CICI & TCI Ltd
2020 – 2021 Nesting Season Final Report

Contents

Conflict Islands Conservation Initiative & The Coral Islands Ltd 2020 – 2021 Turtle Nesting Season

End of Season Report

PROJECT OVERVIEW

The Conflict Islands Atoll, located in the heart of the Coral triangle in Milne Bay, Papua New Guinea is the nesting location of two species of endangered marine turtles. The critically endangered Hawksbill Turtle (*Eretmochelys imbricata)* and the endangered Green Turtle *(Chelonia mydas*) (IUCN Red List). The Coral Islands Ltd (TCI) in partnership with Conflict Islands Conservation Initiative (CICI) has been running a Turtle Conservation Program on 21 of the Conflict Islands since the 2016 nesting season. The program was built around a voluntourism model that relied upon income from overseas volunteers, supplemented by the island's owner Mr Ian Gowrie-Smith to fund the conservation work. The impacts of COVID-19 on this program looked to be devastating because of the significant loss of funding from international volunteers attendance and travel restrictions. The islands were facing months of unprotected and unmonitored poaching of nesting turtles and their eggs, and unemployment of the dedicated team of rangers who have for the past 4 years worked tirelessly protecting them.

The Conservation Ranger Team's dedication was un-waivered by this. They as a team, were willing to come back for the season to protect the turtles without pay. The level of dedication and responsibility the rangers feel for the turtles isastonishing. Fortunately, thanks to our major sponsors for the season - Sea Shepherd and P&O, this was unnecessary. Along with individual and in-country sponsorships, CICI and TCI were able to raise enough funds for the program to run for the 2020-2021 nesting season (refer Project Results below).

The Turtle Conservation Program is one element of our conservation work under TCI and CICI. We are working to understand and map the biodiversity of the Conflict Islands for consideration as a marine managed area. Legislated conservation protection is still limited in Papua New Guinea and the Conflict Islands remains relatively unprotected[1]. Almost uniquely 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, 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. CICI has spent 5 years

[1] The Conservation and Environment Protection Agency (CEPA), formally DEC, was created in 1985 to "ensure natural and physical resources are managed to sustain environmental quality and human well-being" (DEC PNG 2009). CEPA has administered key legislations, including: *Environmental Planning Act 1978; Environmental Contaminants Act 1978; Conservation Areas Act 1978; National Parks Act 1982; International Trade (Fauna & Flora) Act 1979; Fauna (Protection and Control) Act 1966*. Under these legislations, conservation is still limited in PNG. On land, only 3% of the rich forests are protected, with four national parks, three provincial parks and 27 wildlife management areas. Customary ownership has created difficulty in expansion of these protected areas, as 96% of the land is still held this way, however the CEPA continues to explore workable models for conservation management under a "conservation system" DEC PNG 2009.

engaging with the local communities to seek their support in the protection of the Conflict Islands, particualry the protection of marine turtles, sharks, rays, sea cucumbers and corals to name a few. Threats from human impacts, like poaching, are being managed on the Conflict Island Atoll directly by CICI in collaboration and coordination with communities across Milne Bay. After many negoitations, in 2017, CICI put in place a no-take area for marine turtles and sharks.

CICI's ongoing Turtle Conservation Program is designed to monitor and protect nesting turtles of the Conflict Island Atoll by creating a baseline data set that can be used to determine if the management strategies put in place will successfully contribute to the conservation of turtle species nesting here. Some of the strategies are poaching deterrence, egg protection and relocation, nesting population surveys, predation protection, environment clean ups, 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 students, PhD candidates, universities and other conservation organizations, ensuring data sharing and collaborations where possible. For example, CICI participated in trailing updated software for the Secretariat of the Pacific Regional Environment Programme (SPREP), that will aid in the future of data collection for turtles and knowledge sharing for the Pacific, and CICI is proud to be the largest contributors to this data base for Papua New Guinea.

The patrol area consists of 21 islands with the furthest, Auroroa Island, 22kms away at from the base and hatchery at Panasesa Island (Figure 1). This makes the logistics and costs to effectively monitor all the islands to stop all poaching and comprehensive monitoring of the islands and nesting activity exceptionally difficult and expensive. Where possible we base a team of rangers at Auroroa Island on a rotational schedule to make sure all traffic and the islands at the furthest point from the base can be monitored for turtle nesting and potential poaching activity.

Figure 1: Map of the Conflict Island Atoll

In our 2019 – 2020 season our Rangers tagged 119 turtles, relocated 132 clutches and released 13,672 hatchlings to the sea (refer Results below). Last season we also introduced a CICI Turtle Task Force Team, which were a dedicated team of 8 Task Force Rangers who were specifically chosen from outside the surrounding communities, typically come to take turtles from the beaches of the Conflict Islands. Unfortunately, due to this season's financial situation, we were unable to implement the same program. However due to the recent implementation of armed security from Papua New Guinea's leading private security company Black Swan, the Task Force Rangers were replaced by Black Swan Guards. With this increased level of security, a Black Swan Guard always accompanied our Conservation Rangers on their patrols, to help enforce the no-take of turtles. As a result a dramatic drop in poaching incidences from 45 occurrences during the 2019

– 2020 season, to just 5 during the 2020-2021 where recorded – all of which occured in the early stages of the season. This can be seen as a great success and a role that we anticipate implementing in all future programs. This seasons Ranger Team started with 7 of our experienced rangers and 3 trainees but due family reasons one experienced and one trainee ranger had to leave the program early on, which created some difficulties. We were able to find a replacement trainee to help cover the work required who had some experience from working past seasons with TCI. That left us with a team of 6 Conservation Rangers and 3 Ranger trainees for the season, plus the management team that oversee the staff, program, reporting and logistics.

Green Turtle Life Cycle Overview

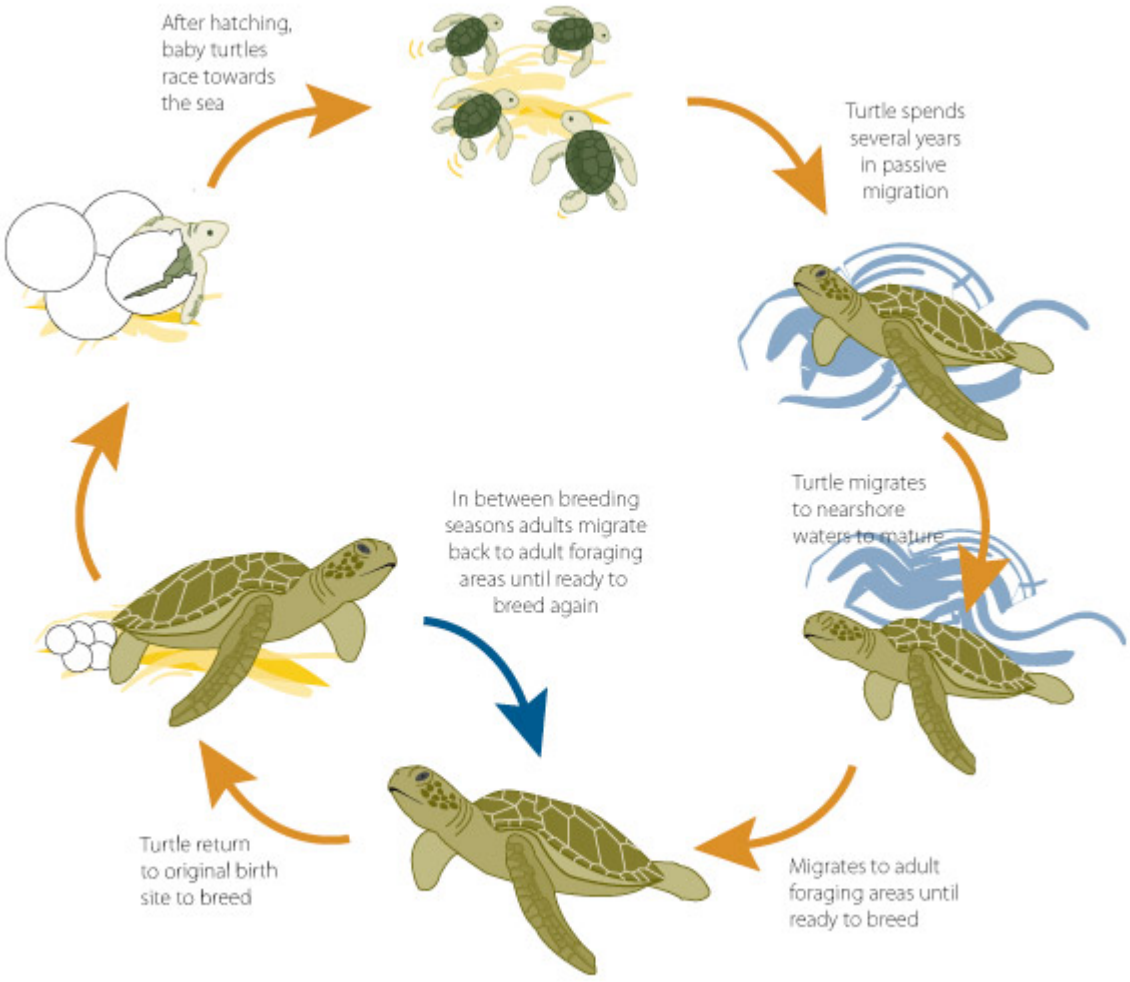


Figure 2: Turtle Life Cycle (courtesy of kingfisherbayresort.blogspot.com)

Turtles take roughly 20 to 30 years to reach sexual maturity. After hatching out of the sand as a 2 to 3 cm hatchling, they head out into oceanic currents for their lost years. After a period of around 10-15 years, those which survive then reside in a coastal reef area where they spend years feeding to reach breeding maturity. Once their biological clock marks the time, they migrate from their foraging grounds to a courtship area and then onto the very same, or nearby location, to where they hatched. CICI monitors green and hawksbill nesting turtles on The Conflict Island Atoll. Research from WWF and one of our directors Christine Madden Hof, has been tracking the Hawksbill turtles, with recent data showing many are migrating across the Coral Sea, to and from the Great Barrier reef in Australia to feed. Data collected from foraging turtles tagged int the Howick Group of islands in the Great Barrier Reef also show long migrations also occur for green

turtles. Turtles do not make this migration annually, but every 5 to 8 years, returning to the Conflict Islands to lay between 3 to 5 nests. Our season here starts in October with the last of the turtles hatching by the end of April.
There is no parental care for turtles and after the female deposits her eggs in her nest, she returns to the sea, with no further interaction with the nest or her hatchlings. Nests vary between 30 cm to 60 cm deep for the different species as does the number of eggs laid in each clutch from as low as 50 to as high as 220 eggs. The sex of the hatchlings is not determined at fertilization, but instead is determined by the temperature that the eggs are incubated in, with temperatures over 29°C producing more females and below producing more male hatchlings. With the warming global temperatures, turtles have been theorized to be producing almost exclusively female hatchlings for the past 3 decades in the northern Great Barrier Reef. The consequences of this could be dire for the future of turtle species. 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 very abridged.

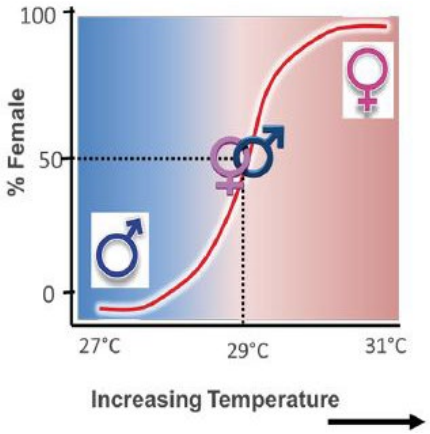


Figure 3: Marine turtle sex-ratio temperature dependence chart (adapted from Morreale et al 1982).

Threats to Turtles Globally and Locally

The global trend for many turtle populations is declining due to many factors that affect them from global to local scales. Global threats include increasing sand temperatures (and likely feminization of the population), sea level rise (causing erosion), pollution (especially plastics), and fishing (either intentional or as by-catch).

For turtles in the conflict islands, key threats are poaching of turtles and eggs, log and plastic debris and erosion of the nesting beaches.

Figure 4: Coastal erosion exposing vulnerable turtle eggs due to sea level rise.(champagnewhisky.com/tag/turtle/)

The carapace of Hawksbill turtles *(Eretmochelys imbricata)* is a highly sought-after material used in the fashion, medicinal and ornamental industry contributing to the illegal wildlife trade. Additionally, population growth in PNG has increased around ~2% each year since 1950 (http://www.worldometers.info), which has put further pressure on turtle populations due to the increased demand for their meat and eggs (as they can fetch a high price (~350 kina ($130 AUD) approximately when sold for cash). Selling turtles is an illegal practice in Papua New Guinea under the *Fauna (Protection and Control) Act 1966*. There is an exception - harvested turtles can be traded for goods, this traditional practice 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 it putsextra pressure on communities to provide for these western celebrations introduced with Christianity to Papua New Guinea. Our Rangers are mostly reformed turtle poachers, who openly admit selling turtles for cash as the most common use for the turtles they harvested, knowing it is an illegal practice, and buy alcohol, betel nut, and Christmas supplies from their “fast cash” from the turtle sale. Enforcement and effective management is and has always been an issue in PNG, even though high level political members condone the illegal sale of turtles.

Figure 5: 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)

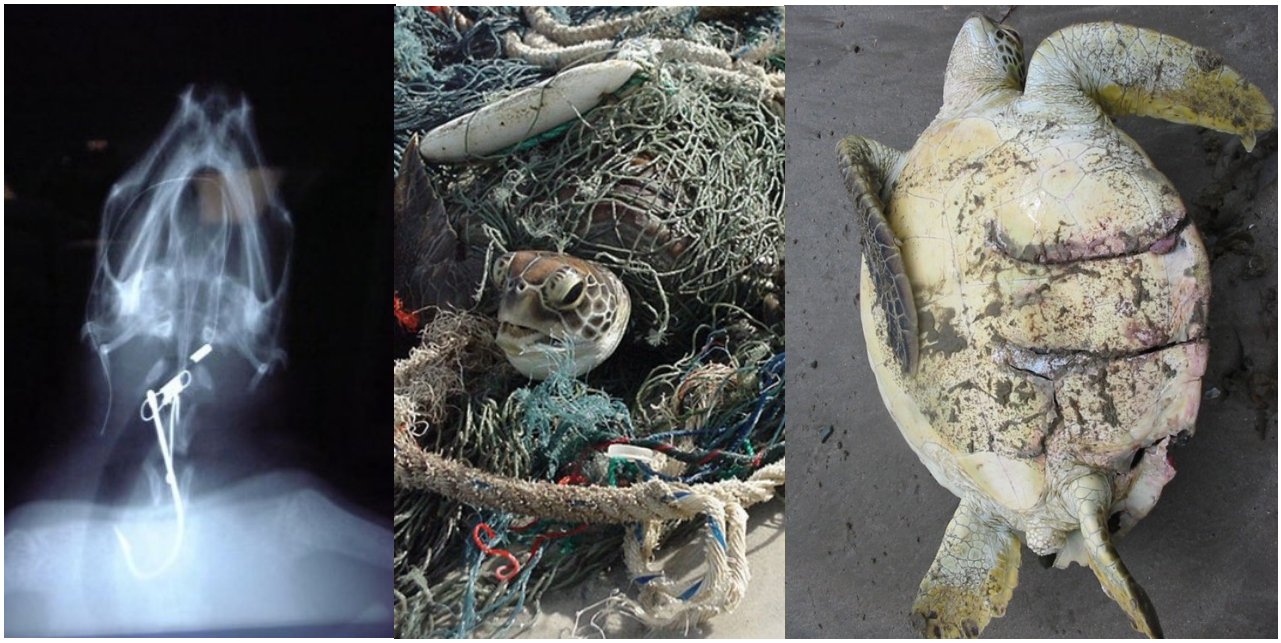


Figure 6: Turtle threats of by-catch from long liner(https://www.seaturtlestatus.org/articles/2007/fishing-technology-gears-up-for-turtle-conservation); passive fishing by discarded fishing nest at sea(http://www.dhimurru.com.au/), part of the plastic pollution problem; and boat strike victim (Ian Bell, Sea Turtle Foundation).

2020-2021 TURTLE CONSERVATION PROGRAM

CICI's Turtle Conservation Project aims to monitor the marine turtle populations at the Conflict Islands Atoll via a long-term tagging program. Beach patrols occur at night when the females are laying, to allow for: tagging of green and hawksbill turtles; taking genetic samples where necessary; facial photo identification; and, other morphological data collection. These patrols also protect the turtles and their eggs from poaching, and enables education and awareness to be conducted when poachers are intersected. This project conducts emergence and hatchling success studies by collecting laid eggs and relocationg them to the Conflict Islands Turtle Hatchery. The nests are incubated and temperature regulated whilst awaiting their emergence. Some hatchlings are rehabilitated at the Nursery until they are healthy enough to be released into the wild, as part of our head start program.

By studying the populations of green and hawksbill turtles, we will be able to create a baseline dataset of nesting and foraging populations around the Conflict Island Atoll that will inform the populations trajectory (stable, increasing or decreasing) and connectivity to other nations, and will help assess the effectiveness of ours and the surrounding communities ongoing conservation efforts.

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 November 2020 - February 2021 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-IGS2000. Recorded data included when a turtle is encountered includes:

Figure 7: Titanium flipper tag on juvenile Green Turtle Ranger (Migration Media Underwater Imaging, 2018)

Figure 8: Facial Identification photo being taken by a CICI Conservation Ranger (Migration Media Under Water Imaging, 2021)

- Species
- Tagging Data
- Facial identification Photo
- Date/ Time of laying
- Island
- GPS location of nest
- Nest Habitat
- Number of eggs laid (if possible)
- Nest Attempts
- Reason for Nest fail
- Nest Relocation

When the female finished laying so as not to disrupt her during this time, she is then flipper tagged on the trailing edge of her front left or right flipper on Pad L3 (closest to the body) if possible, otherwise subsequent Pads, L2 or L3 will be tagged. The turtle is only tagged once on the left flipper when interacted for the first time (a primary tag), and then on the right a second time (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, at www.wildme.org where facial mapping occurs through artificial intelligence. 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.

Egg Collection & Relocation/ Hatchlings

Eggs are only relocated if they are at high-risk of mortality; this includes poachers nearby, predators nearby, or the female has dug her egg-chamber below the high-tide line. Unfortunately, this is the majority of the nests laid in any of the islands. As the female starts laying her eggs into her egg-chamber, she will go into a trance-like state, this is when our Conservation Rangers place a ziplock bag under her cloaca to catch the eggs and the mucous she excretes whilst laying. Once laying has ceased the air is removed from the ziplock bag to mimic hypoxia during relocation, which pauses the development of the embryo until they are again exposed to an oxygenated atmosphere (Williamson et al 2017, Kam 1993, Kennett et al 1993). The eggs are transported to the Hatchery on Panasesa Island as soon as possible from the time of collection, to decrease mortality. 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, females tag number and hatchery position are all recorded. The nest is then covered by a nest protector to exclude any crabs or other predators that may break into the hatchery are and then left for approximately 60 days for the eggs to develop and the hatchlings to emerge.

Figure 9: Turtle Eggs and mucous being captured during oviposition.(Migratio Media Underwater Imaging 2021)

Figure 10: Ranger catching eggs from a laying green turtle. (Migration Media Underwater Imaging , 2021

The nests are observed approximately a week prior to the estimated hatch date for the first signs of emergence of the hatchlings. Once hatched the hatchlings that have no morphological dysfunction are released from the beach closest to their hatchery, while others showing distinct deformation or weakness are brought to the Turtle Nursery 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.

Developmental stage	Morphology	Developmental timeline
Stage 1	No development	0-7 days
Stage 2	Limb buds present	7-17 days
Stage 3	Carapace (shell) present but no scutes on carapace	18-23 days
Stage 4	Carapace scutes, no scales on head and flippers	24-36 days
Stage 5	Head and flipper scales, yolk bigger than turtle	37-43 days
Stage 6	Full embryo yolk smaller than turtle	44-50 days

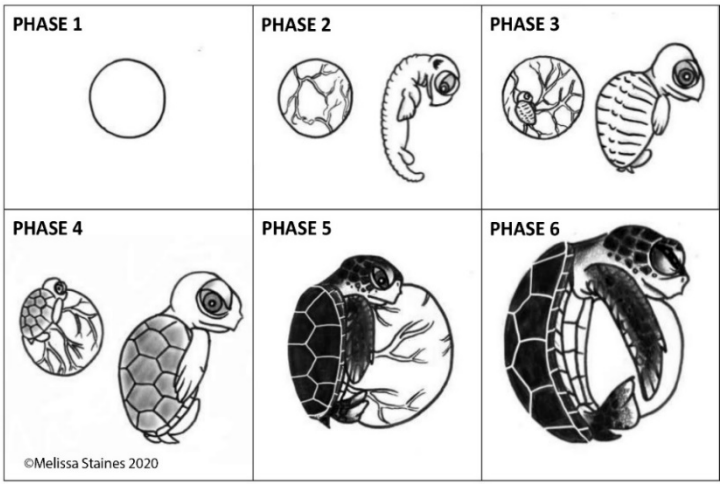


Figure 11: Embryonic development stages used in the field for assessing development stage at death (©Melissa Staines).

Hatchery Construction

Figure 12: Shaded Turtle Hatchery.(Migration Media Underwater Imaging, 2018)

To create our hatchery, we excavated an area 15 meters by 8 meters to a depth of 80 cm, and lined the perimeter with builder's plastic (20cm down in the sand) to stop root invasion (which can cause severe dehydration and death of the developing embryos) and aid in predator exclusion, leaving the base open for natural water drainage. Emcompassed 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 out of 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 any of the birds that had in the past been observed to hunt hatchlings like heron's, kingfishers, and ravens. Shading the hatchery will help aid in the the production of both female and male sexes as the leaf shade cools the sand The nests are watered every second day with fresh water to keep the nests cool and to mimic natural rainfall events.

RESULTS

Nesting Population

The CICI Turtle Conservation Ranger Team, in an effort to implement saturation tagging, were in the field on nightly patrols from early November 2020 through to the end of February 2021. **Table 1** is a summary of the saturation tagging results from this season.

CICI encountered a total of 83 individual Green turtles, five of which were internesting re-captures (re-migrants), which had been previously tagged in the Conflict Islands during our past tagging seasons. These re-migrant turtles will help to build our population profile and where size estimates for the nesting population can be made. Of the five re-migrant turtles, all were first tagged in the 2017 season. 53 Green turtles were encountered only once during the season (primary turtles), and the remaining 30 tagged green turtles were encountered more than once (in-season recaptures) and responsible for 101 nesting attempts.

For hawksbill turtles the Rangers encountered 36 in total, 25 of these were only encountered once (primary), leaving 11 encountered more than once during the season. One Hawksbill turtle (tag number IGS1200) was encountered nesting a total of 6 different occasions across three different islands and laid an average of 166 eggs per clutch (~997 eggs laid in one season). CICI had zero re-migrant hawksbill turtles from our previous nesting seasons, which may indicate that the interbreeding period for this population is longer than that of the green turtles nesting in CI.

Table 1: Number of individual turtles tagged an observed within the Conflict Islands Atoll, during the survey period of nesting females from late November 2020 to mid-February 2021.

Species	New Individuals	Re-migrant Individuals	Total Individuals	In-season Recaptures	One-off Captures
Green Turtle	78	5	83	101	53
Hawksbill Turtle	36	0	36	37	25
Total	**114**	**5**	**119**	**138**	**78**

CICI has tagged a total of 706 individual nesting green turtles and 130 nesting hawksbill turtles since the program started in 2017 (**Tables 2 & 3)**, in the Conflict Islands. Of these, 9 green turtles and 5 hawksbill turtles have been tagged elsewhere, most likely in their foraging grounds before they migrated to the Conflict Islands to nest.

As shown in **Table 2**, the total number of individual nesting green turtles that we encounter fluctuates noticeably year to year. This is a natural fluctuation which occurs for most nesting green turtle populations around the world and has been conclusively associated with the availability of seagrass and algae at the foraging grounds. It takes approximately 18 months for a nesting female to prepare for nesting, however many climate variables change the abundance of seagrass and algae (e.g. cyclones and floods, El Niño and La Niña) which can delay or benefit follicle development.

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 2021 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
Total	**706**	**5**	**8**	**1**	**720**

Table 3 below shows the number of hawksbill turtles tagged each year. A total of 130 indiviual nesting female hawksbill turtles have been tagged since the program started in 2017, however annual nesting numbers remain relatively low in comparison to the number of green turtles tagged. Yet nesting abundance of hawksbill turtles is more consistent between years, with an average of 31 individual hawksbill turtles nesting in CI each year. It may be that any loss of an individual from this population would be at a great cost to the population. Currently, there are hawksbill studies investigating the genetic origin and stock connectivity, migration paths and the potential impacts of climate change skewing hatchling sex-ratios towards female. Hawksbill turtle populations across Asia-Pacific could undergo feminization as a result of warming sand temperatures, which restricts the availability of males in the adult breeding populations.

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 2021 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
Total	**130**	**0**	**4**	**2**	**136**

Since the program commenced, CICI have tagged a total of 857 nesting turtles (**Table 4)**. During the first three seasons of the program (2017, 2018, 2019), data collection used a voluntourism model. Since COVID-19 and the international travel restrictions were implemented, CICI has had to significantly adapt its operations. Prior to the 2020 – 2021 season, CICI averaged 60 international and domestic volunteers to assist on the program each year. Volunteers were heavily involved in monitoring and data collection and included PhD students from three different Australian Universities, as well as university students doing work placements with CICI.

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 2021 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
Total	**837**	**5**	**12**	**3**	**857**

The absence of volunteers did not seem to have any negative impact on the work being conducted this season. The rangers reported that operations were more efficient. This maybe a consideration for the future of the program, especially in a post COVID world, where international travel will continue to be highly restrictive and in Papua New Guinea, being very far behind in ensuring COVID safety with slow rollout of vaccines and dissemination of accurate information especially in the remote villages that CICI staff and volunteers often come in contact with.

Nesting Success and Seasonality

Over prior nesting seasons, CICI attempted to monitor all the nesting islands. This was important to understand turtle nesting activity and whether turtles exhibited any nesting islands preferences. CICI has few available and trained Conservation Rangers and many islands to cover of different sizes and different nesting 'popularity' and suitability which also made the decisions difficult to decide on which islands and how much effort was needed to monitor. Importantly unbiased and consistent data is needed to make population assessments which was the basis for instigating our turtle conservation program. Based on past nesting abundances, for the 2020 -2021 season, effort was concentrated on the four main nesting islands in the Conflict Island Atoll of: Irai, Tupit, Tabanagoal and Panasesa. They are also the closest in distance to the hatchery (based on Panasesa Island), advantageous for relocating clutches. The shorter the time period between oviposition (time of laying), collection and then relocating the eggs into the hatchery delivers a better hatching success of the clutches because the embryos can break diapause (begin developing) as early as 2-3hrs after oviposition.

From December to late January, CICI also had a team based on Auroroa Island to monitor nesting activity and to patrol the eastern half of the atoll for poaching activity. Meaning, spotting and deterring potential poachers from taking turtles from the no-take Conflict Islands. The team is made up of three Conservation Rangers who are non-armed security, and were trained in turtle tagging and conservation techniques, as well as one armed security guard from Black Swan. They commonly surveyed the base island of Auroroa and one other island in a single night on the eastern half of the atoll. The surveying effort across the western side of the Atoll was much greater, as the target islands were able to be surveyed on a more regular basis. When islands were not patrolled, missed tracks were recorded the following day to ensure all nesting activity was recorded. **Table 5** shows a summary of the number of nesting attempts (successful or failed) categorized by island for both nesting green and hawksbill turtles and includes both missed and tagged nesting turtle events. Although Tupit is relatively small in comparison to other popular nesting islands, it has good nesting beach habitat

along the entire perimeter and is least affected by wind and wave erosion. Irai is the largest island in the atoll and is also a very prominent nesting site for green turtles, however the areas where the turtles frequently nest, is subject to changes in the beach profile and erosion due to severe weather events. During this season, seven natural nests which were left in-situ were washed away by coastal erosion during a single storm event. These types of events are becoming more frequent and severe each year and emphasizes the need to relocate as many clutches as possible safety back to the hatchery on Panasesa. Panasesa and Panarakum Islands also ranked highly as popular nesting sites. It is likely during the season nesting events occurred that went unrecorded due to either Ranger error, rainfall, wind or other sand disturbances covering racks, unpatrolled nesting sites, long periods between patrols or alternatively if tracks were not marked correctly when that were initially recorded there may have been double counts of missed nests.

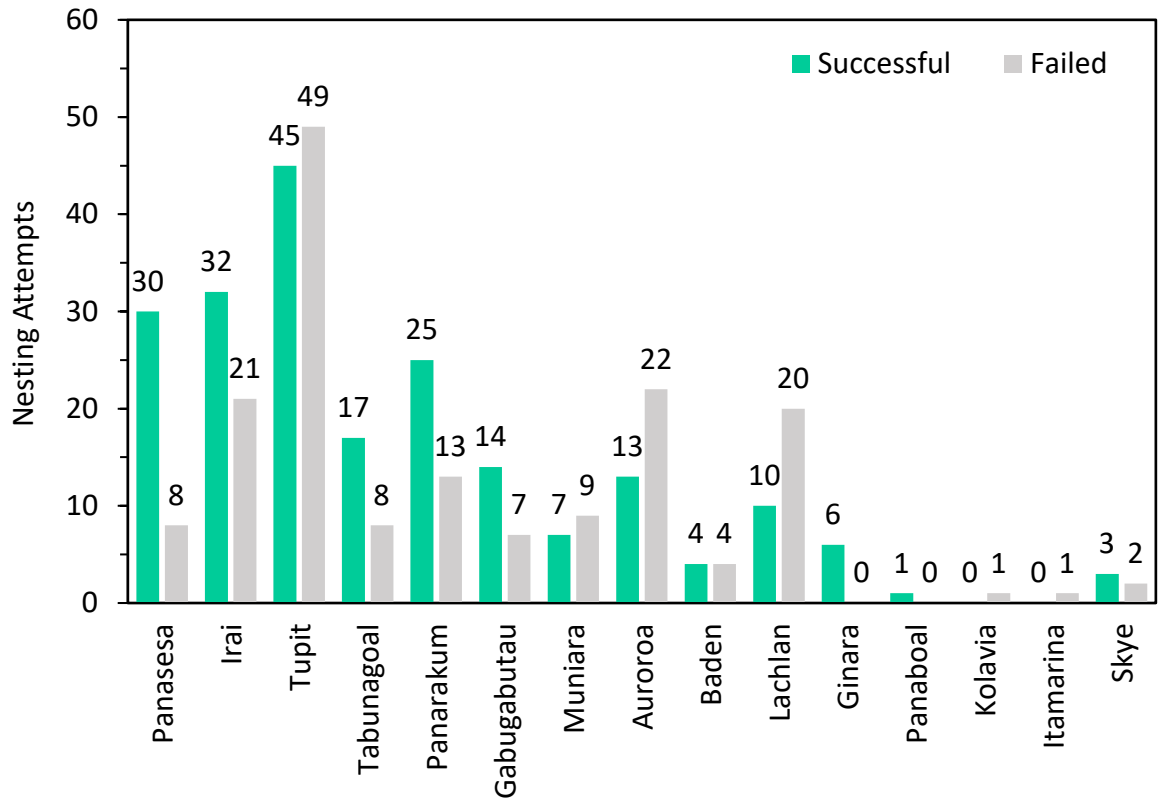
Figure 13: Map of Conflict Islands with each island identified.

Table 5: Number of nesting attempts catergorised by surveyed island in the Conflict Island Atoll for the 2020 – 2021 Turtle Nesting Season, including missed turtles and tagged turtle nesting events.

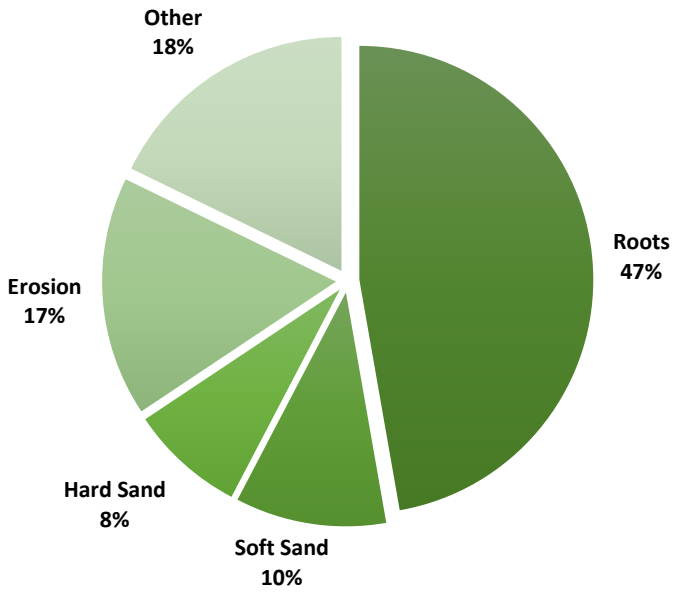
Island	Successful	Failed	Total events (n)
Tupit	45	49	94
Irai	32	21	53
Panasesa	30	8	38
Panarakum	25	13	38
Auroroa	13	22	35
Lachlan	10	20	30
Tabunagoal	17	8	25
Gabugabutau	14	7	21
Muniara	7	9	16
Baden	4	4	8
Ginara	6	0	6
Skye	3	2	5
Panaboal	1	0	1
Kolavia	0	1	1
Total	**207**	**164**	**371**

Due to severe weather conditions, habitat loss, and extreme erosion, turtles are continually struggling to find optimal (suitable) nesting sites to dig their nests. Common issues which prevent turtles from accessing the nesting habitat included large logs and trees washed out from coastal rivers on to the beaches, steep eroded banks that the turtles cannot climb up. This has resulted in the turtles attempting to nest in suboptimal, highly vegetated areas where roots prevent them from being able to dig a complete nest chamber (without assistance) or nesting attempt over multiple nights. Often a female will attempt to dig a nest chamber 2-3 times in a single night, wasting finite energy reserves for breeding successfully. If she is unsuccessful that night and too fatigued to continue digging, she will return the following night and attempt to dig again. A gravid female can hold her eggs in the oviduct for several days and up to 1 week, however some research has shown that in leatherback turtles, this delayed oviposition may decrease embryo survival because of the extended diapause in embryonic development. To date, there is no evidence or research to suggest that this also occurs in green and hawksbill turtles.

Graph 1 below indicates the number of times nesting was attempted on each island and shows how many of those attempts were successful vs the number of failed attempts. Some of these attempts were assisted by the rangers to aid in the successful laying of the nests by the females, however, for most instances the turtle simply failed to dig their egg chamber and could not lay their eggs. Although Tupit Island had the highest density of nesting turtles (94 events total), it also had the highest proportion of failed nesting attempts relative to total nesting events.



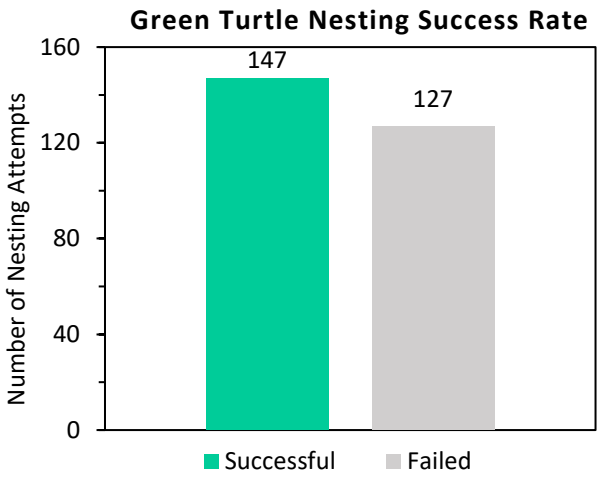
Graph 1: Number of successful and failed attempts of nesting females for both green and hawksbill turtles on each island surveyed within the Conflict Island Atoll in 2020-21 season.



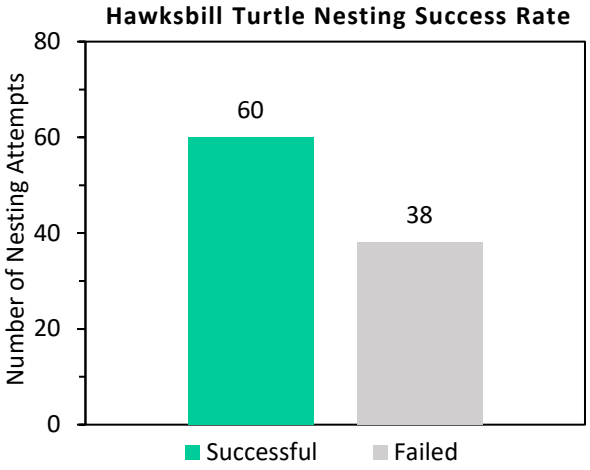
Graph 2: The reasons for nesting failure as a percentage for all islands and both sea turtle species.

Graph 2 shows the reasons for the nesting failures, clearly indicating that the greatest reason for nest failure was due to roots blocking their ability to dig the nest. This is attributed to the lack of accessible and suitable nesting habitat, as sea level rise impacts the islands, washing away the optimal nesting beach habitat forcing the females further into the vegetated zone of the island where the tree root density is much greater. Small grass roots and creeping vines usually do no hinder the digging process. It is when the nesting females are forced into areas where shrubs and trees are growing which have larger and hardened roots that cause the biggest issues for the turtles in their nest excavation.

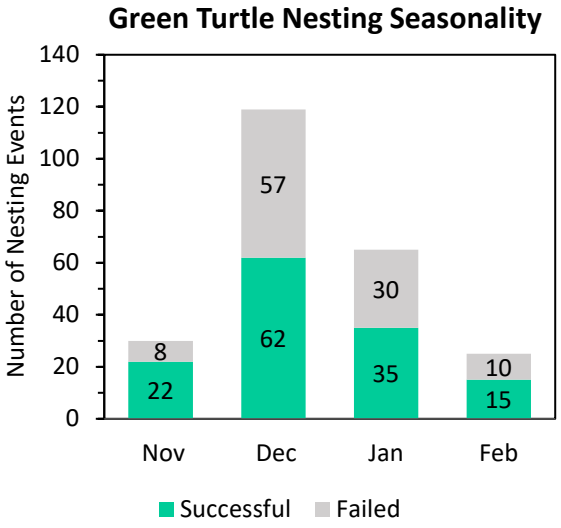
Log interference has recently been studied at Milman Island, a significant nesting site for hawksbill turtles in the northern Great Barrier Reef (Smith et al., 2021), showing log wash is becoming a cross national and regional issue. For each species, their failure rate also varied. Hawksbills failed to nest 39% of the time and green turtles failed 49% of the time, which may be attributed to the different depths of the nests required for each species and behavioral differences between the species. Hawksbills nests are much shallower in the Conflict Islands (30 – 50 cm), potentially why they encounter less tree roots during the nest excavation which tend to be at the depth of green turtle nests (> 50cm). Whereas a green turtle nest can be 50 – 100cm deep and requires intensive excavation. **Graphs 3 and 4** demonstrate the number of times a nesting event occurred successfully or failed between each species. There is a high percentage of nesting failure indicating habitat protection and maintenance should be included in our management strategies moving forward.



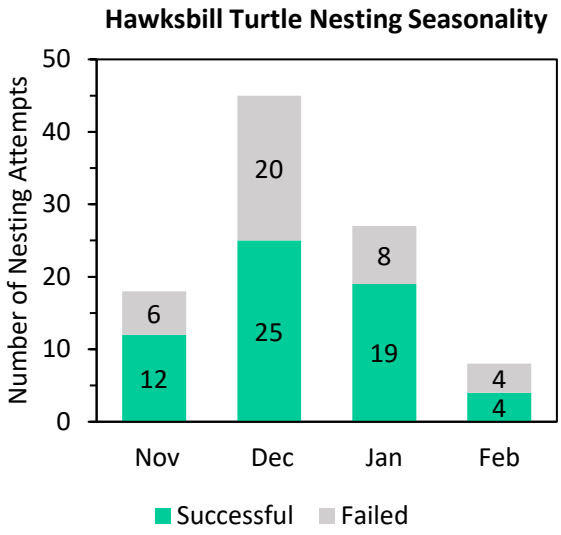
Graph 3 *Number of successful and failed attempts to nest for green turtles.*



Graph 4 *Number of successful and failed attempts to nest for hawksbill turtles.*



Graph 5 *Total number of nesting events by month for Green turtles*



Graph 6 *Total number of nesting events by month for Hawksbill turtles*

By grouping the nesting events by month, CICI can help determine peak nesting events for future monitoring and management. For example, this can help us determine the number and distribution of ranger effort during those time to cope with the increase in turtle numbers. **Graphs 5 and 6** shows that the Conflict Islands had the highest number of encounters in December following by January. This is similar for both the green and hawksbill species, with a strong indication December is the peak time for both species to nest here in the Conflict Islands.

Hatchery Nests

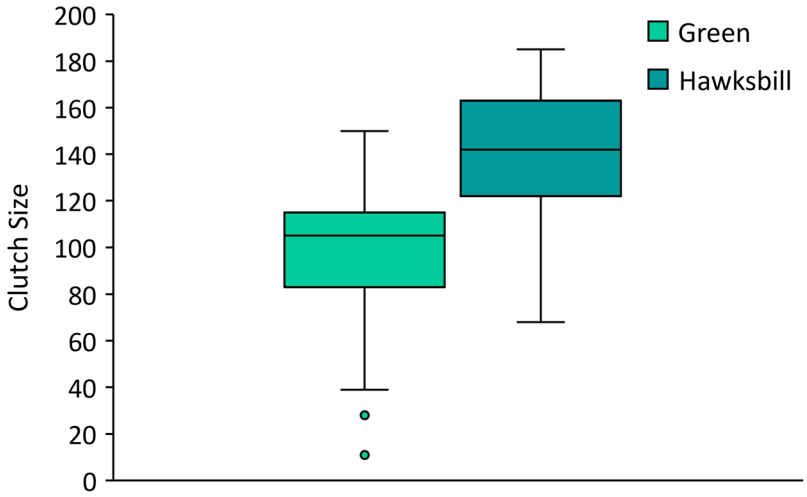
Our translocation work, as part of our management strategy here at the Conflict Island, is a particularly important part of CICI Turtle Conservation Program. The 2020 -2021 season hatchery work produced some incredible results as summarized below. **Table 6** shows CICI relocated a total of 132 clutches, which equated to 8,324 green turtle eggs and 6,741 hawksbill eggs – resulting in a total of 13,672 hatchlings released. Although the number of hawksbill clutches was close to half of the green turtle clutches (49 and 83 respectively), the number of hatchlings produced was relatively similar due to the higher average clutch size of hawksbill turtles compared to green turtles (**Graph 7**). Of the 13,672 hatchlings produced in the hatchery, 13,331 hatchlings were released into the wild. The remaining 341 hatchlings were

temporally held in our nursery facility as they were determined to be unfit for immediate release. Their fitness is determined by observation during and after excavation prior to their release. Hatchlings with low fitness may have physical abnotmalities such as missing body parts, a flip test to test their ability to right them sleves on the sand and general mobility and vigor. If there are any that are still in their shells or have not yet hatched at time of excavation these are also kept.

Table 6: Number of clutches relocated to the hatchery for the 2020 – 2021 Turtle Nesting Season, and corresponding hatchling production.

Species	Clutches Relocated	Eggs Relocated	Hatchlings Released	Hatchlings Produced
Green Turtle	83	8324	7263	7442
Hawksbill Turtle	49	6741	6068	6230
Total	**132**	**15,065**	**13,331**	**13,672**

Green turtles typically lay fewer larger eggs, whereas hawksbills lay larger clutches but smaller eggs. This is indicated in **Graph 7** where you can see the distribution of number of eggs per clutch for both green and hawksbill turtles, with green turtles averaging 105 eggs per clutch and hawksbills averaging 145 eggs per clutch.



Graph 7: Graph showing the variation in the number of eggs (clutch size) laid in the 2020 -2021 nesting season by both green and hawksbill turtles.

The hatching and emergence success rates of our clutches which were relocated into the hatcheries are very promising in comparison to the success rates of other rookeries around the world. In the hatchery, we produced an average hatching and emergence success rate of 93% (Table 7). Unfortunately, CICI had three complete clutches which failed to produce high hatching success rates; one green turtle nest producing only 11 hatchlings and two hawksbill nests that resulted in zero hatchlings. The embryonic development on investigation suggested that for the hawksbill nests there could have been issues with the translocation process, or they were unfertilised, as there was no visible development in any of the eggs (Stage 1 development death). This was similar for the green turtle nest which only produced 11 hatchlings, as the remaining unhatched eggs also had no visible embryonic development. While the reasons behind theses unsuccessful nests will remain largely unknown due to limitations of scientific equipment and techniques available to us here on the Conflict Islands, these nests were anomalies and should not take away from the amazing success of the hatchery. When including failed clutches (**Table 8**) the overall success rate is 89-90%.

Table 7: The average hatching success rate (embryonic survival) and emergence success rates for the relocated green and hawksbill turtle clutches 2020 – 2021 Turtle Nesting Season.

Species	Hatchling Success (%)	Emergence Success (%)	Sample Size (clutches)
Green Turtle	90	90	82
Hawksbill Turtle	95	95	46
Total Average	**93**	**93**	**132**

Table 8: The average hatching success rate (embryonic survival) and emergence success rates for the relocated green and hawksbill turtle clutches 2020 – 2021 Turtle Nesting Season including the 3 outlires of clutch failure.

Species	Hatchling Success (%)	Emergence Success (%)	Sample Size (clutches)
Green Turtle	89	89	83
Hawksbill Turtle	90	91	48
Total Average	**89**	**90**	**132**

During the hatching period, for any hatchlings that were observed to be weak, deformed or otherwise unfit for immediate release, they were temporally held in CICI's nursery until they could be released safely and successfully. Of the 341 turtles kept in the facility, 22 of them unfortunately died before release. CICI successfully released 321 post-hatchlings after effectively rehabilitating them to a point where CICI could be confident of their health (3 – 12 months), giving them the best chance for long term survival. Currently, we have 10 post-hatchlings in the nursery, kept for further observation of birth defects and for longer-term rehabilitation of injury and infection, including a turtle hatched with only one eye and a leucistic turtle, hatched with a lack of pigment making it exceptionally susceptible to predation. The reasons for the death of the 22 hatchlings is unknown without a more specific investigation by a qualified person, such as a veterinarian.

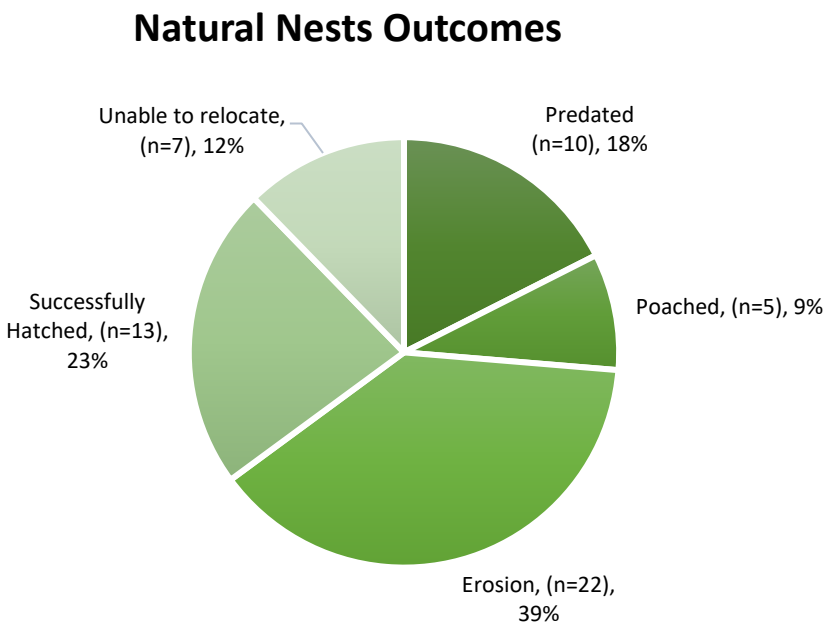
Table 9: Number of turtles kept in nursery for observation and health reasons, deaths in the nursery, healthy hatchlings released after rehabilitation and number of hatchlings currently kept at this time in Nursery.

Species	Taken to Nursery	Died in Nursery	Currently in Nursery	Released
Green Turtle	179	16	10	164
Hawksbill Turtle	162	6	10	157
Total	**341**	**22**	**20**	**321**

Natural Nests

As CICI are unable to relocate every clutch laid, the team attempted to keep a record (and mark) natural nests encountered. This season, CICI also introduced some in-situ nest protection methods. Some of the protection methods encouraged poaching as it made the nests more visible, others were incorrectly implemented allowing predators to get to the eggs. Other nests were retained as in-situ as we were unable to relocate (which was the case for a large majority of nests). **Graph 8** below shows of all the in-situ natural nests marked, 39% of the natural nests were lost or erosion from storm surges, wind and wave action and sea level rise. Only 23% of the nests were able to incubate to a successful hatching event, with other nests lost to predation or could not be located again by the Rangers. The main predator is a species of monitor lizard, along with crabs and the presence of a parasitic fly which lays eggs in the egg chamber, and the

larvae hatch once the ceiling collapses close to the time of emergence of the hatchlings. This parasitic fly and ghost crab predation was also observed in the hatchery conditions. **Table 10** shows that of the 23% nests incubated successfully, 9 of these were green and 1 was a hawsbill turtle nest.



Graph 8: Results of effects on 'natural nests' (un-translocated nests) observed on the islands.

Table 10: Number of Natural Nests where successful hatchings occurred, and nest excavations were possible.

Species	Natural Nests found with successful hatching	No. of Eggs	Hatchlings emerged successfully from Natural Nests
Green Turtle	9	789	524
Hawksbill Turtle	1	167	113
Total	**10**	**956**	**637**

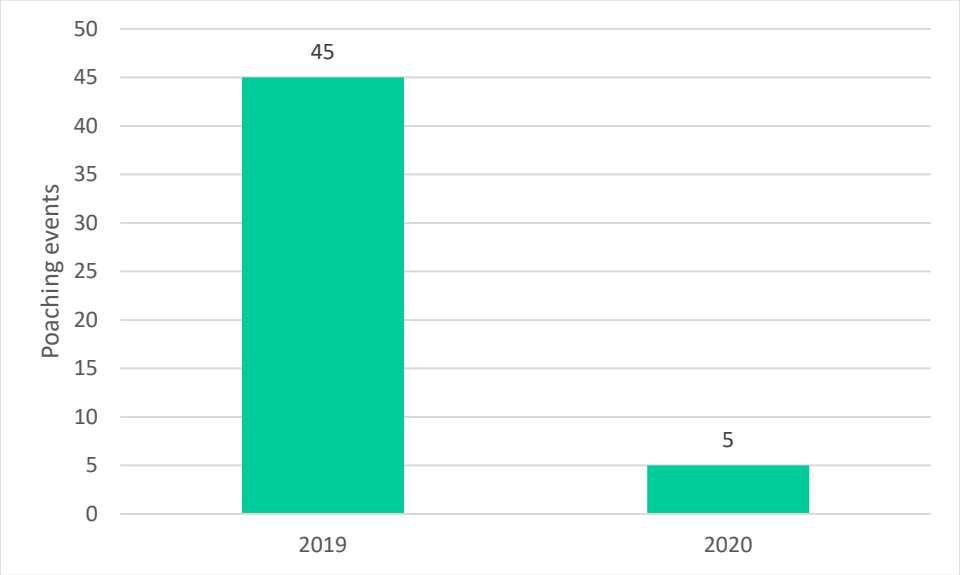
Noteworthy, the hatching and emergence success rates were 25% lower for nests left in-situ compared to clutches incubated in the hatchery (**Table 11**). These nests were also protected by mesh nest protectors from predators.

Table 11: Average Success of natural nests, however each of these nests had been protected from predators with a mesh nest protector.

Species	Hatchling Success (%)	Emergence Success (%)	Sample Size (clutches)
Green Turtle	66	67	9
Hawksbill Turtle	68	76	1
Total Average	**67**	**72**	**10**

Poaching Events

Another positive result from this season, was a significant reduction of the incidences of poaching of turtles and eggs from the islands. This was due to the presence of armed security guards from our Black Swan contractors who accompanied our Conservation rangers on their nightly patrols, and their interception allowing open dialogue and creating awareness and education. After intercepting the first groups of poachers, we had zero incidences from December 2020 until the end of the season in February 2021. In total we had five nests poached and two groups of poachers intercepted. On one occasion, the poachers were dropped off on three separate islands in one night to increase their harvest success. The poachers were escorted out of the atoll by security staff and rangers. They were not successful in taking any turtles or eggs from the islands due to the fast actions from the security team.



PROJECT OUTCOMES

With the help of its partners and sponsors, CICI was able to achieve significant results with the small team on the ground over the 2020 – 2021 turtle nesting season. We have added valuable data to our baseline including our first re-migrant turtles on record, tagged an additional 121 turtles, and was able to collect data on a hawksbill turtle that had been tagged in Australia's foraging ground on Coombe Reef in the Howick Group, in 2017. This again reinforces the interconnectedness of our oceans and turtle population that is shared with Australia and possibly other nations. One of the most significant and interesting finds for this season was one hawksbill contributing almost 1000 eggs, nesting on 3 separate islands over the season.

Despite our successes, we were still faced with a number of limitations due of ranger numbers, weather, funding and in the months preceding, the seasons absence of rangers to prep the islands for nesting. This is usually done in October to remove the large obstructions such as trees and logs which block the access for the nesting turtles. We were also unable to survey any of the foraging population this season. This data collection is usually done during the daytime but with already stretched Conservation Rangers working every night it was decided to remove this monitoring from this seasons data collection activities.

In comparison to past seasons, this nesting season had a low recruitment for green turtles but remained stable for the hawksbills. We still have along way to go before we have a good understanding of the green and hawksbill populations, with further studies and research needing to be conducted. In support of our local communities (providing employment

and capacity building) our wish is to be able to patrol every nesting island every night to ensure we continue to raise awareness of the plight of Papua New Guineas marine turtles and promote protection of the Conflict Islands, whilst we refine our saturation tagging data collection to our targeted islands and foraging grounds to assess population dynamic and trends. Re-instigating our sampling of foraging turtles in the Conflict Islands on a more regular basis will further this understanding to support better conservation and management of the green and hawksbill populations.

There is very strong evidence that these islands and the turtle's use of the island is becoming particularly impacted by sea level rise and the overall effects of climate change. From the rate of failure in nesting (almost half the time), it is imperative that habitat protection and restoration of these islands be considered for future management.

This season, CICI rangers translocated more clutches than in any past season and produced the highest number of hatchlings from our hatchery on record. With over 130 clutches relocated 13,672 hatchlings, hatched and emerged successfully, with an amazing average of 93% success over all for all relocated clutches. The rangers implemented watering, shading and cooling techniques, predator exclusion and close observation over the hatchery which we can assume lead to such great results. To improve our management of CICI's hatcheries we require temperate monitoring devices, that can be used to help monitor the incubation temperatures so we can regulate the incubation temperatures of the clutches to ensure males are also being produced.

Further investigation as to where these hatchlings go once released from the Conflict Islands is needed to help with the local and international management of these highly migratory species including protection. The importance of the pre nesting season clean ups and beach preparations is a key success to nesting females – for example, removing trees that block access, plastic that can increase the temperature of the sand or provide entanglement risk for the turtles, re-sanding and providing safe access points for turtles on the islands and removing and temporary housing build for shelter on the islands to avoid the turtle access being blocked.

Our nursery this season successfully reared 341 hatchlings and released 321 outside of the Atoll. Twenty of them are still in care and awaiting release. Without this facility and the full-time care on one of the rangers these hatchlings surely would not have survived. With the increased security presence during patrol and at the Auroroa base, after initial awareness and education, there was an almost immediate stop of any attempts to poach turtles this season. In the past the Conservation Rangers themselves, or in the 2019 – 2020 season a Turtle Task Force, conducted the enforcement and exclusion of poachers from the islands. This was relatively unsuccessful, with most of the poachers either knowing or being related to the Conservation Ranges themselves practicing there cultural wantok system - i.e. where it is extremely difficult to say no to a relative, friend or member of the same community. After identifying this as an issue and implementing the Alotau based Taskforce Team we had 45 recorded incidences of poaching occur. This is a significant improvement since we started in 2017 and clearly continues to be an effective deterrent for potential poachers which needs to be continued in the future to maintain the protection for the turtles and staff.

Part of the 2020 – 2021 season we also took on two new trainee rangers, as some of our past rangers were not available to return to work. Both trainee's we're outstanding and became valuable members of the team over the season. Both were poachers, who in past years, including last season, came to the Conflict Islands to poach already knowing it is prohibited, and did so successfully without detection from our team. It is of amazing value that we can employ prior poachers and help build better awareness, education and capacity of our youth and local members of the community. Our trainees can now take what they have learnt not only about the turtles but the work CICI is doing in general, back to their villages in the off season for more awareness and education to be spread. We have invited them back to continue to work for the upcoming 2021 – 2022 season as they progressed significantly and more importantly, showed their enthusiasm and willingness to learn and work as part of our great team.

Recommendations for the 2021 – 2022 Season

As COVID is still prevalent and international travel is continuing to be unavailable, we are again faced with having to find alternatives to fund this program to protect the islands and the turtles. We recommend for the 2021 – 2022 season, building capacity and employing nine new trainees to work along side our experienced Turtle Conservation Rangers, effectively doubling our tagging, monitoring, translocation efforts and anit-poaching.

This will allow us to cover 15 islands every night, to have a three base camps, covering the additional location identified as an entry point for poaching. It will allow us to extend our education and awareness for the local communities by providing additional employment for nine youths, from seven different communities. This will help to strengthen our relationships with the communities, build trust and inclusion as well as dispersing additional income that benefits entire family groups. This will require an additional vessel as well as additional field materials. We also recommend maintaining armed security presence within the patrol teams, increasing the safety and efficiency of the anti-poaching campaign. This helps to build the confidence of the Conservation Rangers and take onus of CICI's anti-poaching decision, which otherwise is a heavy burden on the Rangers during the season due to the wantok system that exists within this region of Papua New Guinea.

To reduce our carbon footprint, increase efficiency and lessen the man hours required for data entry, we will continue to trial and use the digital data entry application developed by SPREP. To do so, we will require one off additional equipment purchases for tablets that will be used in the field. Accurately monitoring the incubation temperatures of the clutches is also going to be very important and to do so we are recommending the addition of temperature data recorders that give real time outputs, helping us to control the temperatures to maintain male hatchling production.

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 2020 – 2021 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. The population of turtles is thought to be 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 neighbours 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, Koyo Inia, Patrick Lemeki, Toby Losane, Henry John, Tonny Joe, Dominic Moses and Charlie Ebilon. 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 Sally-Ann Kirarata, 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. And to our Board of Director, Christine Madden Hof for continuing to help us drive our Turtle Conservation Program, and providing valuable project report review. 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 of been possible with out your help.

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