CICI & TCI Ltd
2021 – 2022 Nesting Season Final Report

Conflict Islands Conservation Initiative & The Coral Islands Ltd

2021 – 2022 Turtle Nesting Season

End of Season Report

Report Contents

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About the Conflict Islands

The Conflict Islands Atoll, in the heart of the Coral triangle and part of the Coral Sea in Milne Bay, Papua New Guinea is a bridge between the Solomon Islands, Australia and other interconnected waters of the greater Pacific Ocean.

Within Papua New Guinea, The Conflict Islands are held under a free hold land title, with 100% ownership to Mr Ian Gowrie-Smith and his business The Coral Islands Ltd, and therefore decisions about how the Conflict Islands can be sustainably used and managed falls under the Papua New Guinea *Land Act 1996* and can be made by the owner. Adjacent communities are consulted and are involved in decision making and awareness and education programs are held with active communities.

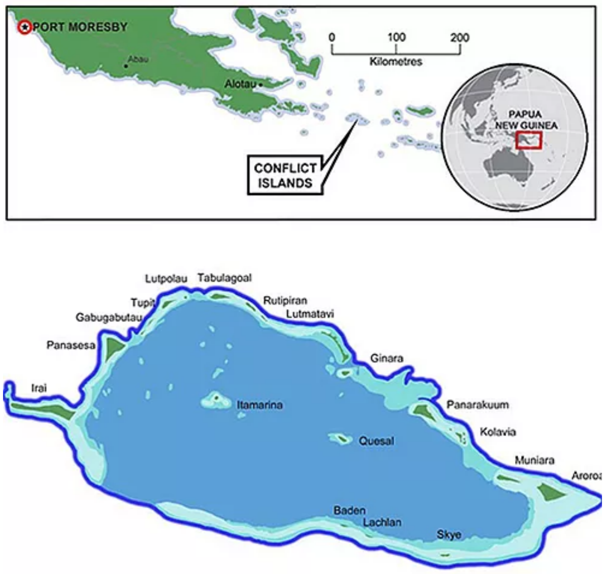

Figure 1: The Conflict Island Atoll is located in the Milne Bay Province of PNG, and within the coral triangle.

The Conflict Islands Atoll has very diverse coral fauna. A total of 418 Scleractinian corals clearly places it within the area of the highest coral diversity in the world ("Coral Triangle") along with the Philippines and Indonesia. The highest average number of species of reef fish (220) was recorded for the Conflict Group. The number of species in the below families is totaled to obtain the Coral Fish Diversity Index (CFDI). The total CFDI for Milne Bay Province is 337 with the following components: Labridae (108), Pomacentridae (100), Chaetodontidae (42), Acanthuridae (34), Scaridae (28) and Pomacanthidae (25). This is the highest total for a restricted location thus far recorded in the Indo-Pacific, surpassing the previous figure of 333 for the Maumere Bay region of Flores, Indonesia. Significant numbers of maori wrasse (*Cheilinus undulatus*), giant clams, white teat and black teat sea cucumber, all IUCN Red Listed as endangered species, also inhabit the reefs of the Conflict Group.

Along with amazing richness of the coral reef and fish biodiversity rivalling that of Indonesia, the Conflict Group has recorded such important mega fauna as whale sharks, reef manta ray (*Mobula alfredi*) giant manta ray (*Mobula birostris*), bowmouth guitar shark (*Rhina ancylostoma*), endemic epaulette shark (*Hemiscyllium michaeli*), bigeye thresher *(Alopias superciliosus*) and marine mammals, such as risso dolphin (*Grampus griseus*), dugongs (*Dugong dugon*), false killer whales (*Pseudorca crassidens*), bottlenose dolphins (*Tursiops sp.*) and reported sightings of orca (*Orcinus orca*) and sperm whales (*Physeter macrocephalus).*

The Conflict Island Group has globally and regionally significant nesting populations of sea turtle, many of which have migrated to the islands from other countries (e.g., Australia) to court and nest. There is also foraging populations that reside in the lagoons of the Conflict Island Atoll.

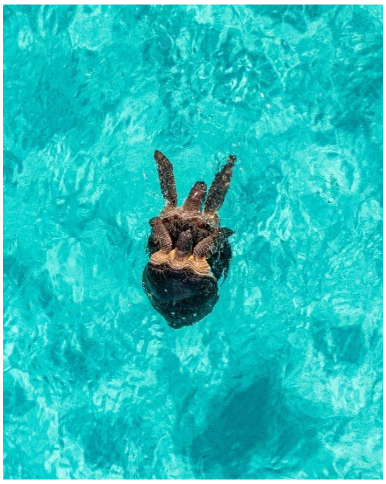

Figure 2: Aerial image of mating green turtles inside the Conflict Islands Atoll lagoon area. (© Migration Media Underwater Imaging, 2021)

The critically endangered hawksbill turtle (*Eretmochelys imbricata*) and the endangered green turtle (*Chelonia mydas*) (IUCN Red List) are the two species known to use the islands to nest, breed and feed, however, there have been multiple sightings of the olive ridley turtle (*Lepidochelys olivacea*) foraging in these waters. There are also images of reported nesting and harvest of olive ridley turtles on surrounding islands which indicates a gap of understanding about this vulnerable species to also be utilizing the area of, around and beyond the atoll.

The Coral Islands Ltd (TCIL) in partnership with Conflict Islands Conservation Initiative (CICI) has been running a Turtle Conservation Program on 21 of the Conflict Islands since the 2016-17 nesting season.

The program was built around a voluntourism model that relied on income from overseas volunteers, but also assisted the attendance of local Papua New Guinea university students and graduates to attend the program to gain experience and knowledge in the field of turtle conservation and husbandry. Financially supplemented by the island's owner Mr Ian Gowrie-Smith where required and small grants and fundraising efforts received, limited conservation work was able to be conducted during the 2020-21 nesting season due to the impacts of COVID-19 and 100% loss of funding from volunteers' attendance and travel restrictions. These issues continue to impact the conservation work into 2023 as tourism confidence, PNG restrictions on COVID-19 policies and numbers of competitors in the same space for voluntourism continues to rise.

Our turtle conservation program has only been able to continue running through the support of our varied and generous sponsors and donors, of which we are forever grateful to for their support in these challenging times.

Turtle Life Cycle

Turtles take roughly 20 to 30 years to reach sexual maturity in the wild. After hatching out of the sand as 2-3 cm long hatchlings, they head out into oceanic currents for their lost years those years where they are difficult to track. After a period of around 5-15 years, those which survive the lost years at sea, they settle to reside in a coastal reef area where they spend years feeding to reach breeding maturity. Once they are sexually mature, they migrate from their foraging grounds to a courtship area and then the females continue to a nearby location close to where they hatched to lay their own eggs.

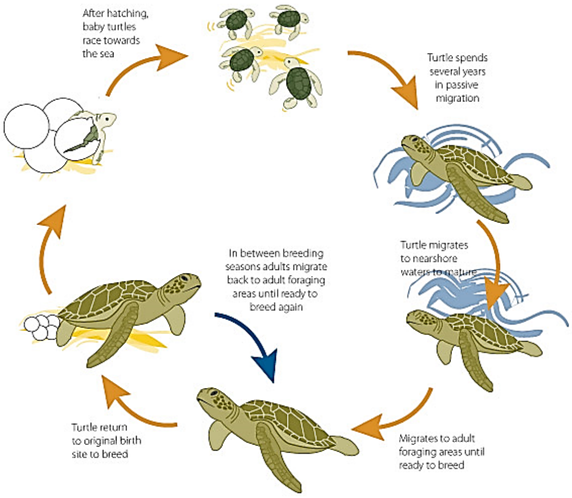

Figure 3: Turtle Life Cycle (courtesy of kingfisherbayresort.blogspot.com)

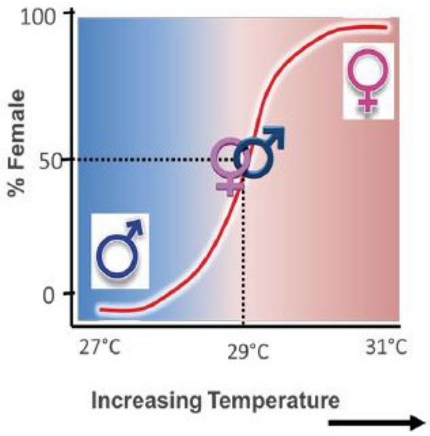

Figure 4: Marine turtle sex-ratio temperature dependence chart (adapted from Morreale et al. 1982).

CICI monitors both green and hawksbill turtle nesting in The Conflict Island Atoll. Researchers from WWF-Coral Triangle Programme and one of our directors Ms Christine Madden Hof, has been satellite tracking some hawksbill turtles that nested on the islands in 2017 and 2018. This data showed that most nesting hawksbills are migrating across the Coral Sea, to and from the Great Barrier reef in Australia to feed. Data collected from foraging turtles tagged in the Howick Island Group in the northern Great Barrier Reef also showed that green turtles have long migrations to the Conflicts to return to their nesting grounds. Female turtles do not make this migration annually, but every 5 – 8 years, returning to the nesting grounds to lay between 3 – 5 clutches of eggs. Whilst male turtles are likely to return to breed 2 – 3 times more frequently than their female counterparts.

The nesting season here starts in October, and the last of the hatchlings usually emerging by the end of April. However, this season (2021-22), the nesting was extended, with the last nest laid on the second of April 2022, and therefore hatchlings will emerge in June. There is no parental care for turtles. After the female deposits her eggs in her nest, she returns to the sea, with no further interaction with the nest or her hatchlings. Nest depth can vary between 30 – 60 cm deep for the different species, as does the number of eggs laid in each clutch. Some females may lay only 50 eggs toward the end of the season, but the total clutch count (number of eggs) can be as high as 220 or more.

The sex of the hatchlings is not determined at fertilization (i.e., by sex chromosomes). Instead, sex is determined by the nest temperature during the middle third of embryonic development. Nest temperatures over ~29°C produce more females, and temperatures below this range produce more male hatchlings. With the warming global temperatures, some sea turtle populations are producing close to 100% female hatchling, such as the northern Great Barrier Reef green turtle population on Raine Island, the largest green turtle nesting site in the world. The consequences of this could be dire for the future of turtle species. Similarly, nest temperatures above 32°C are lethal for developing sea turtle embryos and have huge consequences to the overall health of the hatchling. Along with the low survival rate to maturity, which is less than one in every 1000 hatchlings, the future for the species without expert management and intervention is looking dire.

Figure 5: Turtle threats of by-catch from long liner (www.seaturtlestatus.org); passive fishing by discarded fishing nest at sea part of the plastic pollution problem (www.dhimurru.com.au); and boat strike victim (Ian Bell, Sea Turtle Foundation); coastal erosion exposing vulnerable turtle eggs due to sea level rise (champagnewhisky.com).

Threats to Turtles Globally and Locally

The global trend for many turtle populations is **declining** due to the many factors that affect them in every stage of their life cycles, from global to local scales. Global threats include increasing sand temperatures ('feminization' and lethal incubation temperatures), sea level rise and erosion (nesting habitat loss), pollution (heavy metals, chemicals, toxins and plastics), fishing (either intentional or as by-catch), marine debris (including discarded (ghost net) fishing gear), over-harvest of meat and eggs, and the illegal wildlife trade.

For turtles in the Conflict Islands, key threats are poaching of turtles for meat and eggs, the illegal wildlife trade for "tortoise shell" (hawksbill turtles), erosion caused by sea level rise leading to a loss of available nesting beach, plastic debris, and marine debris including trees blocking access to the nesting habitats. The carapace of hawksbill turtles (*Eretmochelys imbricata)* is highly sought-after used in the fashion, medicinal and ornamental industry contributing to the illegal wildlife trade.

Figure 6: Security removing turtles from sailu that had been taken from the beaches of the conflict islands after a discussion with poachers.

PNG's human population growth has increased around ~2% each year since 1950 (http://www.worldometers.info). In combination with the global increase in the cost of living, further pressure has been put on turtle populations as there is an increased demand for their meat and eggs to substitute income for villages. When sold for cash, these products can be sold for ~350 kina ($130 AUD) at local markets. The sale of any turtle product is illegal in PNG under the *Fauna (Protection and Control) Act 1966*. Traditional trade is legal and widely used across the rural and maritime regions of the country. The turtle nesting season coincides with Christmas and New Year, and every year where the demand for cash increases and puts extra pressure on communities to provide for these western celebrations introduced with Christianity to Papua New Guinea.

Our team of Rangers are without exception, reformed turtle poachers, who openly admit to selling turtles and was the most common use for the turtles that they harvested. It is known to be an illegal practice but without any enforcement especially in rural communities there is no hesitancy to sell turtles openly. As stated by our rangers, they money they got from selling turtles was often used to buy alcohol, betel nut, and Christmas supplies. Enforcement and effective management have always been an issue in PNG, even though high-level political members condone the illegal sale of turtles.

Figure 7: Illegal sale of turtle products in Papua New Guinea, jewelry and picture frames in Jacksons International Airport in Port Moresby and the turtle meat for sale in Alotau fish market. (Images from Migration Media Underwater Imaging, 2018)

Figure 7. Collection of images taken at Jacksons international departure airport lounge shop with turtle products for sale in May 2022 (© Migration Media Underwater Imaging, 2022).

Turtle Monitoring and Protection Program Overview

Figure 8: New dingy and outboard generously sponsored by Sea Shepherd and named by rangers as "Baby Blue"

CICI's ongoing Turtle Conservation Program is designed to monitor and protect nesting turtles and their eggs of the Conflict Island Atoll. Over the years we have also been creating a baseline data set that CICI and others will be able to use to determine if the management strategies put in place are successfully contributing to the conservation of green and hawksbill turtles. Supported my nesting population survey monitoring, some of the species management strategies used are poaching deterrence, egg protection, translocation, nest cooling, "head-start" hatchlings, environment clean ups and community education and awareness. The program is continually evolving and adapting the methods and techniques to keep up with worlds best practice and to ensure laws, ethics and regulations are adhered to. This also involves partnering with government, students, PhD candidates, universities, scientific advisors, and other conservation organizations, ensuring data sharing and collaborations where possible.
The project area consists of the atoll's 21 islands with the furthest being Auroroa Island, ~ 22 kms away from the base and hatchery at Panasesa Island. This makes the logistics and costs to effectively monitor all the islands difficult and expensive to run.

CICI's Turtle Conservation Project aims to monitor the marine turtle populations at the Conflict Islands Atoll via a long-term tagging program to allow population trends and trajectories to be calculated (i.e., is the population increasing, stable or declining). Beach patrols occur at night when the female turtles come up to lay. At this time, the rangers are able to tag green and hawksbill turtles, take genetic samples where necessary, collect facial ID photos, and other morphological data collection such as carapace length (CCL) and nest depth. These patrols also protect the turtles and their eggs from poaching and enables education and awareness to be conducted when poachers are encountered. This project conducts emergence and hatchling success studies by collecting eggs and translocating them to the Conflict Islands Turtle Hatchery. The nests are incubated, and temperature regulated using shade and irrigation to produce healthy hatchlings and not all females. Some hatchlings are raised in the on-site nursery until they are healthy and strong enough (3 – 12 months) to be released into the wild as part of our 'head-start' program.

Figure 9: Titanium flipper tag on juvenile green turtle (©Migration Media Underwater Imaging, 2018)

This season we faced many new challenges, from the effects of Covid-19 (e.g., availability of vaccines for staff), and significant storm surge flooding of the main island as a result of climate change. Despite these challenges we continued our efforts and expanded our Community Conservation Ranger Team to include 12 new Trainee Rangers to the team. Not all stayed through the season and replacements were brought in to cover their vacancies but overall, the recruitment and expansion was a huge success.
Our primary rangers of the team this season consisted of Steven Amos as Project Manager, Henry John and Patrick Lemeki as Team Leaders, Jeffery Evennett as our Science Officer, and Toby Losane as our Community Consultant.
Our new trainees were recruited from both the Engineer and Deboyne Groups of islands to the West and East of our Atoll respectively. They were Eddie Allan, Ryan Henry, Banian Leonard, Clinton Luke, Jack Marko, Badi Seko, Jonathan Weinam, Michael Moten, Rodney Taliya, Wesley Malui, Nathaniel Willy and Norman Poate. Youth engagement was a priority as we aimed to meaningfully employ, educate, teach new skills and conservation principles to the trainees regardless of

past opportunities, education or experience levels. All the trainees in the past had either eaten, harvested, or killed turtles and their eggs. After the season concluded all of the trainee rangers shared, they had a change of heart and mind about turtles and now are strong advocates for turtles' protection. Knowing all the struggles and threats turtles face they will take this knowledge and information back to their communities and villages along with their new passion to protect them.

In addition to the Community Conservation Rangers, we also employed a security team from a Port Moresby based firm, to patrol the atoll at night to help to alleviate the pressure on the rangers when faced with poachers. These poachers are often family relations or community members of the rangers from their villages. This system of the outside security firm worked very well with very few incidences of active poaching from the islands this season. This patrol team also assisted with nest translocations throughout the season. With the additional rangers in place, we were able to set up 3 ranger stations. One at Panasesa Island (Base), one at Auroroa Island and our additional ranger station originally at Ginara Island. Due to extreme weather events and storm surges flooding of the island, the Ginara team was later moved to Panaboal Island (Figure 9).

Figure 9: Conflict Island Map with Island names and locations of ranger deployments.

The rangers would rotate through each of the stations throughout the season, experiencing both camping field work and when based at Panasesa a more comfortable home style field condition. There are limitations on the efficiency of working from the field stations, with no access to power for lighting or charging equipment, and the transport of food and fuel to the sites for the period they remain on the islands. Another logistical difficulty faced is the long transportation distances when translocating eggs to the hatcheries at Panasesa Island, in sometimes in difficult weather conditions.

Figure 10: Field camp at Panaboal island

METHODS

Tagging and Patrols

The tagging method was adapted from standard SPREP tagging instructions (Geermans, 1993) sections 2 (2.2) and 3 (3.1, 3.2and 3.3). Female turtles were tagged on nightly patrols during the months of October 2021 – April 2022 across the entire atoll. The patrols started at nightfall through to the lowest point of the tide every night. The turtles were tagged with standard self-locking titanium tags. The tags belong to the Conflict Islands Conservation Initiative; tag series IGS0001-IGS3000.

Recorded data included when a turtle is encountered includes:

- Species
- Tag ID number
- Carapace length and width (CCL and CCW)
- Injuries, diseases or scars on the nesting female
- 2x facial identification photos (left and right)
- Date and time of laying event
- Nesting island
- GPS location of nest
- Nest Habitat (e.g., bare sand, grass)
- Number of eggs laid (total clutch count, TCC)
- Number of nests building attempts
- Reasons for nest failures (e.g., tree roots, erosion)
- Nest Relocation information

Figure 11: Facial Identification photo being taken by a CICI Conservation Ranger (©Migration Media Under Water Imaging, 2021)

So as not to disrupt her during the egg laying phase, the female turtle is not handled/touched until she is near completion of laying. She is then flipper tagged on the trailing edge of her front left or right flipper on pad L3 (closest to the body), otherwise subsequent pads, L2 or L1 will be tagged. The turtle is only tagged after laying is finished and only once on the left flipper (a primary tag), and then on the right flipper on the second time the turtle is encountered (recapture). The tag number will be recorded as well as any injuries or previous tags. Where possible we also record a facial identification photograph, that is later uploaded to an online database (www.wildme.org) where facial mapping occurs through artificial intelligence (AI) software. Turtles have a unique scale print on their faces that in the future we hope will be able to be used effectively to identify individual, and to replace the flipper tags.

Figure 12: Turtle Eggs and mucous being captured during oviposition. (©Migration Media Underwater Imaging 2021)

Egg Collection & Relocation/ Hatchlings

Eggs are only relocated if they are at high-risk of mortality. This may include poachers, predators or if the female has dug her egg-chamber below the high-tide line as they are at risk to drowning and erosion. Unfortunately, most clutches of eggs laid have to be relocated to a hatchery due to the high levels of threats.

As the female starts laying her eggs into her egg-chamber, she is no longer susceptible to disturbance. This allows our Conservation Rangers to easily place a ziplock bag under her cloaca to catch the eggs and the mucous she excretes whilst laying (Figure 10). Once laying has finished, the air is removed from the ziplock bag minimize exposure to oxygen during relocation, which pauses the development of the pin head-sized embryos until they are placed into their new nest site (Williamson et al 2017, Kam 1993, Kennett et al 1993).

Figure 13: Ranger catching eggs from a laying green turtle. (© Migration Media Underwater Imaging , 2021)

The eggs are then carefully transported back to the hatchery on Panasesa Island via boat. This process is done as quickly as possible from the time of collection, to minimize the risk of mortality caused by rotations of the egg.

A replicate nest is dug in the hatchery, to the same depth and width as the natural nest and is covered with the same sand the was removed to excavate the nest. The species, number of eggs and estimated hatching date, female's tag number and hatchery position are all recorded on the data sheet. The nest is then covered by a nest protector to exclude any crabs or other predators. The eggs are then left for approximately 60 days to develop and allow the hatchlings to emerge.

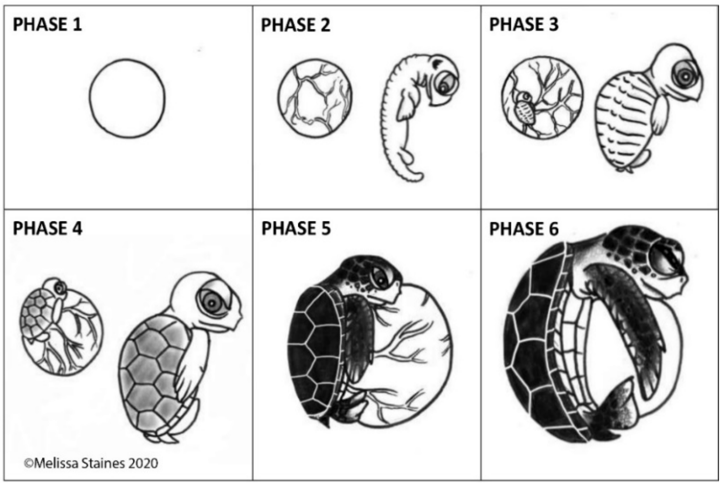

Figure 14: Embryonic development stages used in the field for assessing development stage at death (©Melissa Staines).

The nests are observed approximately a week prior to the estimated hatch date for the first signs of emergence of the hatchlings. Hatchlings with no morphological mutations are released on the beach closest to their hatchery. Whilst others showing distinct genetic deformities or weakness are brought to the nursery onsite for further husbandry and observation. The nest is then excavated to determine the hatchling and emergence success, and to identify if any eggs that did not develop, at what stage their development ceased. This entails opening any unhatched eggs to look for different stages of development (Figure 11). This helps us to improve our relocation and incubation techniques.

Hatchery Construction

To create our hatchery, we excavated an area 15m x 8m to a depth of 80 cm, and lined the perimeter with builder's plastic (20 cm down in the sand) to stop root invasion and aid in predator exclusion, leaving the base open for natural water drainage. Roots alone can cause severe dehydration and death of the developing embryos.

Encompassed by a 60cm tall fence, this area is then refilled with beach sand from the ideal location for natural nesting. A roof to provide shade is then constructed over the top of the whole area, made from bush materials such as natural wood and woven coconut leaves for the roofing. A bird exclusion net is then placed to cover the gap between the roof and the top of the fence to ensure no predation (by animals alone, not humans), of emerged hatchlings by any of the birds.

Figure 15: Shaded Turtle Hatchery. (©Migration Media Underwater Imaging, 2018)

This season, we placed temperature data loggers into some of our hatchery nests to determine if our current management strategies were producing temperatures that would likely result in balanced hatchling sex ratios. These strategies include shading the hatchery and treating the area with desalinated freshwater to keep the sand cool, mimic natural rainfall conditions. This season, as we had such a high number of nests and additional three hatcheries were constructed without any cooling treatment applied prior to the translocation of eggs. We also needed to reuse two of the hatcheries to cope with the numbers of nests being protected.

RESULTS

1. Nesting Population Surveys

Table 1: Number of individual turtles tagged an observed within the Conflict Islands Atoll, during the survey period of nesting females from late September 2021 to the end of March 2022.

Species	New Individuals	Re-migrant Individuals	Total Individuals	In-season Recaptures	One-off Captures
Green Turtle	655	10	665	502	658
Hawksbill Turtle	35	1	36	14	47
Total	**690**	**11**	**701**	**516**	**705**

Table 2: Number of Green turtles observed within the Conflict Islands Atoll, during the survey period from 2017 when the program commenced until the end of 2022 nesting season.

GREENS					
	New Turtles	Re-migrant Turtles	SPREP Tags	QLD Tags	Total
2017-18	234	0	5	1	240
2018-19	52	0	2	0	54
2019-20	342	0	1	0	343
2020-21	78	5	0	0	83
2021-22	655	10	3	0	669
Total	**1,361**	**15**	**11**	**1**	**1,388**

Table 3: Number of hawksbill turtles observed within the Conflict Islands Atoll, during the survey period from 2017 when the program commenced until the end of 2022 nesting season.

HAWKSBILL					
	New Turtles	Re-migrant Turtles	SPREP Tags	QLD Tags	Total
2017-18	30	0	2	0	32
2018-19	40	0	2	1	43
2019-20	25	0	0	0	25
2020-21	35	0	0	1	36
2021-22	35	1	1	0	37
Total	**165**	**1**	**5**	**2**	**173**

Table 4: Number of green and hawksbill turtles tagged and observed within the Conflict Islands Atoll during the survey period from 2017 when the program commenced until the end of 2022 nesting season.

COMBINED GREEN & HAWKSBILL DATA					
	New Turtles	Re-migrant Turtles	SPREP Tags	QLD Tags	Total
2017-18	264	0	7	1	272
2018-19	92	0	4	1	97
2019-20	367	0	1	0	368
2020-21	114	5	0	1	119
2021-22	690	11	4	0	706
Total	**1,527**	**16**	**16**	**3**	**1,561**

2. Nesting Success

Table 5. Number of nesting events throughout 2021 – 2022 nesting season.

Species	Successful Nests	Failed Nest Attempts
Green Turtle	815	1,184
Hawksbill Turtle	47	28
Totals	862	1,212

Table 6. Number of clutches Translocated and Protected in 2021 – 2022 season.

Species	Total Number of clutches Translocated	Total Number of eggs Translocated
Green Turtle	616	56,763
Hawksbill Turtle	39	4,560
Totals	**655**	**61,323**

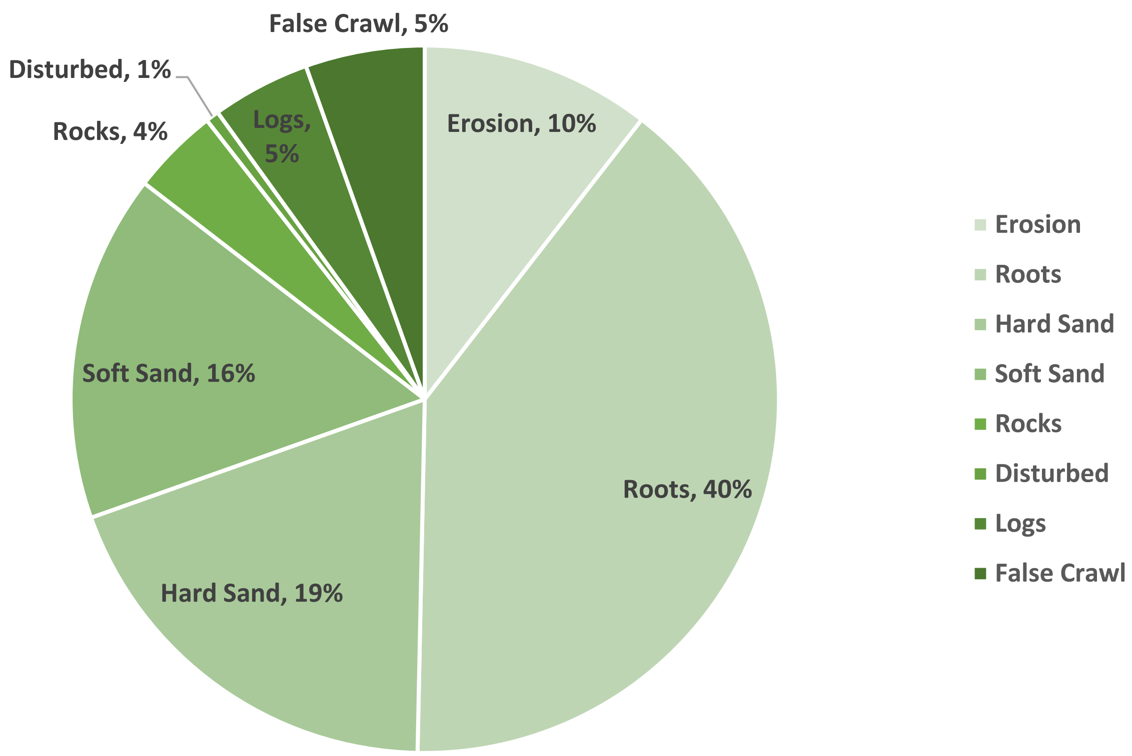

Figure 16. Reasons for failed nesting attempts of green and hawksbill turtles during the 2021-2022 nesting season.

Table 7. Number of nesting attempts categorized by surveyed island in the Conflict Island Atoll for the 2021 – 2022 Turtle Nesting Season, including missed turtles and tagged turtle nesting events for both Green and Hawksbill turtles.

Island	Green	Hawksbill	Total events (n)
Irai	399	4	403
Tupit	297	3	300
Auroroa	257	12	269
Panarakum	237	21	258
Muniara	156	10	166
Tabanagoal	107	3	110
Panasesa	106	5	111
Panaboal	98	0	98
Lachlan	70	1	71
Skye	70	3	73
Baden	69	4	73
Koliva	66	7	73
Gabugabutau	48	1	49
Ginara	11	1	12
New Island	5	0	5
Itamarima	3	0	3
Rutipiran	3	0	3
Quesal	1	0	1
Total	2003	**75**	**2078**

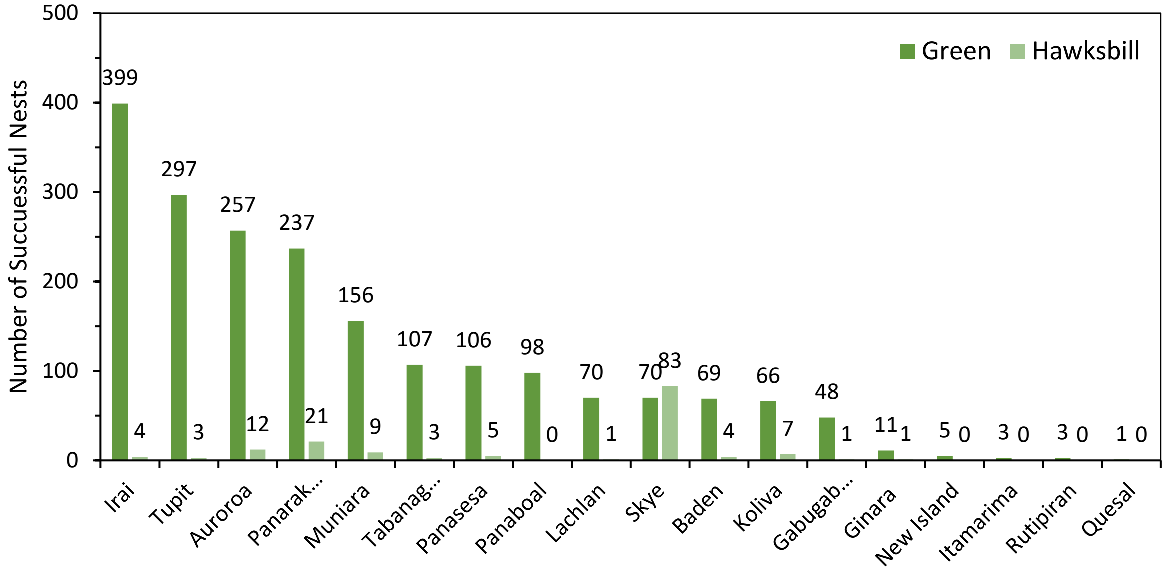

Figure 17. Number of successful nests for green (dark) and hawksbill (light) turtles across the islands of the Atoll in 2021-2022 season.

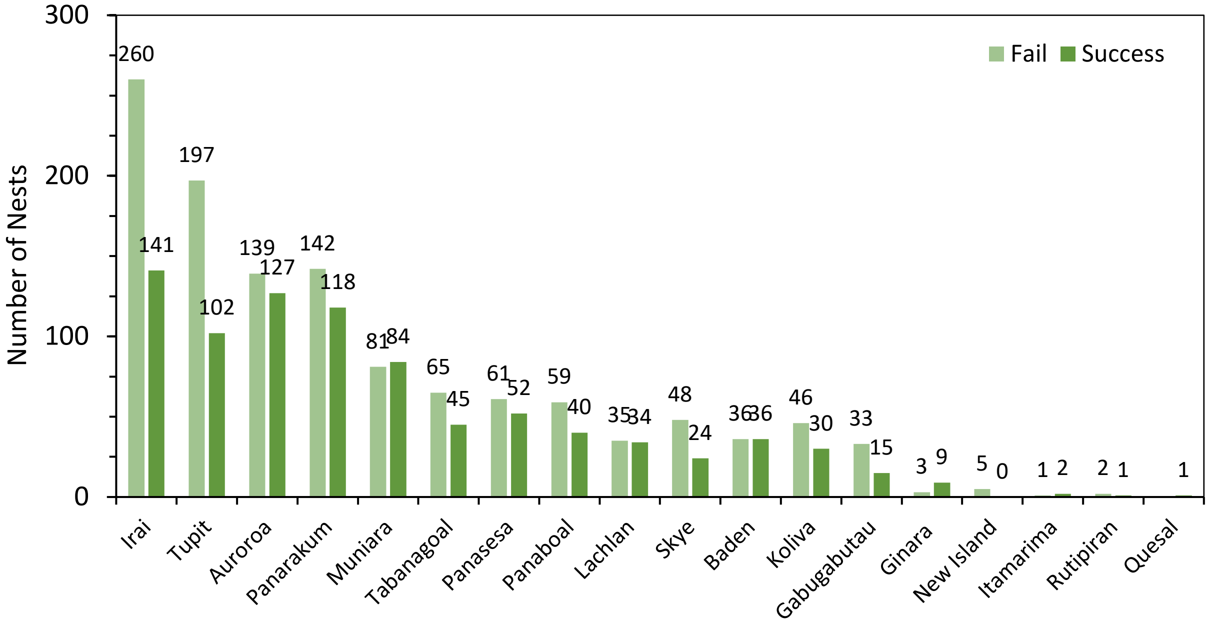

Figure 18. Number of successful (dark) and failed (light) nesting attempts form females (both green and hawksbill) on each island surveyed within the Conflict Island Atoll in 2021-2022 season.

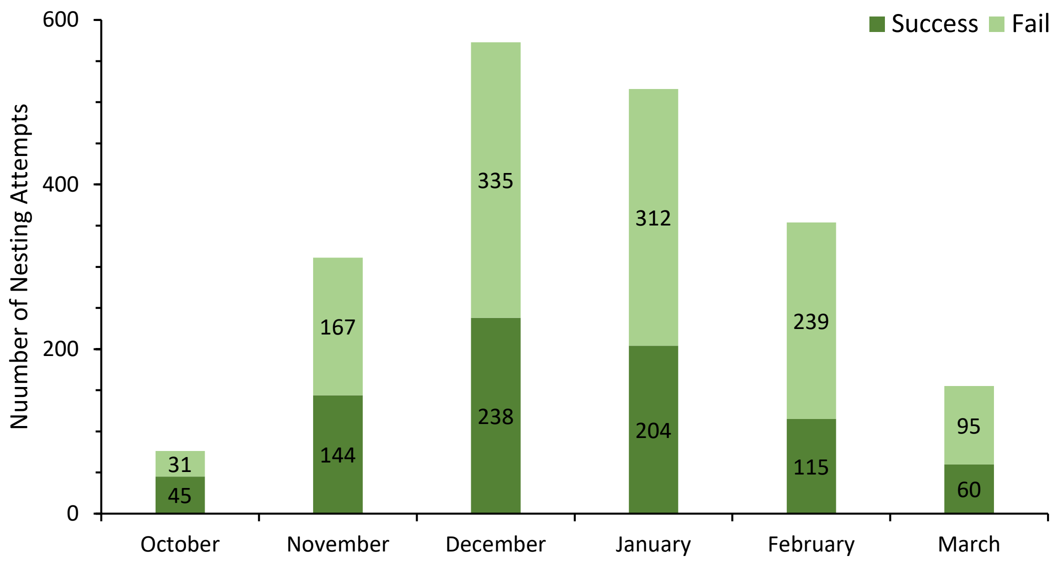

Figure 19. Total number of failed (dark) and successful (light) nesting attempts for each month by green turtles throughout 2021 – 2022 season.

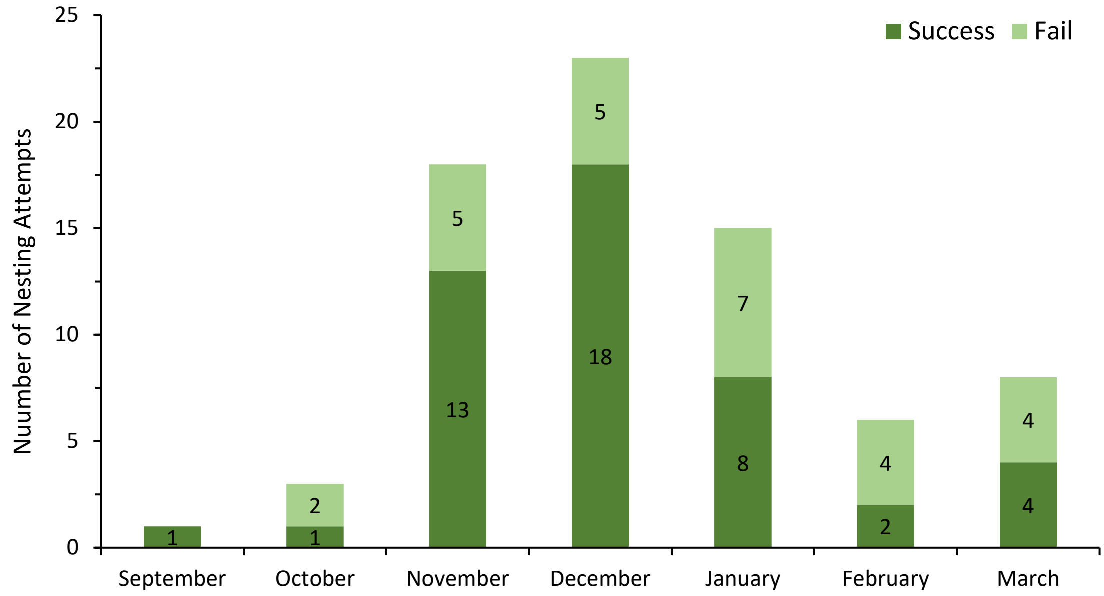

Figure 20. Total number of failed (dark) and successful (light) nesting attempts for each month by hawksbill turtles throughout 2021 – 2022 season.

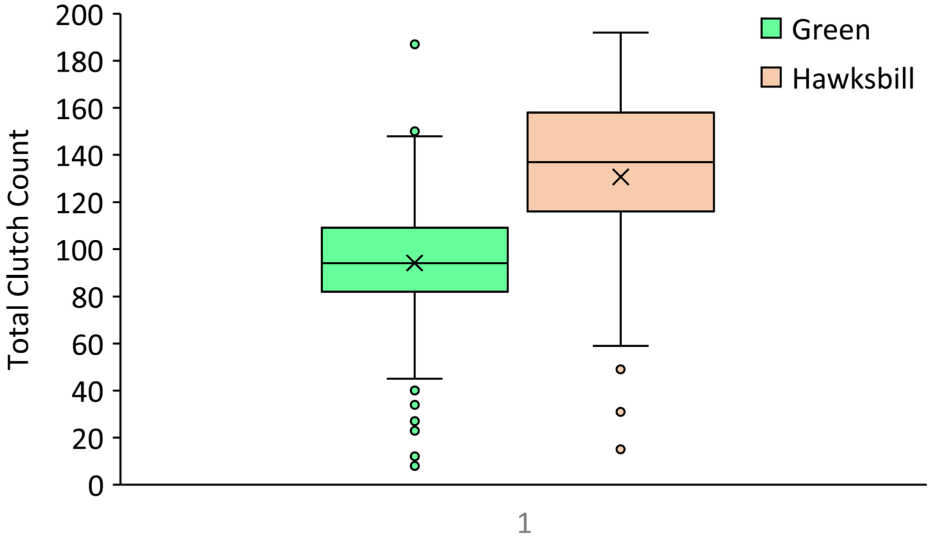

Figure 21. Box and whisker plot showing the variation in the number of eggs (clutch size) laid per nest in the 2021 -2022 nesting season by both green (green) and hawksbill turtles (orange).

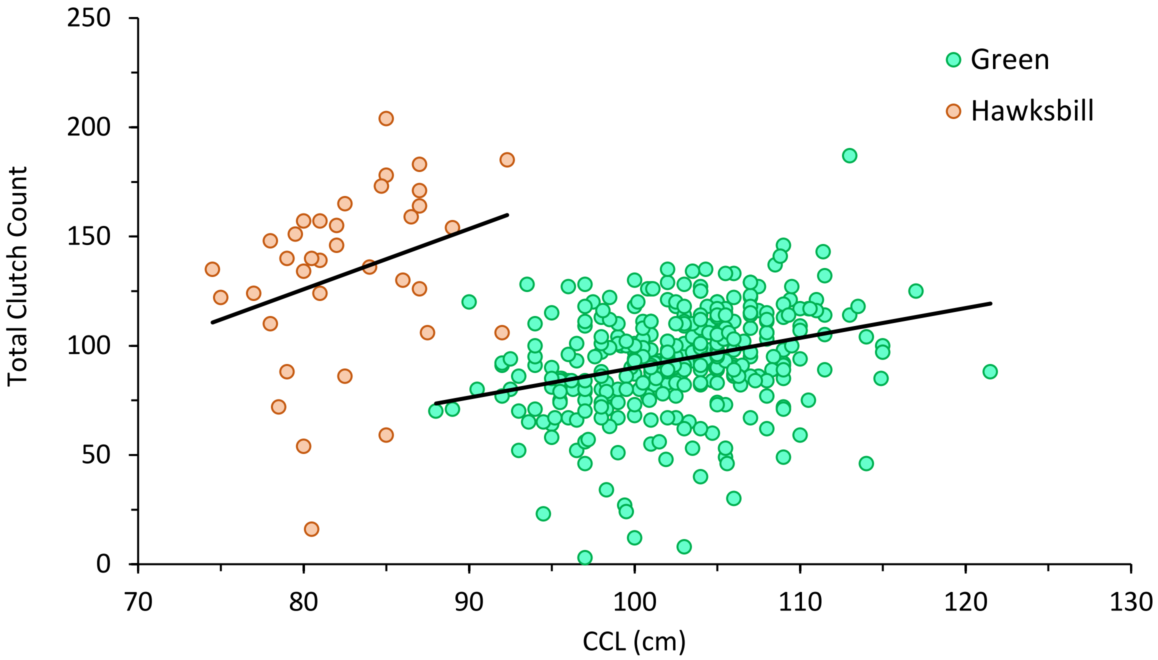

Figure 22. Relationship between female curved carapace length (CCL) and the number of eggs per clutch (total clutch count).

3. Hatchery Success

Table 8. Number of hatchlings released from translocated nests in hatchery during the 2021 – 2022 season to date.

Species	Nests Relocated	Number of Eggs	Number of Hatchings
Green	616	56,774	48,604
Hawksbill	39	5,095	4,560
Total	**655**	**61,869**	**53,164**

Table 9. Number of clutches relocated to the hatchery for the 2021 – 2022 Turtle Nesting Season, and corresponding hatchling production.

Species	Hatchling Success (%)	Emergence Success (%)	Sample Size (clutches)
Green Turtle	87.5	98.3	616
Hawksbill Turtle	91	98	39
Both Species Average	**87.7**	**98.3**	**655**

Table 10. Average incubation days for the different hatchery locations and treatments and average incubation temperatures for green turtles.

Hatchery	Average Incubation Days	Average Incubation Temperature (°C)
Temporary Shaded Unwatered	56	29.2
Shaded and Watered	62	28.3

4. Hatchling and Egg Morphometrics

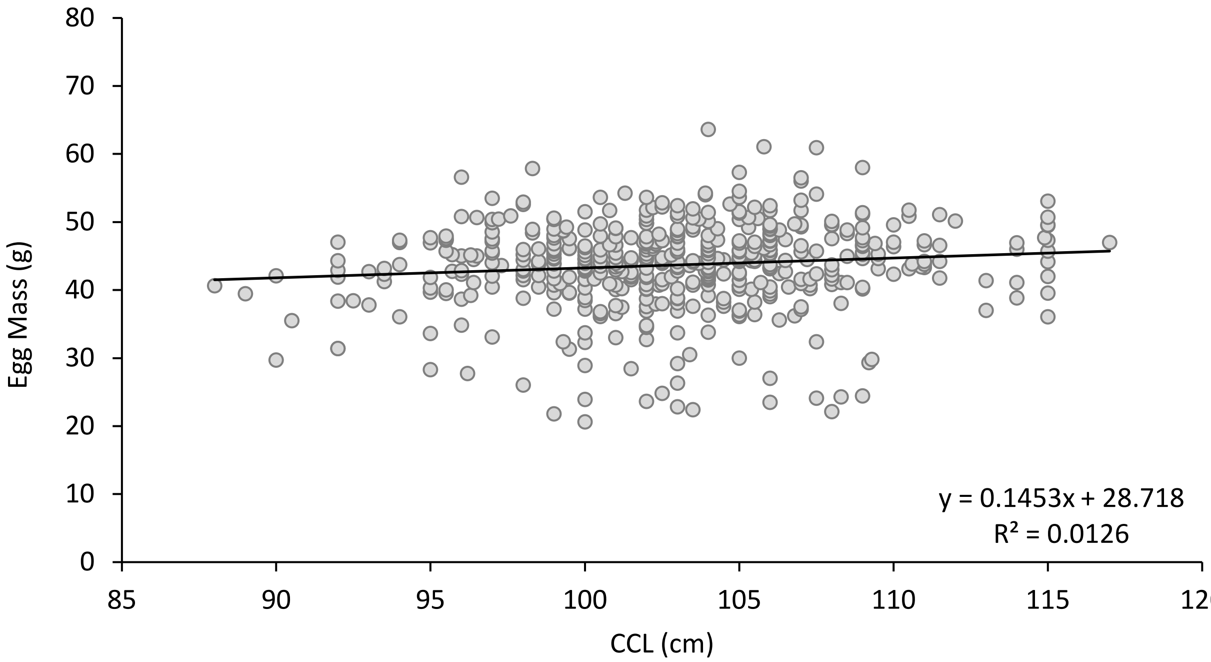

Figure 23. Scatter plot showing the relationship between the female size (CCL) and the average egg mass for green turtle clutches.

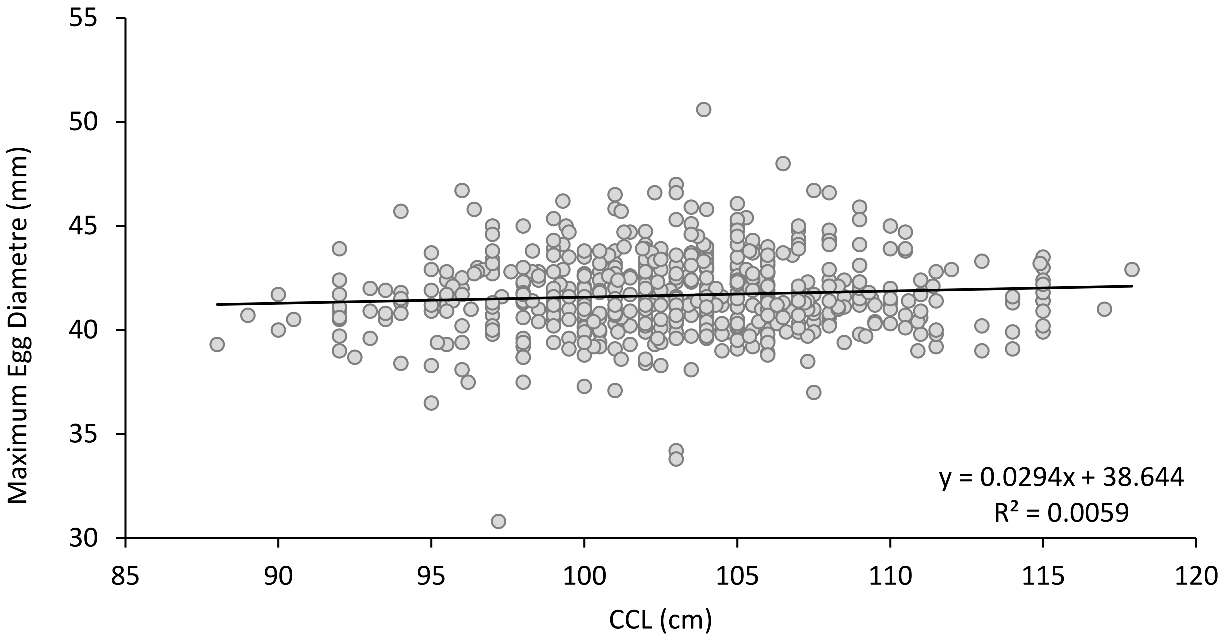

Figure 24. Scatter plot showing the relationship between the female size (CCL) and the average maximum egg diameter for green turtle clutches.

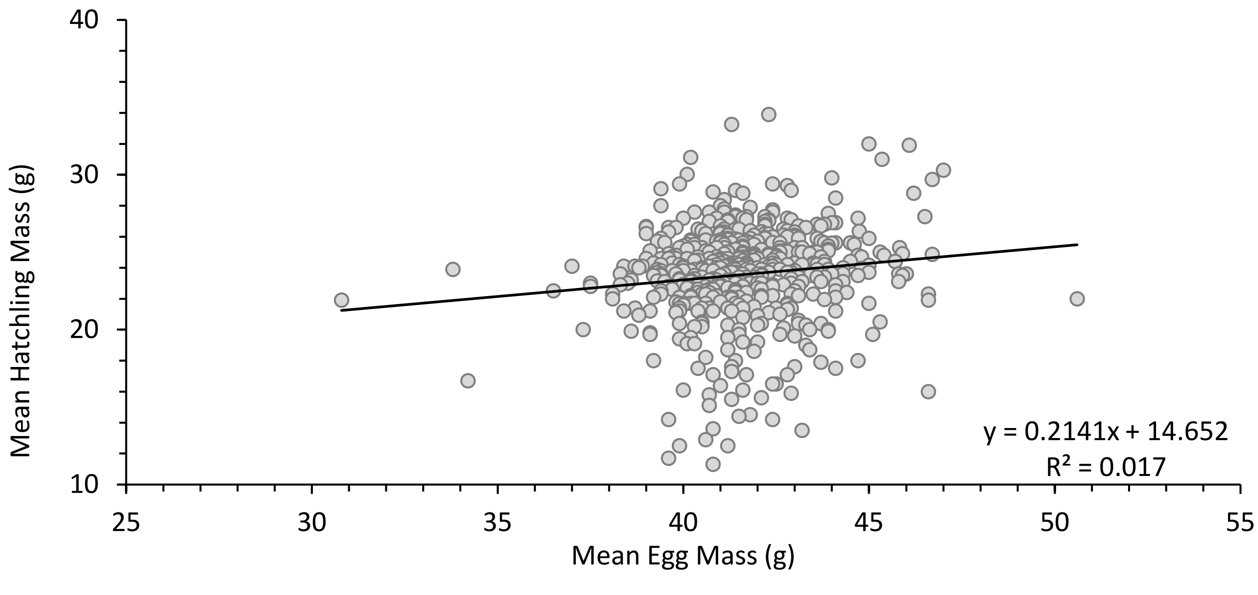

Figure 25. Scatter plot showing the relationship between the mean egg mass and the mean hatchling mass for green turtles.

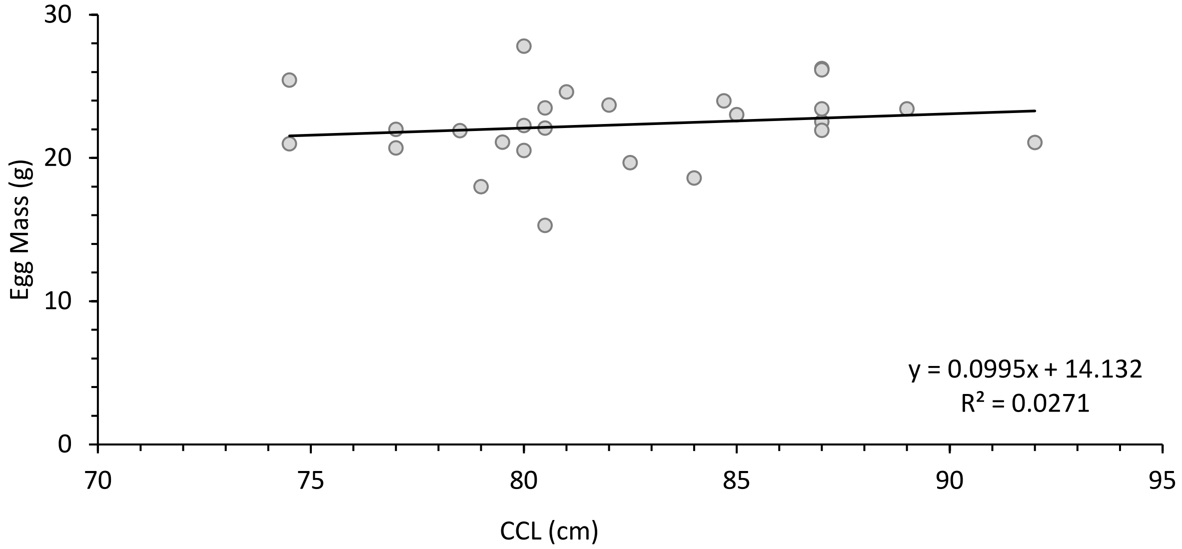

Figure 26. Scatter plot showing the relationship between the female size (CCL) and the average egg mass for hawksbill turtle clutches.

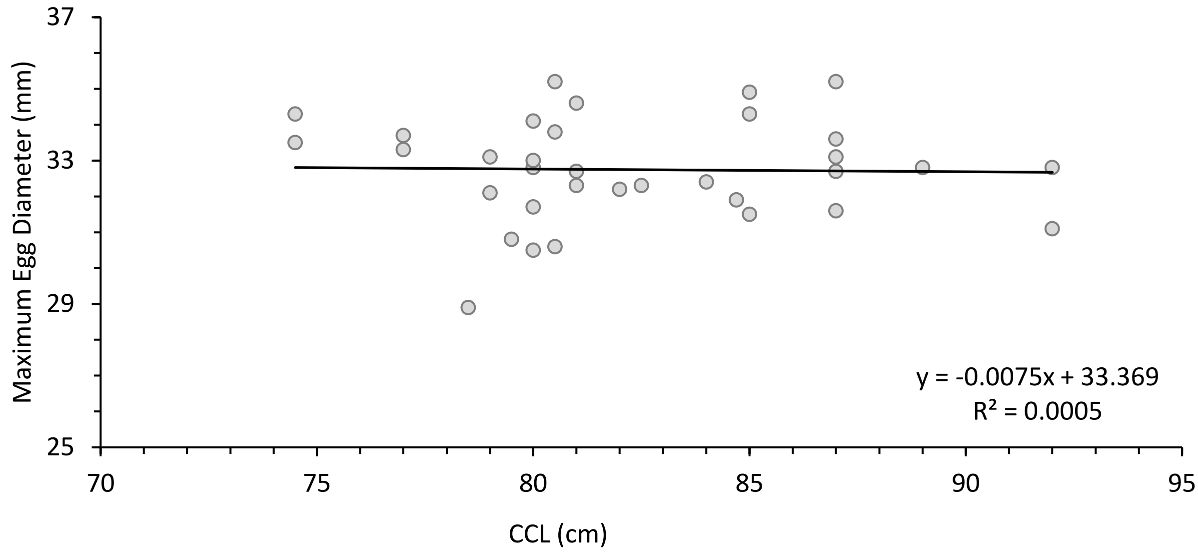

Figure 27. Scatter plot showing the relationship between the female size (CCL) and the average maximum egg diameter for hawksbill turtle clutches.

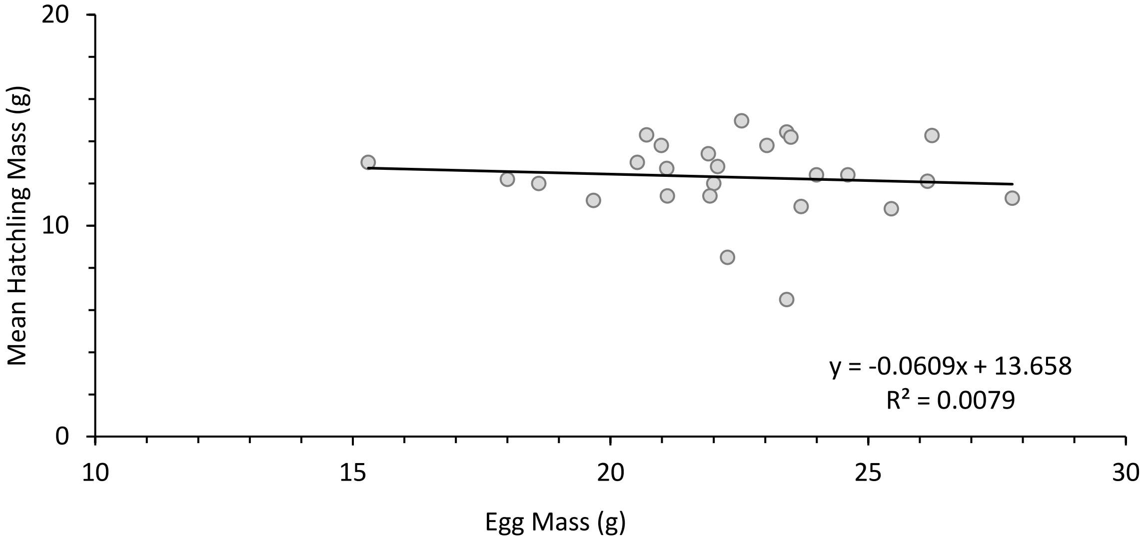

Figure 27: Scatter plot showing the relationship between the mean egg mass and the mean hatchling mass for hawksbill turtles.

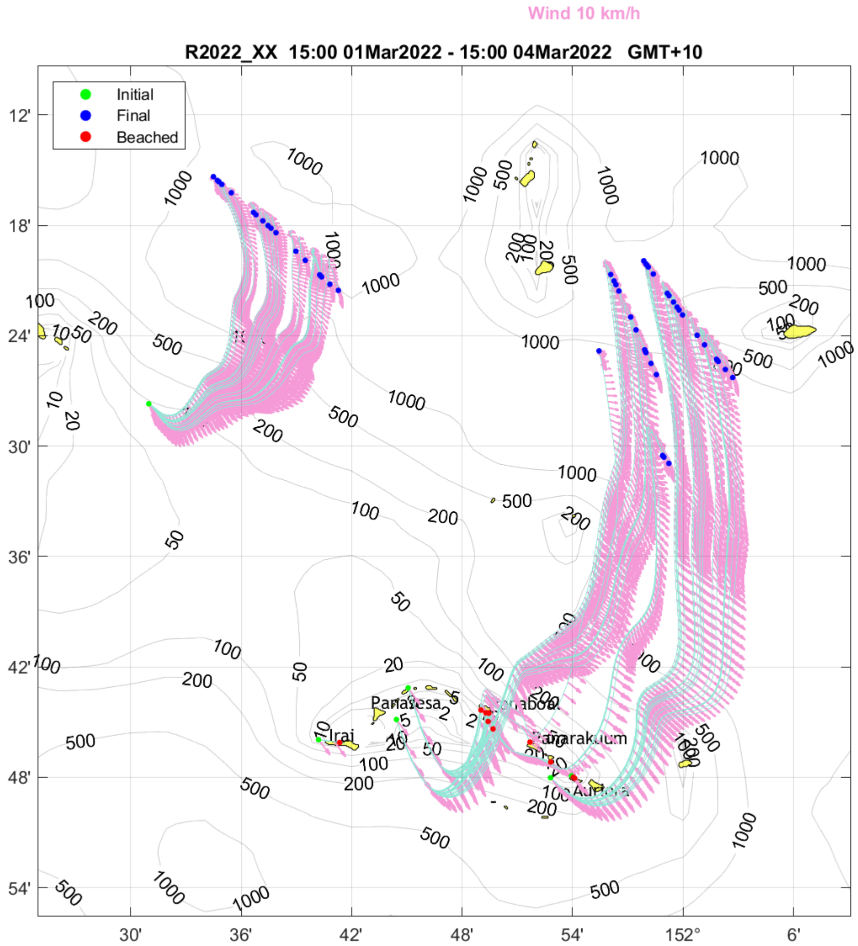

Figure 28. Modeled hatchling dispersal of releases done from beaches where the eggs were originally hatched from. Image generated from John Luick from AusTides.com

5. Nursery Success

Table 11. Number of turtles kept in nursery for observation and health reasons, deaths in the nursery, healthy hatchlings released after rehabilitation and number of hatchlings currently kept at this time in Nursery until March 2022.

Species	Live Eggs Taken to Nursery	Hatchlings Taken to Nursery	Live Eggs Died in Nursery	Hatchlings Died in Nursery	Total Released from Nursery
Green Turtle	20	57	0	1	55
Hawksbill Turtle	5	7	1	0	10
Totals	25	64	1	1	65

** 4 green turtle live eggs still kept and 16 live green turtle hatchlings, and 1 hawksbill turtle live eggs still kept in nursery. 96% successful rehabilitation of live eggs and hatchlings from the nursery to release to the ocean until March.*

6. Natural Nests

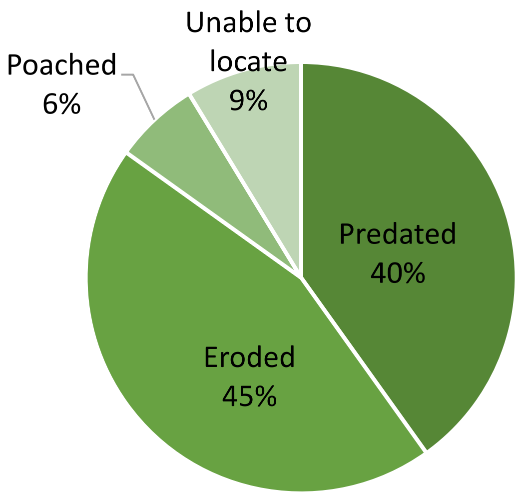

Figure 29. Reasons for unsuccessful 'natural nests' (in-situ nests) observed on the islands.

Table 12. Number of natural nests laid, successful hatching and lost nests in the 2021 – 2022 season.

Species	Number of Natural Nests	Successful	Impacted/ Lost	% Lost
Green Turtle	207	39	168	81
Hawksbill Turtle	6	2	4	66
Total	**213**	**41**	**172**	**81**

Table 13. Number of natural nests where successful hatchings occurred, and nest excavations were possible as most of these nests had been protected from predators with a mesh nest protector by the Rangers.

Species	Natural Nests found with successful hatching	No. of Eggs	Hatchlings emerged successfully from Natural Nests
Green Turtle	39	3086	2336
Hawksbill Turtle	2	248	200
Total	**41**	**3334**	**2536**

Table 14. Average Success of natural nests, however most of these nests had been protected from predators with a mesh nest protector.

Species	Hatchling Success (%)	Emergence Success (%)	Sample Size (clutches)
Green Turtle	76	79	39
Hawksbill Turtle	83	83	2
Average	**79.5**	**81**	**41**

7. Turtle Poaching

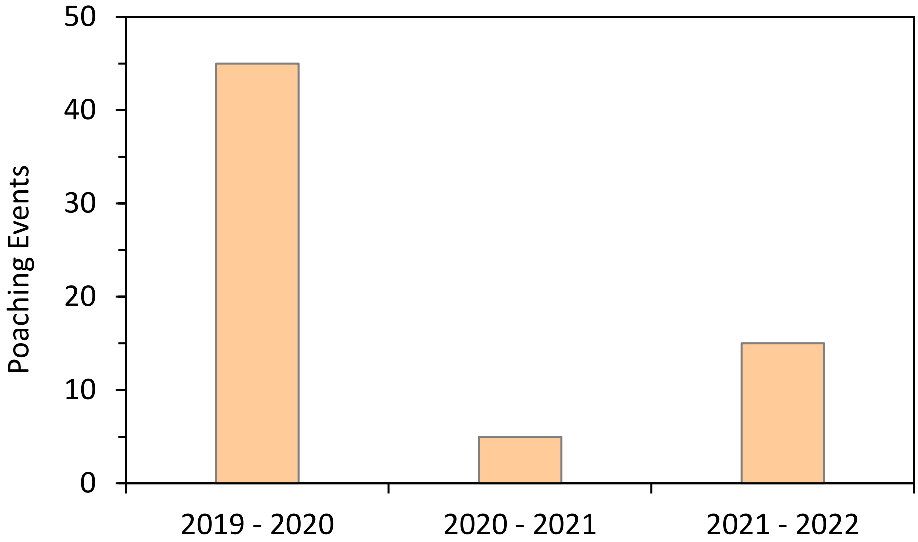

Figure 30. Number of poaching events that occurred within the Conflict Island Atoll over the past three nesting seasons.

8. Monitoring Logistics

Table 15. Number of turtles tagged and recorded by each ranger for the 2021 – 2022 Nesting Season.

Ranger	Recorded	Tagged
Steven	204	29
Toby	122	60
Ryan	124	40
Clinton	257	44
Patrick	212	50
Banian	135	45
Eddie	117	31
Tonny	18	13
Wesley	24	8
Jonathan	120	49
Michael	136	45
Badi	41	51
Rodney	108	68
Jack	129	35
Henry	81	23
JJ	5	2
Nathaniel	74	8
Norman	74	18

Table 16. Number of tags used in the 2021 – 2022 nesting season and cost.

Species	Tags Applied	Cost
Green Turtle	657	$1,971.00
Hawksbill Turtle	35	$105.00
Damaged or lost tags	30	$90.00
Total	**722**	**$2,166.00**

Table 17. Number of hours spent training new recruits (n = 13) for 2021 – 2022 Nesting Season.

Position	Training Hours
Marine biologist	196
Science officer	1176
Head Ranger	1176

9. Marine Debris Surveys

Table 18. Results of Marine Debris and Plastic Removal for 2021 – 2022 Nesting Season

Kilograms of waste removed	2,959
Number of pieces of waste removed	113,201
Number of people who participated	231
Number of islands cleaned	82

PROJECT OUTCOMES

Faced with continued COVID-19 challenges, severe weather, additional training needs, and the busiest nesting season on record for the Conflict Island Atoll, this 2021 – 2022 season has been truly incredible. Since the Turtle Monitoring project commenced in 2016, CICI has been monitoring the nesting population of green and hawksbill turtles the numbers indicate that we have a large population of green turtles that utilize many island beaches to nest with Irai island recording 399 nesting events across the season. We have a large recruitment of new females the nesting population with 655 new turtles being tagged and only 13 re-migrants into the population. This number of re-migrants is our largest number on record but is still a relatively low number. Nevertheless, it is encouraging to record re-captured turtles to aid in our population trend and trajectory assessments. Turtles were encountered from other existing tagging programs, with 'R' tags from SPREP (The Secretariat of the Pacific Regional Environment Programme), tagging programs being found on the turtles nesting here linking these turtles to international areas of significance. It is unknown from SPREP's records where these turtles were originally tagged.

The hawksbill turtles annual nesting number remain constant between 35 – 40 individuals each season averaging 35 annually. This season there was only 1 re-migrant hawksbill turtle and this is our first re-migrant hawksbill since the program commenced. It is too early to predict as more data is required, but the low hawksbill population numbers and limited recaptures may be indicative of a declining hawksbill population.

The nesting success of the turtles this season was heavily impacted by severe weather events, ongoing coastal erosion, sea level rise and loss of habitat from theses environmental effects. Of the 2074 nesting attempts, only 862 resulted in a nest being successfully laid. This is an incredible failure rate of 71%. Although most females, if unsuccessful in their nesting attempts, will return to the beach to try again either the same night or the following night, the energy and effort expended in the 1,212 failed nesting attempts by the females is staggering. The most common causes of the failures to nest recorded are roots (40%), hard sand (19%) and erosion (10%) with other causes including soft sand, rocks, and logs. These major causes of failure are from the loss of viable nesting habitat available on the islands for the turtles to nest. With ever increasing effects of climate change, sea level rise and worsening sever weather events here in Papua New Guinea, we are experiencing high levels of negative beach loss around all islands of the atoll. The impact of this for the nesting females is having to climb further into the vegetation and dig amongst the roots of the trees and bushes growing on the foreshore, often encountering roots too large for them to break through, consequently causing the turtle to fail in digging her egg chamber and failing to nest. This is also the area where there is hard sand compacted by time also blocking any digging attempts made by the females. Retention of sand and the protection of viable nesting areas and habitats for the turtles may be required in the future if supported by the community and government.

Turtles will often lay between 3 to 5 clutched of eggs per nesting season and our records show that 112 green turtle females laid more than once with 25 green turtles recorded to nest 3 times. Three individuals recorded successful nests and 3 green turtles nested on 4 occasions throughout the season. Seven hawksbill turtles nested twice and only one was recorded to nest 3 times this season.

Few nests were lost due to egg translocation including nests moved by the rangers from the outer islands to the base hatchery. The rangers with the cooperation of the security patrol, were able to translocate 616 green turtle nests totaling 56,763 eggs and 39 hawksbill nests totaling 4560 eggs to the safety of the hatcheries on Panasesa Island. This accounts for 79% of the successfully laid nests (green and hawksbill combined) recorded throughout the atoll. With the increase in ranger numbers and in turn increased effort enabled greater protection and a reduction of threats from poaching, predation (by animals alone, not humans), erosion and being submerged under storm surges and king tides.

The geomorphology, vegetation type, beach profile and size of islands (for example) may play a role in the islands preferred by turtles to nest. For Green turtles this season, Irai seemed to be the preferred nesting island with 399 nesting events. Of these, 141 were successful nesting attempts (35%). Tupit one of the smaller islands, had the second highest numbers of nesting attempts (297) with 102 clutches laid successfully (34%). Arorora was the third highest encounter island with 257 nesting attempts and 127 were successful (49%), Panarakum the fourth with 237 nesting attempts and 118 clutches laid (49%).

Hawksbills favored Panarakum Island with 21 encounters and 14 of these encounters resulting in successful nesting attempts (66%). Auroroa island recorded 12 encounters resulting in only 5 successful nesting attempts (41%), Muniaria 9 encounters and 6 were successful nesting attempts (66%), and Kolivia where 6 out of 7 nesting attempts were successful (85%). This information is very useful for the future management and logistics of our monitoring program, indicating which islands are favored and for which species. This gives us an indication if we are faced with less rangers or inability to cover all the islands where to concentrate our patrol focus on for maximum impact and effectiveness.

Figure 31. Black mold on eggs from a low success nest from a natural nest.

Our data also shows that there is a clear peak in seasonality for both species in December for nesting activity. There is a slight variation for green and hawksbills outside of December, with the second highest activity in January for green turtles and for hawksbills in November. Again, this will assist us in future on when to concentrate our efforts for maximum impact.

With a staggering number of nesting females this season we were able to produce from our hatchery, a record number of 52,795 turtle hatchlings. Of those hatchlings 4,449 were critically endangered hawksbills, vital to the future of the species. We translocated 616 green turtle nests and 39 hawksbill nests. This season we had 9 green turtle and 1 hawksbill turtle failed translocated nests The causes for these failures are unknown, but theories suggest bacterial infections, fungal infections, damage to the embryo during the translocation process and predation by parasitic and carnivorism insects living in the sand. Noted on most of the unhatched clutches was the presence of 'black fungus' which we don't know what it is or what causes it to occur. Often with the presence of this fungus we see insect lavae infecting some of the eggs in the clutch as well. This requires further investigation to identify what the causes of these failures are, if they are caused by the handling of the eggs or if it is a natural cause.

In our analysis of the data collected, green turtles laid on average between 82 and 109 eggs per nest with an average of 94 eggs. Hawksbills laid between 116 and 158 eggs per nest with an average of 137 eggs. The highest number of eggs laid by one green was 187, which is uncommonly high and for the hawksbills their highest egg count was 192. Our data also shows that there is a positive correlation between the size of the nesting females for both green and hawksbill turtles, measured by curved carapace length (ccl) and the number of eggs laid per clutch. This indicates the larger females to be of greater importance to the population, as they have a higher fecundity potential. Also, the data indicates green turtle female size, egg diameter and egg mass correlates to female size producing larger eggs. The larger the female the greater mass and diameter there is the the eggs. This then translates into the hatchling's health as when we examined the relationship between the mass of the egg and the mass of the hatchling there is a significant relationship which is indicative of the health and energy available for the hatchling upon hatching. This trend, though far less sample number, is the same throughout the hawksbill turtles. Meaning larger females contribute significantly to the population and long-term survivability.

We were surprised by this season's sheer number of nesting events and the number of at-risk nests. Due to the high number of translocations, we were required to build 3 additional hatcheries to cope. Due to the rush in which we needed to construct the additional hatcheries one of them was left un-shaded until after some nests were placed. This resulted in a shortened incubation period to hatching. All other hatcheries that were shaded and in one case cooled with additional fresh water before translocation took place, the incubation period was on average 62 days whereas the unshaded was only 56 days. The average temperature of the shaded nests, through data collected using OnSolution iButton temperature data loggers was 28.3°C and the temporary shaded hatcheries averaged 29.2°C. This data can help inform and allow us to estimate the sex ratios of the clutches in each of the hatcheries with the assumed pivotal temperature for sex determination being around ~29°C for both species (Hays et al. 2017).

This season due to the high number of hatchlings being produced and the high levels of movement of the rangers throughout, we implemented a new hatchling release strategy which meant, after the hatchlings were excavated, they were then transported back to the original islands where they were collected from as eggs to be released This was enacted to reduce local and learned predation of hatchling release from Panasesa, and to help distribute the imprinting locations of the hatchlings for nesting and migrations as adults. We were also very lucky to have John Luick who from AusTides.com volunteered his time to give us some predictions of the hatchling dispersals upon release. This will need to be refined for future use but initially can help make management decisions about the time and location of future releases.

To ensure all hatchlings produced from our program have the best chance of survival on excavation of the nests we identified any hatchlings that needed rehabilitation assistance before being released. These were hatchlings with large yolks exposed, any unhatched eggs which we term 'live eggs' that were yet to hatch, any with injuries or deformities and any they were weak or showed lameness upon release. In doing this we discovered several deformed hatchlings, albino, leucistic, blind, hatchlings having limbs and head deformities. From these hatchlings kept for observation we had a 96% successful rehabilitation of all live eggs and hatchlings released back into the wild. These releases were always done in conjunction with the release of other hatchlings to provide safety in numbers.

Most natural nests identified as high risk were translocated into shaded hatcheries. This season there were 213 natural nests left *in-situ* (not translocated). Of those, 19% (41 nests) produced hatchlings, the remainder nests made up 81%, and resulted in a high failure rate for any nests not translocated. From 41 natural nests, there were 200 hawksbill hatchlings and 2,336 green hatchlings produced. The primary reason for loss/failure of natural nests was due to erosion (45%) and predation (40%) (e.g. monitor lizards), with 6% being lost to poaching by humans and 9% were unrecovered. With this significant loss of natural nests, it shows our management strategy of translocating as many nests as possible of the at-risk nests is a positive strategy for the protection of nests and the species. We also saw a greater incidence of poaching of natural nests compared to last season from beaches this season and can possibly be assumed that those nests that cannot be relocated were poached as well. This shows that we do need greater deterrence strategies to stop the take of turtles from the Conflict Islands, but without any laws in place to help us enforce this we can only use the private land ownership for protecting turtles.

The mobile patrol team worked effectively to stop the take of most of the adult nesting turtles during the season however there are always incidences of take that we are unable to attend or go undetected due to the scale of the site we are trying to protect. Over the months of the project which extended through to June 2022 due to the nest hatch dates, the Team leaders and trainee rangers worked tirelessly to protect and conserve the turtles and islands. There were more than 2,500 hours of training conducted by our marine biologist, science officer and Head Ranger. Throughout the season close to 3 tons of marine debris were removed from the shores of the islands of the Conflict Island Atoll and not including the pre nesting season clean ups which removed trees, logs and other debris that would otherwise block the nesting females from coming ashore to lay their nests.
Overall, this season has been a huge success with some very interesting lessons learnt, new data collected, and many more turtles protected and introduced into the wild population.

RECOMMENDATIONS FOR THE 2022 – 2023 SEASON

To be able to continue operating this program we need to plan sustainable finance for a non-voluntourism model. With the pressure having to rely on the donations of other non-for-profits or business is not sustainable for a long-term plan with insecurity looming over each following season.

More efficient use of boats and fuel for the patrols and relocations of the eggs could be managed better giving more cost-effective outcomes. The quality of items purchased in Papua New Guinea such as raincoats and head torches are unreliable, poor quality and break frequently requiring replacement frequently or using many batteries throughout the season. It would be favorable to be able to purchase high-quality long-lasting equipment for the harsh conditions the rangers need to endure.

This coming season we anticipate having a dedicated ranger for hatchery and nursery monitoring and supervision, to ensure conditions, data and hatchlings have more attention and higher reliability data collected.

We have identified an area of education to increase trainees' skill and knowledge of different technologies such as computers, GPS and smart phones. This training for the trainees on computer uses and technologies will help them develop themselves for their future and other possible job opportunities.

ACKNOWLEDGEMENTS

On behalf of Mr Ian Gowrie-Smith, and the Managers Hayley Versace and Edward Cardwell, we would like to express our sincere gratitude, to you the communities of the Deboyne and Engineer Groups for your co-operation and fulfilment of the restrictions of island stays during the 2021 – 2022 Turtle Nesting Season at the Conflict Islands and no-take of turtles as we work together now and into the future to protect your turtle populations for generations to come.

There is concern the population of turtles at the Conflict Islands is still decreasing so it will take efforts from all of us to save these animals from extinction. Our combined efforts will hopefully mean numbers will start to increase on these islands in the future. Again, we thank you, our neighbors very much for your co-operation and for sharing your community with us to help monitor the Conflict islands this season. We would also like to express a sincere gratitude to the hard work of our Conversation Rangers who work tirelessly, almost seven days a week for five months of the year to protect the turtles, collect this valuable data and promote a positive conservation message to their communities. Thank you, Steven Amos, Jeffery Everenett, Patrick Lemeki, Toby Losane, Henry John, and out trainee rangers Eddie Allan, Ryan Henry, Banian Leonard, Clinton Luke, Jack Marko, Badi Seko, Jonathan Weinam, Michael Moten, Rodney Taliya, Wesley Malui, Nathaniel Willy and Norman Poate. We would like to acknowledge the rest of the the staff from the Coral Islands Limited, who work to support the Conservation Rangers and help the islands running so we can achieve the conservation work. Thank you for stepping in driving dinghies, doing the maintenance and caretaking of the island's infrastructure. Thank you to Maureen Lako, who keeps the Rangers fed and the accommodation clean. Thank you to our Phd candidate Melissa Staines for your contribution to the project report and data analysis. Also thank you to the volunteers who contributed in some way in the background including John Luick for your tide mapping and Sonnie Flores for your efforts in entering our facial ID information to the wildme.org platform, and Unity Roebeck for your assistance with working through the TREDS database with SPREP.

We would also like to acknowledge and thank all those who privately contributed to the program with financial and in-kind donations. This season would not have been possible without your help.

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PROJECT IMAGES

Figure 12: CICI's 2021 - 2022 Ranger Team, Back row l to r Jack Marko, Jonathan Weinam, Michael Moten, Banian Leonard, Wesley Gorden, Henry John, Eddie Allen and Steven Amos. Front row l to r Ryan John, Patrick Lemeki, Rodney Taliya, Clinton Luke and Badi Seko.

Figure 13: Patrick training Rodney on turtle biometric data collecting

Figure 14: Toby and Rodney doing beach clean ups

Figure 16: Eddie and Jonathan out on patrol collecting egg data

Figure 15: Marine biologist Hayley, training rangers on identifying different embryonic development phases in unhatched eggs

Figure 18: Michael measuring hatchlings while Jack does the data recording of hatchlings.

Figure 19: Wesley collecting eggs from a laying green turtle

Figure 17: Head Ranger Steven Amos and trainee ranger Banian doing data entry.

Figure 9: Rodney collecting eggs for translocation.

Figure 10: Rangers Badi and Jonathan collecting hatchling data in the hatchery.

Figure 11: Trainee ranger collecting biometric data on nesting female green turtle11

Figure 203: Ranger Michael and Clinton collecting eggs from a a female hawksbill nesting in the day time.

Figure 12: Ranger Toby protecting a natural (in-situ Nest)

CONFLICT ISLAND'S CONSERVATION INITIATIVE

Conflict islands
PARADISE IN THE CORAL SEA

Figure 15: Marine Biologist conducting training in next excavation and hatchling data collection

Figure 16: Ranger Steven with a day nesting hawksbill turtle

Figure 16: Busy nights during this season with multiple turtles nesting on sections of baches at one time

Figure 17: Mature male turtle observed while diving at the Conflict Islands

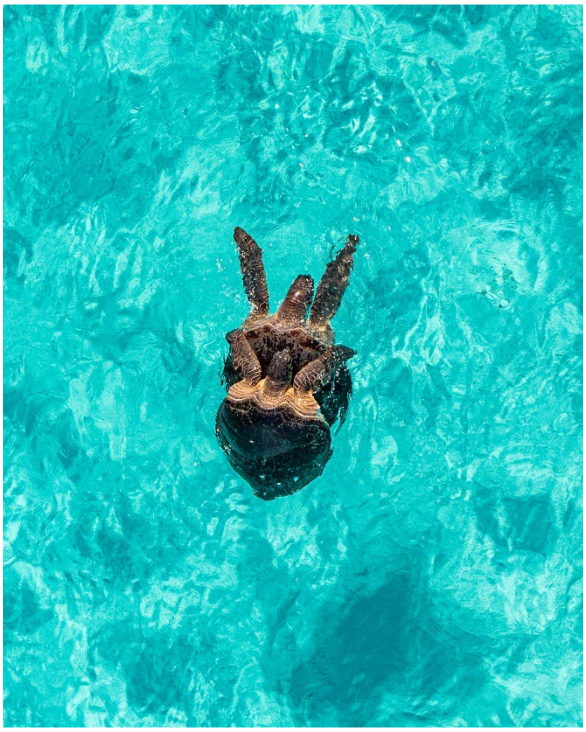

Figure 18: Mating green turtle out the front of the resort on Panasesa Island in October 2021

Figure 19: Goanna actively predating a turtle nest

Figure 20: Extreme high tides elevated water table levels leaving turtles diffing egg chambers that would fill with water

Figure 21: Female struggling to dig egg nest through roots

Figure 22: Natural nest covered and camouflaged from poachers

Figure 23: Green turtle egg collection into ziplock bag for translocation.

Figure 24: Failed natural nest due to intrusion of roots to egg chamber causing damage and leaving vulnerable to predation.

Figure 25: Beach clean ups, plastic removal and burning of logs on nesting beaches around the atoll

Figure 26: Rangers pictured with hessian sacks filled with marine debris ready to be weighted and audited.

Figure 26: Ranger Henry weighing a bag of marine debris

Figure 27: Some commonly collect brands and items on beach clean ups.

Figure 28: Hermit crab seeking refuge in marine plastic washed ashore

Figure 29: Trainee ranger Eddie finding a large quantity of lost fishing gear on a beach clean up

Figure 30: Trainee rangers auditing marine debris

Figure 31: Ghost net removed during beach cleanups

Figure 32: Refrigerant gas cylinder collected on a beach cleanup.

Figure 33: foreign brands often are collected including beauty and medical products

Figure 34: Hatchery shading and construction on original hatchery

Figure 35: Due south full sun hatchery in construction

Figure 36: Plastic barrier to prevent predation from crabs effecting translocated nests.

Figure 37: Hatchery reaching full capacity early in the nesting season

Figure 38: Our temporary hatchery reaching full capacity

Figure 39: Hatchling excavations from hatcheries

Figure 40: Nursery preparations and cleaning for arrival of hatchlings

Figure 41: Black Swan Security team

Figure 42: Release of poached from islands

Figure 43: Turtle being cut free from poaching restraints often used to keep turtles alive once captured for days at a time

Figure 44: Turtle that was trapped in eroded roots and released by our rangers on patrol

Figure 45: A turtle that was trapped and died from her injuries before our rangers could free her.

Figure 45: Intercepting a passing sailu by Rangers and security with awareness conducted by rangers

Figure 46: Community leader conducting awareness to community of the CICI program for consultation

Figure 47: Rangers having effective dialogue and awareness with passing community members on the CICI program and protection around turtles

Figure 48: Ranger Toby conduction community awareness

Figure 49: Field Camp at Auroroa

Figure 50: field camp

Figure 51: Field Camp


Figure 52: Damage from severe weather and storm system


Figure 53: Flooding at camp kitchen after storm surge and severe weather


Figure 54: King tide and storm surge flooding base camp


Figure 55: Tent area completely flooded by storm surge and king tide resulting in the shifting of the camp to a new island.

Figure 56: Green turtle hatchling being released at sunset

Figure 57: Green turtle hatchlings making their way to the ocean at sunset

Figure 58: Conjoined twin green turtles that died at phase six of development

Figure 59: Leucistic green turtle hatchling, adopted.

Figure 60: Ranger Toby releasing hatchlings at the island which they were collected from as eggs

Figure 61: Releasing a green turtle hatchling at sunset

Figure 62: Hawksbill turtles emerging from the sand

Figure 21: Rangers excited to be releasing over 1000 hatchlings at Panasesa Island, left to right Rodney, Clinton, Badi, Steven and Jayjay

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