 at 8:30am

6. NEWS ARTICLE

https://issuu.com/first_nations_telegraph/docs/traditional_owners_share_sea_turtle

www.firstnationstelegraph.com

Traditional Owners share sea turtle camp

supplied by Leigh Harris
21 July 2015

For twelve years li-Anthawirriyarra Sea Ranger Unit and the Yanyuwa families (living in and around Borroloola in the southwest Gulf of Carpentaria, NT) have held an annual two week turtle camp around September/October on West Island – a remote location in a remote locality.

This is peak nesting season for Wundanyaka (mostly Wirndiwindi or flatbacks aka natator depressus) and the rangers and families use this opportunity to undertake invaluable research into the nesting habits of these turtles, using a complementary blend of Indigenous Knowledge and scientific method.

To ensure this work continues, li-Anthawirriyarra has hosted three "eco tours" in 2012, 2013 and 2014. During these tours we invited guests from all over Australia to attend turtle camp, mingle with the families, learn about Yanyuwa ways and participate in the nightly turtle research.

Participants heard Yanyuwa songs for the islands, watched turtles lay, and saw hatchlings make their dash for the open sea. All the while they were accommodated in luxury tents, fed, entertained and allowed plenty of time to just "kick back" and relax in the pristine surrounds of the southwest Gulf. One visitor summed up the general feeling of all thus:

"Close to my best holiday ever…a wonderful and exceptional experience".

Once again, we invite paying guests to be part of this once in a lifetime experience. Once in Borroloola, li-Anthawirriyarra Rangers will transport visitors to Mule Creek Boat Ramp, where they will travel for forty minutes by barge to Maabayj (North Beach, West Island). Upon arrival, all will be accommodated in luxury "eco-friendly" tents and provided with three meals a day. Daily activities

will include tours – fishing and site seeing - to surrounding islands, singing, dancing and other workshops and two nights of "up close and personal" interaction with Wundanyuka in a carefully monitored and professionally managed environment.

Turtle camp – Namu-Yuwa ki-Wundanyukawu (Law for the Sea Turtle) – represents much more than a simple tourism event. Paying guests will be investing in the future of this research and thus the overall health and well-being of Australia's turtle populations. Importantly they will also be supporting a fledgling economic enterprise for the benefit of the Yanyuwa and wider Gulf communities. As one senior ranger/ traditional owner succinctly states, "We need proper jobs for [those] kids, so they can learn about their country and look after it properly for everyone".

Above: Accommodation. Below: Turte hatchlings

Booking for this unique cultural and environmental experience at the 2015 Maabayj Turtle Camp can be made online at www.tours.borroloolasearangers.com.au or by calling Ii-Anthawirriyarra Sea Ranger Unit in Borroloola.

7. WEB CONTENT

https://www.niaa.gov.au/indigenous-affairs/environment/yanyuwa-ipa-and-li-anthawirriuarra-sea-rangers

8. NEWS ARTICLE

https://www.abc.net.au/news/rural/2011-10-10/tagging-sea-turtles-in-the-gulf-of-carpentaria/6177768

avirus Politics World Business Analysis Sport Science Health Arts Fact Check Other

ABC RURAL

Tagging sea turtles in the Gulf of Carpentaria

At the end of September every year the Lianthawirriyarra Sea Rangers camp for two weeks on a remote island in the Gulf of Carpentaria to count, measure and tag flatback turtles.

It's the time of year when the turtles come to lay eggs on the beach, and the rangers take the opportunity to survey and track the population.

It's a massive job.

The group is based in Borroloola, on the McArthur River, just inland from the coast.

About 20 people camp for a fortnight on West Island, which is part of the Sir Edward Pellew Group of Islands in the Gulf.

9. NEWSLETTER

https://nailsma.org.au/uploads/resources/Kantri-Laif-Issue-1.pdf

Borroloola first to track Flatback Turtles

10. DOCUMENTARY ON LOOKING ARE TURTLES

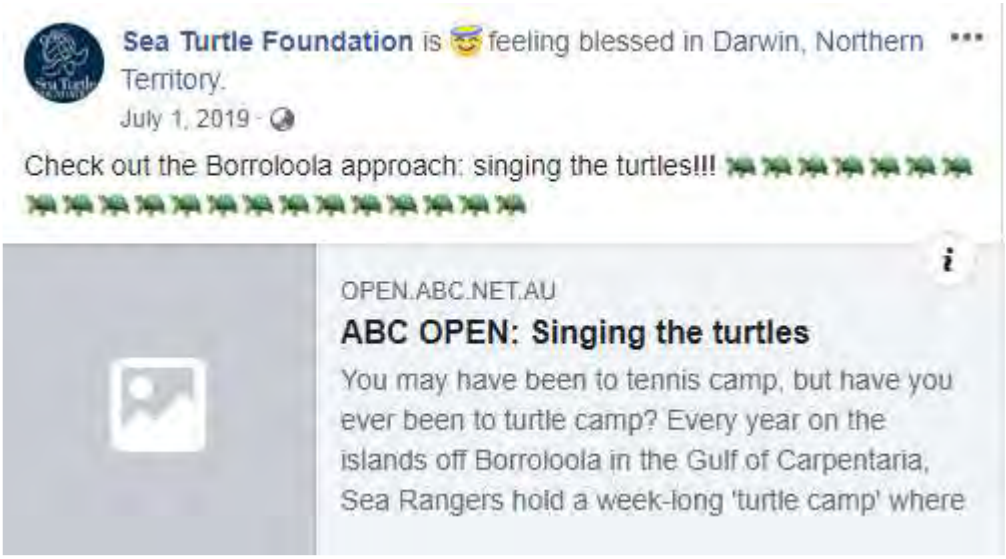
https://www.seaturtlefoundation.org/2017/09/looking-after-turtles-our-culture-our-future/

11. NEWS ARTICLE

https://www.abc.net.au/triplej/programs/hack/turtles-rangers-sustainable-hunting-traditional-borroloola/9443202

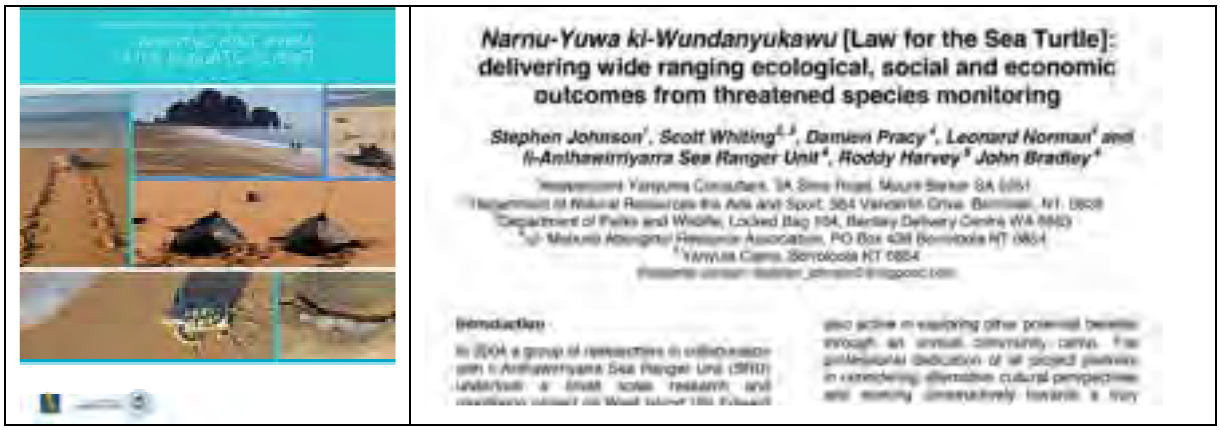
12. WEB VIDEO

https://www.facebook.com/watch/?v=10154302187919873



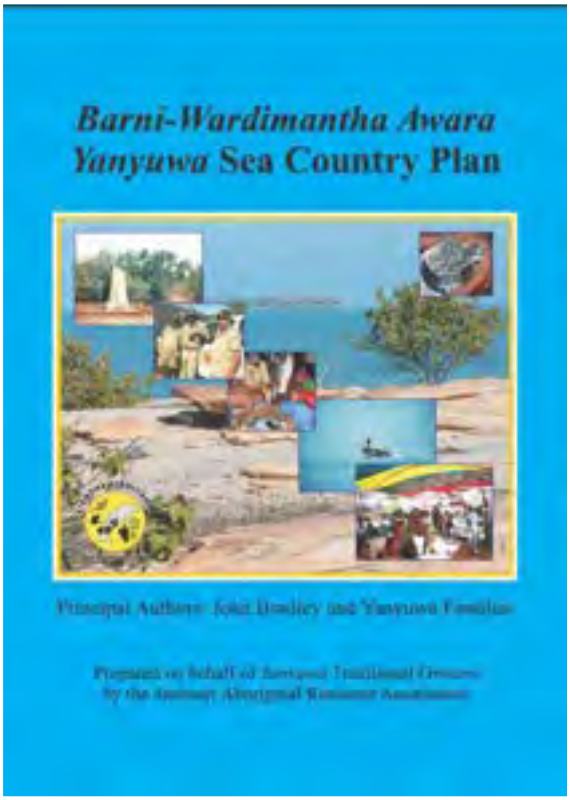
13. CONFERENCE PAPER

https://www.dpaw.wa.gov.au/images/conservation-management/marine/20150211_proceedingswa_turtlesymposium14_finweb_2.pdf



Narnu-Yuwa ki-Wundanyukawu [Law for the Sea Turtle]: delivering wide ranging ecological, social and economic outcomes from threatened species monitoring

14. SEA COUNTRY PLAN 2006



https://maps.northwestatlas.org/files/montara/links_to_plans/NT/7.%20IPA%2047%20Yanyuwa%20Sea%20Country%20Plan.pdf

APPENDIX 2 – GALLERY OF PHOTOGRAPHS

SICK TURTLES

Figure 33. 'Floating or sick turtle', the flatback turtle is trying to dive but unable to.

Figure 35. Dead turtle found by the li-Anthawirriyarra and Parks and Wildlife Rangers.

Figure 36. Dead turtle found by the li-Anthawirriyarra and Parks and Wildlife Rangers.

Figure 34. Parks and Wildlife Ranger with a male flatback turtle.

COMMUNITY PARTICIPATION

Figure 40. Compilation of photos of community engagement and involvement.

2007 IMAGES:

Figure 40 Flatback turtle.

Figure 41 Dead flatback turtle washed up on beach.

Figure 42 Flatback turtle returning with one tag and re-tagged.

Figure 43 Ghost crab predation on flatback hatchling.

Figure 44 Flatback hatchling.

Figure 45 Adult flatback turtle returning to the water.

Figure 46 Sheralee Simon and daughter Tomasina.

Figure 47 Thomas Simon holding a flatback hatchling.

Figure 48 Sheralee Simon and Diane Quayle rescuing a flatback hatchling.

Figure 49 Rescuing a flatback hatchling.

Figure 50 Greg Quayle with a flatback hatchling.

Figure 51 Flatback hatchling.

Figure 52 Sea snake washed ashore at West Island.

Figure 53 Shirley Simon and Tomasina Simon at the turtle camp.

Figure 54 Diane Quail working at the camp.

Figure 55 Greg Quail cooking dinner.

PHOTOGRAPHS - 2008

Figure 56 Getting ready

Figure 57 checking hatchling success

Figure 58 Releasing the turtle.

Figure 59 Night-time talks.

Figure 60 Night time talks.

Figure 61 Tagging a turtle.

Figure 62 Beach Transport.

Figure 63 Wishing the turtle good luck.

Figure 64 Hatchlings.

Figure 65 Steve Johnston at Vanderlin Island.

Figure 66 Measuring a turtle.

Figure 67 A green turtle with a deformed carapace.

Figure 68 Recording data.

Figure 69 Looking at turtle photos.

Figure 70 The kitchen.

Figure 71 Measuring a turtle.

Figure 72 Recreational time

Figure 73 Transport

Figure 74 A few minutes rest before the night work.

Figure 75 Getting ready for the hungry masses.

Figure 76 The camp.

Figure 77 Ranger Boat.

Figure 78 Checking on hatching success.

Figure 79 Counting eggs.

Figure 80 Measuring the bottom of the nest.

Figure 81 Counting eggs.

Figure 82 Measuring eggs.

Figure 83 Traditional Owners.

Figure 84 Running repairs.

Figure 85 Running repairs.

Figure 86 Keeping the fluids up.

Figure 87 Sunset.