STATUS OF SEA TURTLES
IN TRINIDAD AND TOBAGO

Summary of Findings of the National Sea Turtle Conservation Programme

2013 - 2018

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Disclaimer:

Contents

Acknowledgements

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Name of Stakeholder	Type of Organisation	Contribution
TRINIDAD		
Fishing Pond Turtle Conservation Group	**CBO**	**Data Collection, Protection**
Grande Riviere Nature Tour Guide Association	**CBO**	**Data Collection, Protection**
Nature Seekers	**CBO**	**Data Collection, Protection**
Wildlife Watch Environmental Group	**CBO**	**Data Collection, Protection**
Pawi Sports, Culture & Eco Club	**CBO**	**Data Collection, Protection**
Sans Souci Wildlife & Tourism Development Organisation	**CBO**	**Data Collection, Protection**
St David Empowerment and Developmental Organisation	**CBO**	**Data Collection, Protection**
Nature Maintaince Verdant Conservation Group	**CBO**	**Data Collection, Protection**
Blanchisseuse Environment & Community Organisation	**CBO**	**Data Collection, Protection**
Las Cuevas Eco-friendly Association	**CBO**	**Data Collection, Protection**

Name of Stakeholder	Type	Contribution
TOBAGO		
The Environmental Research Institute Charlotteville ERIC	**CBO**	**Data Collection, Protection**
Save Our Sea Turtles (SOS)-Tobago	**CBO**	**Data Collection, Protection**
North East Sea Turtles (NEST)	**CBO**	**Data Collection, Protection**
Speyside Eco-Marine Park Rangers	**CBO**	**Data Collection, Protection**
Anse Fromager Ecological & Environmental Protection Organisation	**CBO**	**Data Collection, Protection**

Name of Stakeholder	Type of Organisation	Contribution
Environmental Management Authority	Gov't	Protection, Permissions Technical Support Project Collaboration
Forestry Division-Ministry of Agriculture, Lands and Marine Resources)	Gov't	Protection, Technical Support
DNRF, THA	Gov't	Protection, Permissions Technical Support Project Collaboration
University of Trinidad and Tobago	Gov't	Technical support for Hatchery, Tank Husbandry and DNA analysis
Institute of Marine Affairs (IMA)	Gov't	Technical-support for Satellite Tagging and Beach Profiling Project Collaboration

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Background of Conservation

The Republic of Trinidad and Tobago supports the largest nesting assemblage of Leatherback sea turtles (Dermochelys coriacea) in the Western Hemisphere and one of the largest island-nesting population of Leatherbacks on Earth. Trinidad and Tobago after the recent decades' marked declines of the Guianas population is largely responsible for sustaining the Northwest Atlantic Leatherback assemblage, which during non-nesting periods distributes from the Canadian Arctic to the tropical West coast of Africa. It is fair to surmise that Trinidad is one of the most valuable nesting sites on earth.

Management responsibility for this vital nesting colony is the responsibility of the Government of Trinidad and Tobago's Wildlife Section, Forestry Division. Active management of the colony began in the late 1980's and early 1990's with efforts from the Trinidad and Tobago Field Naturalists' Club and the Point-a-Pierre Wildfowl Trust to stop rampant killing of adult females on the nesting beaches for sport and meat. However, limited financial and personnel resources meant that most such efforts were incomplete and many hundreds of females were slaughtered each year. In response, the Wildlife Section initiated the formation of local non-governmental conservation groups and established co-management of the nesting beaches with those local NGO's. Initial support for training and scientific oversight was provided by the regional conservation organisation Wider Caribbean Sea Turtle Conservation Network (WIDECAST). Success in reducing poaching has been almost complete, particularly at the 3 primary Trinidad nesting colonies of Fishing Pond, Matura and Grande Riviere beaches. This came from conducting nocturnal beach patrols, tagging of nesting turtles, collection of morphometric information, documentation of mortality sources, assessment of population trends and behavioural patterns, supervision of ecotourism, and education of the public.

The success in reducing poaching in Trinidad through the establishment of a local co-management program has been a major achievement in preserving the nesting colonies. Furthermore, the environmental outreach activities conducted by these village organisations have been extraordinarily successful in elevating the status of sea turtles among Trinbagonians. As a result of dedicated community-led efforts that span many years, Leatherback populations have stabilised in our country. In contrast, some of the largest Leatherback populations in the world are now nearly extinct because such care has not been taken. The most dramatic declines have occurred in Pacific Mexico and Costa Rica, as well as in Malaysia and other Asian countries. Except for French Guiana-Suriname, most Caribbean populations are also very small.

The island of Trinidad supports more than 80% of all Leatherback sea turtle (Dermochelys coriacea) nesting in the insular Caribbean Sea and is the 2nd largest nesting colony in the world with an estimated 6,000 Leatherbacks nesting annually (Fournillier and Eckert, 1999). The majority of this nesting is concentrated on the North and East coasts of the island, with occasional nests laid along the South coast and Tobago. Leatherbacks nesting on Trinidad distribute throughout the North Atlantic as demonstrated by both flipper tag returns and satellite telemetry and reside for part of the year in virtually every North Atlantic coastal nation (Eckert, 1998; Eckert, 2005; James et al., 2005).

In Trinidad and Tobago, we will better understand the global nature of the threats the population faces by tagging all Leatherbacks. A Satellite-tracking project by Dr Scott Eckert revealed that Leatherbacks travel to two areas of the world after nesting in Trinidad: Canadian waters off Nova Scotia and to the Cape Verde islands off the West Coast of Africa. Researchers are currently collaborating in both of those areas and will utilize that relationship to contact fisherman in those areas to advise them of our Project and to be on the lookout for turtles tagged in Trinidad and Tobago.

Up to 2012, most resources had been dedicated to addressing the immediate threats to the population. The result indicates that the status of the nesting stock is still unclear, and there isn't a quantified assessment of population size. Both of these values are vital to the sustained management of this important nesting aggregation.

As part of a wider programme to promote the recovery of sea turtles on the twin islands of Trinidad and Tobago, Turtle Village Trust embarked on the National Monitoring Programme (NMP) in 2008.

Over the past 10 years, the Turtle Village Trust has been supporting a National Monitoring Programme through the sponsorship of BHP Billiton Trinidad & Tobago and more recently and consistently Atlantic LNG. This support saw the involvement of groups in Grande Riviere, Matura, Fishing Pond and Southwest Tobago in consistent monitoring efforts.

As an approach to sea turtle protection and rehabilitation the Forestry Division and WIDECAST designed a National Sea Turtle Recovery Action Plan. One of the recommendations of this document was to implement a full scale national sea turtle tagging and monitoring programme. As such, in 2013 TVT acquired resources from the Green Fund to establish the National Sea Turtle Conservation Project and increase patrol coverage, equipment acquisition and enhance public education of the conservation efforts expanding the programme to a national level on beaches of Trinidad and Tobago.

Research conducted on our local beaches informs sea turtle conservation and management and awareness which in turn promotes sea turtle conservation throughout the world. The 5 species of sea turtles nesting and foraging in Trinidad and Tobago were designated Environmentally Sensitive Species in 2014 (EMA 2014).

Legal Basis

The Government of Trinidad and Tobago has international obligations under the following Conventions for the protection of all migratory sea turtles:

(a) the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) which entered into force in Trinidad and Tobago on 18th April, 1984;

(b) the Protocol concerning Specially Protected Areas and Wildlife to the Cartagena Convention (SPAW Protocol), which entered into force in Trinidad and Tobago on 18th June, 2000;

(c) the United Nations Convention on Biological Diversity (CBD) which entered into force in Trinidad and Tobago on 1st August, 1996;

(d) the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention) which entered into force in Trinidad and Tobago on 24th January, 1986.

To ensure compliance with these international obligations, adequately protect all migratory sea turtles and achieve the objectives of Caribbean Environment Programme's Regional Programme for Specially Protected Areas and Wildlife (SPAW), The Strategy for the Development of the Caribbean Environment Programme (1990-1995) called for "the development of specific management plans for economically and ecologically important species", making particular reference to endangered, threatened, or vulnerable species of sea turtle.

Where Climate Change is concerned, Trinidad and Tobago is signatory to two international conventions: the United Nations Convention and Climate Change (UNFCCC) and adjoining the Kyoto Protocol (1997) and Paris Agreement (2015).

Trinidad and Tobago, being a member of the international and regional conventions previously stated, have implemented local mechanisms of protection- laws and legislations, etc. to support these regional initiative goals and objectives. These locally implemented strategies were to protect our Flora and Fauna as well as combat the issues of Land-Based Sources of Pollution.

Locally, sea turtles were first protected on land under the Conservation of Wildlife Act (Chapter 67:01) 1963; and the Fisheries Act (Chapter 67:51) 1975. In 2011, the Fisheries Act, Chapter 67:51, was amended to give full protection to all sea turtle species.

In 2011 the Sea Turtle Recovery Action Plan for Trinidad and Tobago was approved by government, (***http://www.widecast.org/Resources/Docs/STRAP_Trinidad_and_Tobago_2010.pdf***). This recovery action plan summarizes the known distribution of sea turtles, discusses major causes of mortality, evaluates the effectiveness of existing conservation laws, and prioritizes implementing measures for stock recovery. The objective of the recovery action plan series is not only to assist Caribbean governments in the discharge of their obligations under the SPAW Protocol, but also to promote a regional capability to implement science-based sea turtle management and conservation programs.

In 2014 the government identified the responsible Agency for sea turtle management as the Environmental Management Authority. In keeping with this mandate, the EMA designated all five sea turtles as Environmentally Sensitive Species under the EM Act Chap 35:05 of 2001 and the Environmentally Sensitive Species Rules, 2001. The Legal Notices for the designations prohibits the taking, removing, harming, injuring, hunting, selling or killing of the species as well as the destruction or alteration of its habitat.

The minimum enforcement of protective legislation provided by the Government of the Republic of Trinidad and Tobago (GORTT) continues to negatively affect the long term survival of sea turtles that nest or inhabit the territorial waters of T&T.

INTRODUCTION

Sea turtles were among the first marine species to benefit from legal protections and resolute conservation efforts around the world. However, all species of sea turtles are globally classified as Threatened on International Union for Conservation of Nature's Red List of Threatened Species and are vulnerable to a wide range of threats including ingestion and entanglement in marine debris, harvest of eggs or turtle meat, loss of nesting and foraging habitat and fisheries interactions. The effect of destructive changes to the environment have been intensified significantly in recent decades due Climate Change impacts.

The sea turtle fauna of Trinidad and Tobago (T&T) is one of the most diverse in the Caribbean. Three species, the Leatherback (*Dermochelys coriacea)*; Hawksbill (*Eretmochelys imbricata)*; and Green turtle (*Chelonia mydas*) nest on the twin islands beaches. Two other species, the Loggerhead (*Caretta caretta)* and Olive Ridley (*Lepidochelys olivacea*) have been recorded in its coastal waters and in strandings.

The Leatherback population, which nests on the East and Northeast coasts of Trinidad and on the smaller island of Tobago is one of the largest in the world. From current available data, Leatherback sea turtle nesting accounts for the majority of known sea turtle nesting activity in T&T.

Nesting by the Hawksbill turtle places a distant second, and, in order of abundance, nesting by or hard-shelled species Green turtles, Olive Ridley and Loggerhead ranges from occasional to rare (*STRAP, 2010.*)

Nesting sites for Hawksbill, Green and other hard-shelled species of sea turtles are often located on small, not easily accessible, isolated beaches, sometimes associated with shallow offshore reefs. This combination of factors makes monitoring of these species on a regular basis difficult relative to the monitoring of Leatherback turtles which predominantly select wide, long, sandy coastlines for nesting.

Sea turtles regularly migrate vast distances between feeding areas (foraging grounds) and nesting beaches. Turtles that nest in T&T come from widely scattered foraging grounds, many of which are outside the territorial boundaries of the country. Satellite tagging of Leatherback turtles nesting in T&T show that they migrate throughout the tropical and sub-tropical Atlantic before returning to nesting beaches (*James et. al, 2005; Bond and James, 2017*). The migratory patterns of the islands' nesting Hawksbills and Green turtles are recently being described. Opportunistic tagging of juveniles, turtles captured offshore and post-nesting females from 5 areas; North Coast, Grand Riviere, North-West Peninsula, East Coast in Trinidad and around Tobago, reveals that these species migrate shorter distances and stay within tropical waters. The foraging grounds for these turtles seemed to mainly consist of coral reef ecosystems and in general coincided with protected areas.

Management of current threats falls short of what is necessary to prevent further population declines and ensure species' survival.

If sea turtles go extinct, many other plants and animals in marine ecosystems will be negatively impacted and the environment will be irreparably altered. Sea turtles are also an economic resource, particularly to local communities, providing a potential food source, a tourism attraction and ecosystem services- benefits such as seagrass maintenance, coral reef management, beach stabilisation and climate regulation.

Conservation successes have been achieved through regional agreements for unified management approaches, national legislations to protect species and their habitats and community-based conservation programmes that offer viable alternatives to consumptive use.

Community persons play a central role in conserving local sea turtle populations and in documenting the abundance and distribution of nesting females and turtles in offshore areas. Beach patrollers, tour guides, fisherfolk and other citizens help provide a better understanding of the biology of sea turtles. Local communities must manage their natural resources and ensure a future with healthy wildlife, including sea turtle populations, and sustainable economic growth.

Fostering a conservation ethic among community residents and the civil society helps narrow any gaps in government regulations, persons make the choice to preserve without a law or penalty. Individuals and private corporations can withstand pressure from private interests and changes in the political climate.

Sea Turtles in Trinidad & Tobago

There are five species of marine turtle that come ashore to nest in Trinidad and Tobago:

- The Leatherback Turtle: *Dermochelys coriacea*
- The Hawksbill Turtle: *Eretmochelys imbricata*
- The Green Turtle: *Chelonia mydas*
- The Loggerhead Turtle: *Caretta caretta*
- The Olive Ridley Turtle: *Lepidochelys olivacea*

Hawksbill, Green, Loggerhead and Olive Ridley turtles occupy feeding areas in the coastal waters of Trinidad and Tobago year-round, that they also share with turtles from different regional stocks and breeding units, which nest in neighbouring countries.

Leatherback Sea Turtle

In Trinidad, the critically endangered Leatherback turtle (*Dermochelys coriacea*) is commonly called "caldong" or "coffinback." Leatherbacks are the largest marine turtle and one of the largest reptiles in the world. Adult males can exceed 9 feet in length and weigh 2000 pounds or more (Gulko and Eckert 2003). The record male Leatherback curved carapace length (the length of the carapace from notch to tip, excluding the head and tail), stranded on the West Coast of Wales in 1988, was over 3 metres (10 feet) and weighed 916 kilogrammes (almost 2020 lbs). Females generally have a carapace length of 130-175 centimetres (approximately 4.5-6 feet) and weigh 260-500 kilogrammes (approximately 575-1100 lbs).

These turtles are the most dominant nesting species on Trinidad's beaches. They are overall black with white spots (can also be a pink colouration). Unlike other marine turtles they do not have a hard upper shell but rather a leathery carapace, which is relatively soft and has longitudinal ridges. Their large flippers and unique, ridged carapace allows them to swim long distances and dive to depths necessary for them to swim to their foraging areas in the Northern Hemisphere's colder waters while aiding in escaping predators. Adults lack head and flipper scales, while both adults and hatchlings lack flipper claws. Leatherback front flippers are longer and more paddle-like than the other sea turtle species.

Based on current knowledge, it is not possible to precisely determine the exact age of a living Leatherback. However, they are long-lived, needing 25-30 years just to reach sexual maturity. Some suggest Leatherbacks cannot live more than 100 years in the ocean, due to the number of threats that exist but it is likely they can live much longer based on their maximum size and known growth rates. Bones, near the turtle's eyes, have "rings" much like a tree does and are research is ongoing on whether or not the number of rings indicates a turtle's age. This ageing technique can only be examined on tissue of dead Leatherbacks.

Green Sea Turtle

Locally known as "green turtle" and "greenback", Green sea turtles are recognised by their rounded, blunt beak with one pair of prefrontal scales. Greens are variably coloured with light to dark brown, shades of green including olive and four pairs of non-overlapping lateral carapace scutes.

Adults attain weights of 230 kilogrammes (500lb) and grow to 95-120 centimetres in length.

Green turtles travel extensively during their first decades of life before reaching sexual maturity, at estimated 18-36 years of age.

Young Greens may feed on a diverse diet of crustaceans, worms, molluscs, tunicates and coelenterates which are also harbouring in Sargassum seaweed rafts in the open sea. Adult Green sea turtles are exclusively herbivorous feeding on seagrasses typically *Thalassia testudinum* known as "turtle grass".

Hawksbill Sea Turtle

Hawksbills are locally known as “oxbill” and “chicken turtle”. The species is distinguished by a narrow, pointed, bird-like shaped beak. The carapace is often posteriorly serrated and the four pairs of lateral carapace scutes overlap, like shingles on a roof. There are 2 pairs of prefrontal scales with surrounding tissue resembling a cross or ‘T’ just above the breathing nares (nostrils).

Adults can weigh 90 kilogrammes (198lbs) and have a curved carapace length of 90 centimetres from nuchal notch to posterior tip of marginal scute. The carapace has been prized for is “tortoise shell” of brown, orange, golden colouration for use in craft and jewellery.

Available evidence demonstrates that Hawksbills reach sexual maturity between 15- 40 years. During a normal life cycle, individual turtles disperse and migrate over long distances to about 1,000 kilometres, however, these turtles may be sedentary and resident for long periods in feeding areas, between reproductive migrations. Aggregations of Hawkbills at foraging grounds and other non-reproductive areas are a mix from distinct genetic stocks, populations. Each nesting population forms a discrete genetically isolated entity.

Loggerhead Sea Turtle

Loggerhead turtles can be distinguished by their relatively large heads. Adult Loggerheads are approximately 80-100 centimetres curved carapace length and can weigh 120-200 kilogrammes. Their hard shells are generally a reddish brown. They have more than one pair of prefrontal scales and five or six costal scutes, the first of which touches the nuchal scute. Each flipper has two claws. These turtles are found nesting less frequently than the other three hard-shelled species.

Olive Ridley Sea Turtle

The Olive Ridley is very rare to our islands. They have a dome shaped carapace and are olive or greyish-green in colour. These adult turtles are relatively small at approximately 55-80 centimetres curved carapace length and 45-50 kilogrammes. Their carapace can be divided into 6 or more costal scutes, the first of which touches the nuchal scute. They have more than one pair of prefrontal scales and one or two claws on each flipper. Olive Ridleys can perform a unique nesting habit whereby large numbers, hundreds or thousands, of these turtles come ashore to nest at the same time in the same location. This phenomena called “arribada” nesting occurs only on a few beaches worldwide and does not include Trinidad and Tobago, where few solitary nesting events have been reported.

Trinidad and Tobago Sea Turtle Rookeries

Trinidad and Tobago has over 65 beaches that have been identified for sea turtle nest monitoring based on reports of nesting and nesting data collected. Each site was evaluated by the Species nesting, Level of nesting and Accessibility. These beaches are adjacent to thirteen communities in Trinidad and twelve in Tobago.

Defined Nesting Beaches Identified In Trinidad and Tobago

Characterizing a nesting beach as an 'Index', 'key' or 'survey' site implies the consistent and long-term application of standardized population monitoring protocols to ensure the data are suitable for trend analysis. Survey boundaries are established and, ideally, adhered to from year to year, keeping in mind that the precise boundaries of sea turtle nesting beaches may shift over time. In designating the nesting site, we attempt to describe the range of threat and protection levels, and the range of turtle population densities. The emphasis of this protocol is on establishing methods for measuring trends in relative abundance at fixed locations, therefore, the sampling strategies at each site should ideally be structured in a manner that allows inference to a larger area of interest.

In further defining nesting beaches we also consider the aspects of remoteness and access. This allows us to conduct a cost benefit analysis when assigning resources towards a monitoring regime.

Index Beaches

Index beaches are those that are historically known to support large numbers of nesting events annually. These designated sites are monitored for long-term fluctuations in nesting numbers and hatch success, as described by the STRAP (*CEP Technical Report No. 49, STRAP, 4.112)*.

The State of the World's Sea Turtles (SWOT) 2011 Guidelines *(SWOT Scientific Advisory Board 2011. SWOT Minimum Data Standards for Nesting Beach Monitoring. Technical Report)* for selecting index beaches/sites:

1. At the country level, each country should choose at least one index site for each species that nests at any significant level.

2. An index beach might be selected because it hosts a significant proportion of the overall nesting population within a region or country, even if numbers are small.

3. If there is significant population structure (e.g. genetics, Regional Management Units), then index sites should be selected to represent the various segments of the regional population.

4. Index beaches may include major nesting sites already under intensive study and long-term monitoring.

5. Index sites for all countries should remain consistent from year to year and receive sufficient resources to maintain adequate and consistent monitoring.

The Index beach approach assumes that annual abundance patterns observed through comprehensive monitoring of the Index beach, reflects the pattern at all other beaches being used by the same nesting population of that species.

The Index sites identified under the Project are:
Grande Riviere, Matura, Fishing Pond, Grand Tacarib, Manzanilla, San Souci/ Big Bay, Blanchisseuse (Marianne) Bay, Turtle Beach, Grafton, Back Bay Mt Irvine, Hermitage, Cambleton. Four of the Index sites were under monitoring prior to the Project inception. These include Grande Riviere, Matura, Fishing Pond and Turtle Beach. These are considered historical for reporting purposes.

Key Nesting Beaches

Numerous separated or non-contiguous beaches used by the same population of nesting females but the nesting turtles show lower fidelity to a particular site or nesting is dispersed over several sites but none at significantly high levels to be Index beaches. *(SWOT Scientific Advisory Board 2011. SWOT Minimum Data Standards for Nesting Beach Monitoring. Technical Report)*

The number of nesting species and annual nesting averages are considerably lower than for Index sites, for the equivalent monitoring coverage. Compared with other nesting sites, nesting is quite low (<50 nesting events per season, <5 nesting events per week) and may be better suited to monitoring at low levels of survey effort with emphasised coverage during peak period and then combining data of many sites for analysing overall abundance.

These sites provide insight into the nesting range of sea turtle species in T&T, particularly as most host several nesting species.

Survey beaches

Our nesting population utilises numerous, detached beaches but it is not possible to distribute the limited resources for maximum coverage at all sites. Therefore, to characterise the annual nesting abundance, the data from high-density sites (Index/ Key) can be supported by monitoring many sites at low levels of survey effort and then performing a common analysis.

Where anecdotal evidence exists, the aspect of the beach and proximity of the beach to known nesting sites suggests there may be some nesting activity, it is important to get an estimation of the nesting numbers on these beaches, for use in population assessments, record tag returns for migratory analysis and influence area use management. These survey sites generally support lower nesting numbers but also typically have more abundant hard-shell nesting activity.

Beaches without previous nesting records should not be omitted from the monitoring programme since low nesting effort could have been overlooked by inexperienced surveyors. Colonisation of new beaches and changes to nesting beaches can occur.

Remote Beaches

These difficult to access sites, while they present logistical challenges predominantly due to their remoteness, provide insight into the overall nesting range of sea turtle species in T&T and give particular insight into the hard-shell nesting population.

Key sites identified for monitoring under the Project are:

North Trinidad: Madamas, Grand Tacarib, Paria;

North West Trinidad: La Tinta, Bande du Sud, Biscayen, Tortue Bay

North-East Tobago: Hermitage, Pirate’s, Lover’s, Cambleton, Iguana, Dead Bay, L’Anse Fourmi

In order to more accurately assess the activity, during peak nesting, a National Census survey of a 10-14 night period is required. The Census gives an estimate of nesting females and an indication of nest success at the period of highest nesting density, across beaches not routinely monitored.

This mid-season survey at remote sites allows for a sub-sampling, to enhance the total abundance estimates, that maximises the probability of encountering nesting females. The census is a complete count of females for a 2 week (or longer) period to give the mean number of females nesting per night. Since the period of highest density is known, a mid-season Census should be undertaken for a minimum two-week period during the period of highest density nesting, to maximise the sighting probability. The intensive survey consists of a complete count of nesting activities.

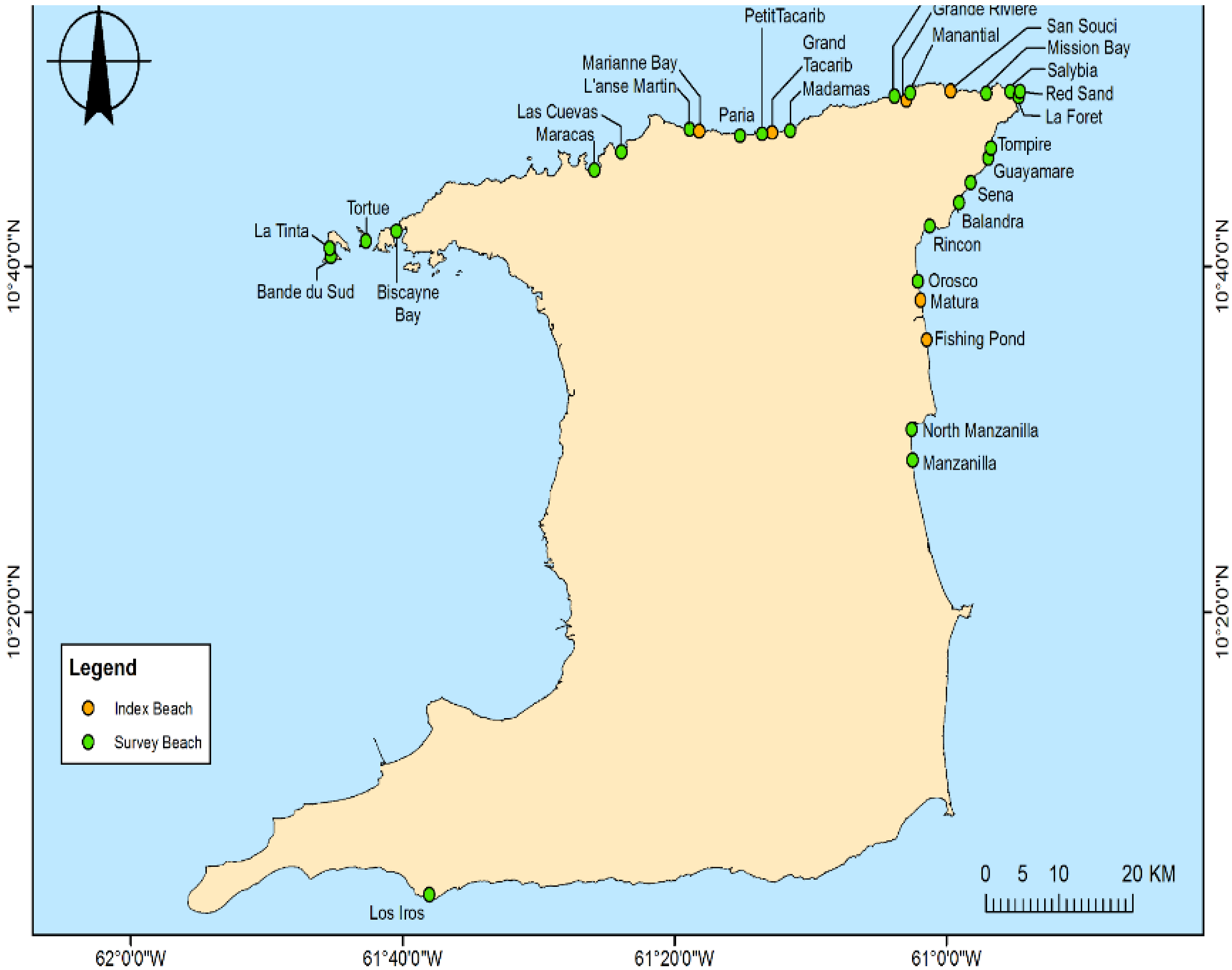
Profile of Sea Turtle Nesting Beaches

Based on the data collected, each site was evaluated by the Species Nesting, the Level of Nesting and Accessibility. This assessment is critical when determining the extent of allocated monitoring coverage and the timing of this coverage.

The assessment was conducted in consultation with the community groups, Department of Natural Resources Tobago (DNRE), Environmental Management Authority (EMA), Institute of Marine Affairs (IMA) and the Forestry Division is listed in the tables below. The assessment for each of the Nesting Beach in Trinidad and Tobago identifies the Primary and Secondary Species Nesting, the Nesting beach Designation and Access.

Trinidad:

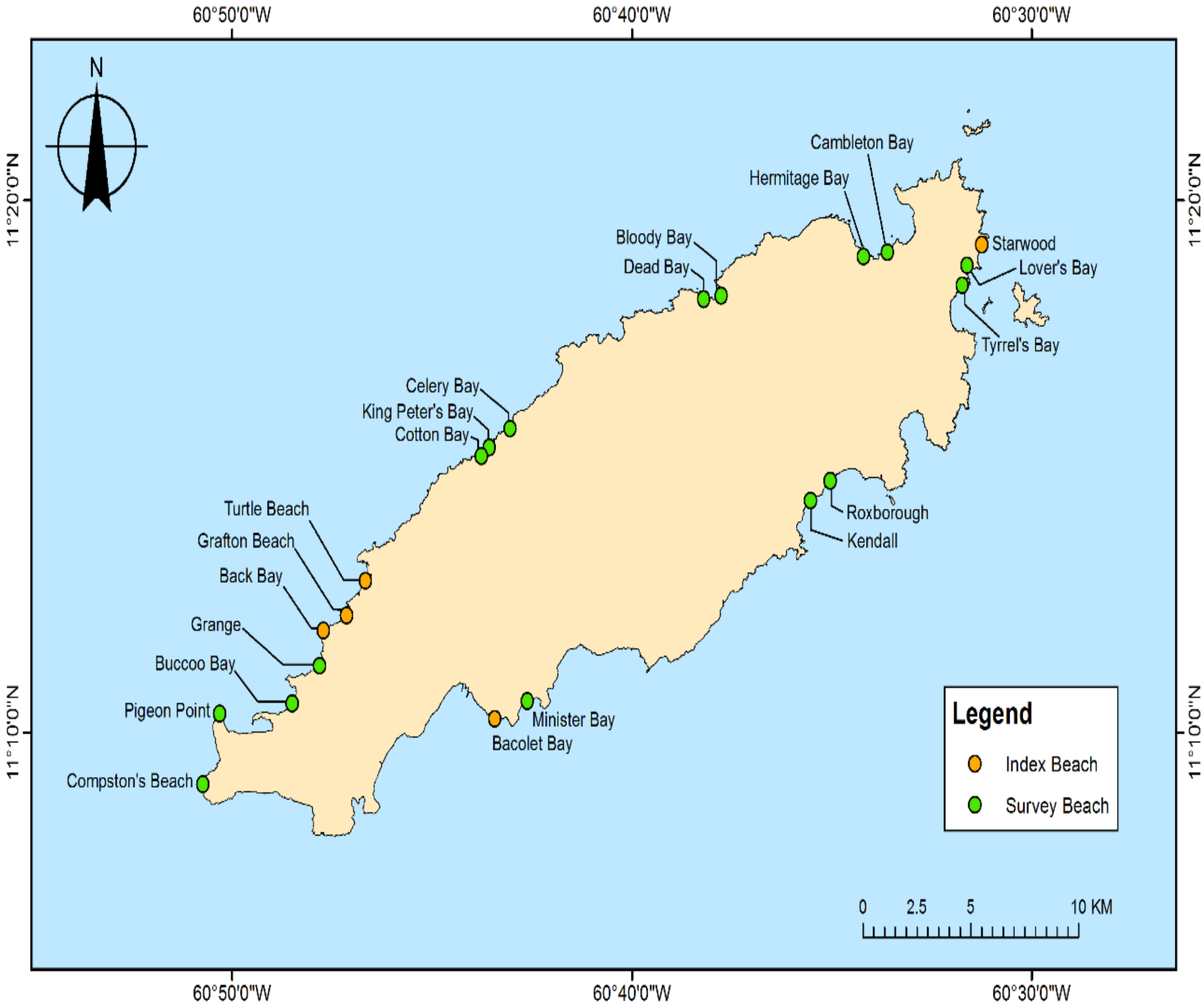
Figure 1 Index and Key Nesting Sites in Trinidad



Nesting Beach	Species Designation		Nesting Designation		Access
	Primary Species Nesting	Secondary Species Nesting	Index Beach	Key Nesting Rookery	Remote
Trinidad					
Bande du sud, Chacachacare	HWK	GRN	y		y
La Tinta, Chacachacare	HWK	GRN		y	y
Tortue Bay, Huevos	HWK	GRN	y		y
Biscayen Bay, Monos	HWK	GRN		y	y
Maracas					
Las Cuevas Beach	LBK	HWK		y	
La Payalle (Las Cuevas)	LBK	HWK			
L'anse Martin/ Yara/ Damian (Blanchisseuse)	LBK	HWK			
Marianne Bay, Blanchisseuse	LBK	HWK		y	
Paria	LBK	HWK	y		y
Petit Tacarib	LBK	HWK			y
Grande Tacarib	LBK	HWK	y		y
Madamas	LBK	HWK	y		y
Homard	HWK/GRN	LBK			
Grande Riviere	LBK	HWK/ GRN	y		
Manantial	HWK	GRN			y
Charama (North Manzanilla)	LBK	HWK/ GRN		y	
Lysae (North Manzanilla)	HWK	LBK/ GRN		y	
Manzanilla/ Cocal Bay/ Bell Piece	LBK	HWK/ GRN	y		
Fishing Pond	LBK	Mixed	y		
Orosco (Matura)	LBK	HWK/ GRN	y		
Rincon (Matura)	LBK	HWK	y		
Textel (Matura)					
Balandra Beach	HWK			y	
Sena Bay	LBK	HWK		y	
Guayamare	LBK	HWK/GRN			
Tompire	LBK	HWK			
Red Sand (Toco)	HWK				
Salybia (Toco)	HWK	LBK			
La Foret (Toco)	HWK			y	
Patience (Toco)	HWK	GRN		y	
Mission	HWK	LBK			
San Souci Beach	HWK	LBK		y	
Big Bay, San Souci	LBK	HWK	y		
Mayaro/ Guayaguayare	HWK	LBK			

Tobago:

Figure 2 Index and Key Nesting Sites in Tobago



Nesting Beach	Species Designation		Nesting Designation		Access
	Primary Species Nesting	Secondary Species Nesting	Index Beach	Key Nesting Rookery	Remote
Tobago					
Turtle Beach (Great Courland)	LBK	HWK	y		
Grafton (Stonehaven Bay)	LBK	HWK	y		
Back Bay, Mt Irvine	LBK	HWK/ LOG	y		
Grange	LBK	HWK/ GRN			
Buccoo Bay	HWK	GRN		y	
Pigeon Point	HWK			y	
Compston's Beach	HWK			y	
Lambeau (Magdalena)	HWK			y	
Bacolet- Minister's Bay	HWK	LBK		y	
Hope	LBK				
Goldsborough/ Richmond	LBK	HWK			
Big Bay (Moriah)	LBK	HWK		y	y
Arnos Vale/ Anse Fromager/ Little Bay/ Celery (Moriah)	HWK	GRN			
King Peter's Bay; (Moriah)	HWK	GRN		y	y
Roxborough	LBK	HWK			
Kendal	LBK	HWK			
Star Wood (Speyside)	HWK	GRN			y
Speyside (Lover's Bay, Bateaux)	HWK	LBK			
Speyside (Tyrell's, Lucy Vale)	HWK	LBK		y	
Charlotteville (Man-O-War)	HWK	LBK			
Dead Bay	LBK	HWK		y	y
L'Anse Fourmi	HWK	GRN		y	
Bloody Bay	LBK	HWK			y
Hermitage	HWK	GRN	y		y
Pirate's Bay	LBK	HWK			y
Cambleton	HWK/ GRN	LBK	y		y
Iguana	HWK			y	y
Castara					
Englishman's Bay					

Climate Change

Beach morphologies are in constant transition but known patterns and cycles are transforming on account of more intense climatic changes. Beaches are experiencing higher erosion/accretion rates which then affect the carrying capacity of each site, affecting hatchling success, there is also a change in sediment compositions on beaches which would result in sand temperature changes affecting the sex ratios of hatchlings or a change in nesting species distribution. Vegetation along beaches is also being impacted, increasing erosion and possibly changing nesting species distributions.

Higher incubation temperatures of sea turtle nests results in more female turtle offspring. Incubation temperatures above a threshold can lead to embryonic mortality and decreased hatching success. The effect of increased atmospheric greenhouse gas concentrations has been increased global average temperatures, at a rate of 0.2°C per decade for the last 30 years. The resulting higher sand and nest temperatures along with increased global sea surface temperatures, ocean acidification levels and increased sea levels, will directly impact the reproductive patterns of sea turtles.

Monitoring beach and nest temperatures over time in different locations, can be used in conjunction with estimates of nest success and sex ratios of hatchlings produced to describe and predict the potential impact of climate change.

The projected increases in global temperatures influencing sex ratios in sea turtle populations, will result in fewer male offspring and the population will become increasingly female-biased. It is possible that low numbers of males would result in reduced fertilisation capacity and loss of genetic variation.

If temperatures exceed the upper lethal temperature threshold, egg mortality will lead to decreased population size.

The risk of rising temperature increases the likelihood for population extinction. Sea turtles will be forced to make behavioural adaptations to this including nesting in areas shaded with vegetative cover, expanding their nesting range to cooler beaches or shifting the timing of nesting to cooler months.

Temperature Profiling

Nesting female turtles do not exhibit care to their offspring after laying eggs. The array of factors for site selection by a nesting female for laying of a clutch is not fully understood. The nesting beach is the incubator for egg clutches and its physical characteristics must provide a suitable microclimate for embryonic development. Successful nest incubation relies on the presence of suitable conditions in the beach sand; temperature, humidity, salinity and levels of respiratory gases (O_2 and CO_2).

Beach temperature is determined by the exchange of thermal energy of the sand surface with the local climate and then the transmission of heat through the sand column. Patterns of change in beach temperatures reflect the physical characteristics of the beach and the local climatic conditions. The sand temperature at nest depth is determined by the rate at which heat is transmitted through the sand grains and water. The colour, particle size and moisture content affect the extent and rate in which the heat is transferred from the sand at the surface to the sand at nest depth.

Nest temperatures are influenced by several factors including nest location within the beach, nest depth and extent of shading or vegetative cover.

Sea turtle eggs incubate within a thermal tolerance range, with the lower lethal temperature of 25°C and the upper lethal temperature of 35°C. Incubating temperature influences the expression of sex genes within developing embryos during the middle third of the incubation period.

During embryonic development within the nest, genes become activated which determine whether male or female gonadal development occurs and are linked with the environmental temperature within the nest. There is a pivotal temperature in which the nest produces male turtles to female turtles in a ratio of 1:1. Cooler temperatures will result in more males while higher temperatures result in more female turtles.

Table 1 PIVOTAL INCUBATION TEMPERATURE FOR SEA TURTLE SPECIES IN WHICH 50% FEMALE AND 50% MALE HATCHLINGS ARE PRODUCED

Sea Turtle Species	Pivotal Incubation Temperature	Source
Green	29.2°C - 29.3°C	*(Godfrey and Mrosovsky 2006)*
Hawksbill	29.2 °C	*(Mrosovsky et al. 1992)*
Leatherback	29.5°C	*(Furler 2005)*
Loggerhead	29.3 °C	*(Mrosovsky et al. 2002)*
Olive Ridley	30.7°C	*(Casthelоge et al. 2018)*

Pivotal temperatures have largely been derived from laboratory incubation of eggs from different species and populations. There is no historical data on the pivotal temperature from *in situ* nests on beaches in Trinidad and Tobago.

Genetic studies

Sea turtles' life cycle involves complex migrations through oceanic waters and coastal foraging habitats traversing geopolitical boundaries and thus management jurisdictions. Genetic studies can be used in differentiating biologically distinct populations (population boundaries) and describing the connectivity between nesting rookeries and foraging grounds (migratory connectivity).

The taxonomy of marine turtles is now well-established based on nuclear and mitochondrial genes and complex population structures are enlightened by population genetic and phylogeographic studies.

Genetic and genomic studies are key to inform the designation of conservation units- Evolutionary Significant Units, Distinct populations Segments and Regional Management Units. Trinidad and Tobago data is limited but sampling coverage of Greens and Leatherbacks within the Atlantic are considered data sufficient for analysis and designation of conservation units. There are sampling gaps for the Hawksbills regionally which have limited the designation of conservation units. Improved sampling efforts are required to increase the power of analyses to detect population structure and define the population boundaries.

Genetic fingerprinting can be used to describe the relatively unknown male component of the sea turtle population. The Breeding Sex Ratio is important to understand and monitor over time as it provides insight into how risks of climate change can effect change to populations over time.

To determine genetic populations, mitochondrial DNA (mtDNA) is typically used as maternal DNA is conserved between generations as opposed to genomic DNA. The relative mixing of mtDNA haplotypes can be ascertained and the identification of maternal aggregations.

The effect of increased atmospheric greenhouse gas concentrations has been an increased global average temperatures. The resulting higher sand and nest will directly impact the reproductive patterns of sea turtles since higher incubation temperatures will result in more female hatchlings. Understanding how female-biased clutches of hatchlings translates to adult sex ratios over time is important for understanding the risks of climate change to the nesting population.

Sea turtles, like other reptiles, are dependent on temperature to determine gender – a phenomenon called temperature dependent sex determination (TSD). At the start of gonadal development (known as bipotential gonads), several genes are known to become active in preparation of specific cell-type precursors that support either female or male ducts and organs. The relative expression of four genes within a clutch gives an indication as to the ratio of female and male hatchlings which will result.

The Sea Turtle Recovery Action Plan for the Republic of Trinidad and Tobago (STRAP) recommends two research activities to be pursued as part of the National Sea Turtle Conservation Programme:

"that genetic research be conducted to define the genotypes comprising nesting and foraging populations, and how these relate to populations elsewhere in the region."

*"*Using genetic research, determine stock origin for all major nesting and foraging assemblages in Trinidad and Tobago. Collaborate with experts in sampling and interpretation; publish results."

Nesting Beach Monitoring

Nesting Beach Monitoring provides a physical presence of community team members on beaches at the time of nesting. Community persons that are engaged to undertake monitoring have no enforcement responsibility for sea turtle protection and risking their own safety. While this is so, the very presence of these committed persons act as a deterrent to poaching and other activities which endanger turtles. While there is no historical data to quantify the extent of poaching activities, apart from accounts of community persons and groups working on the beaches, they all agree that their presence as part of the National Sea Turtle Conservation Project and also the Education and Awareness activities executed by our trained community Tour Guides has attributed to reduction and in some cases elimination of poaching activity at nesting sites. (see Poaching Report)

Throughout the National Sea Turtle Conservation Project our nocturnal beach monitoring involved collection of morphometric information as well as the documentation of mortality sources and tagging of nesting turtles, assessment of population trends and behavioural patterns, supervision of eco-tourism and education of the public.

The nesting beaches are assigned teams of community persons based on the size of the beach and the number of turtles expected (based on the past records of turtle sighting). The main goal is to identify all females that used the beach over the monitoring period and record all nests made by each female. When nesting turtles are found, trained community team members follow standard protocols for collecting data on the beach zone, date, time, weather, species and activity of the turtles and tagging where appropriate. All such information is recorded on a standard data sheet. These standard protocols and procedures were developed and compiled in a booklet “Taggers Training Manual” under Phase 1 of the Green Fund National Sea Turtle Conservation Programme. This was made available to all community groups and is used as resource materials to facilitate training by TVT and the various community conservation groups.

Table 2 MONITORING DISTANCES OF KEY NESTING SITES

Beach	Distance monitored/ km	Beach	Distance monitored/ km
Fishing Pond	10.46	Turtle Beach	1.76
Grande Riviere	1.6	Grafton	0.92
Matura (Rincon & Orosco)	12.8	Back Bay, Mount Irvine	0.44
Bande du Sud, Chacachacare Island	0.75	Hermitage	0.2
La Foret	0.14	Cambleton	0.16
Tortue Bay, Huevos Island	0.14	King Peter's Bay	0.43
Big Bay - Sans Souci	3	Minister's Bay	1.2
Grand Tacarib	2	Belle Garden	0.45
Manzanilla	9	Cotton Bay (Big Bay) - Moriah	0.14
Marianne Bay	2	Buccoo	1.4
Sans Souci	0.4	Goodwood Bay	0.2
Las Cuevas	2.2	Goldsborough	0.8
Madamas	0.5	Man-o-War	0.4
Paria	1.5	Crompston's Bay	0.4
Sans Souci	0.4	Dead Bay	0.06
Las Cuevas	2.2	Grange	0.08
Madamas	0.5	Crompston's Bay	0.4
Paria	1.5	Dead Bay	0.06
Sans Souci	0.4	Lambeau	2
La Foret	0.14	Lambeau (Magdalena Hotel)	0.25
North Manzanilla: Charama & Lysae	0.37	L'Anse Fourmi	0.1
Guayamare	0.7	Lovers Bay	0.15
Mission	0.3	Lucy Vale Bay	0.17
Patience	0.5	Pigeon Point	0.8
Salybia	0.7	Roxborough	0.5
Tompire	0.8	Star Wood	0.2
Biscayen Bay, Monos Island	0.12	Tyrrel Bay	0.58
Balandra	0.6		
Maracas	1.6		
Morris Bay, Monos Island	0.1		
Red Sand	0.15		
Sena	1		

Turtles that successfully excavate a nest chamber and deposit their eggs are measured (length and width of carapace in centimetres), checked for physical damage or distinct markings, their flipper tags read and recorded and passive-integrated transponder (PIT) tags scanned and recorded from each turtle's shoulder or neck area. If flipper or PIT tags are not present, the data collectors/ patrollers would fit these to the turtle. Tags allow for the unique identification of individuals and therefore analysis of their individual nesting history and the national population estimation. Patrollers remain with the turtle to confirm the nesting event outcome. The numbers of persons present at the nesting event are also recorded and whether or not the turtle was disturbed by the presence or activities of persons and artificial lighting.

While every effort is made to witness all nesting activities, turtles are occasionally missed. This might be because the number of data collectors/ taggers engaged cannot physically cover the nesting site or the personnel remained with a nesting turtle until she returns to the sea for her protection or when several turtles emerged simultaneously, data collection on one may cause another to be missed. To compensate for this morning counts are factored into the Project's onshore activities.

METHODOLOGY, DATA COLLECTION & ANALYSIS

Nesting Beach Temperature Profiling

METHODOLOGY

To get a better understanding of variances in temperature on nesting beaches in Trinidad and Tobago, data was collected during the period of August 2013 and December 2018, from five beaches (Hermitage in Tobago; Grande Riviere; Matura; Tortue Bay in Huevos and Bande du Sud in Chacachacare) and analysed.

The Data Loggers collected data for a minimum of 56 and a maximum of 145 days and were programmed to collect temperature data at timed intervals (20- 60 min) in their respective sites. On Hermitage, Grande Riviere, Rincon data loggers were placed in Hawksbill nest clutches during laying, at the assumed middle of the clutch, approximately 40cm. The female Hawksbill was allowed to nest unaffected. At hatchling emergence or up to 7 days post-hatching the data loggers were exhumed.

Loggers at Tortue Bay and Bande du Sud were not placed in incubating nests. These were buried at the average mid-clutch nest depth (40cm) as well as 60cm and 20cm. Note was made of the site conditions specifically sun exposure. At Tortue Bay, a temperature data logger was tied to a densely leafed tree in the vegetated area (shade) and another tied to the trunk of a dead coconut tree to provide local atmospheric temperature. It was assumed that there was no diel variation in the proportion of sun exposure during daylight hours.

DATA COLLECTION & ANALYSIS

The data from the sites were analysed based on geographic location. Beach and site mean monthly temperatures were calculated by summing the mean daily sand temperature (at each depth) for each month.

Tobago Temperature Profiles

a) **Hermitage Tobago**

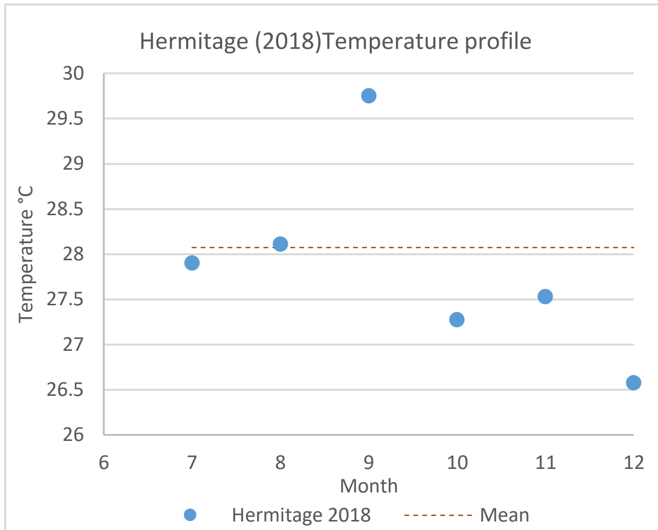


Table 3 *TEMPERATURE PROFILES FOR HERMITAGE 2018*

	TEMPERATURE PROFILE
No. of temperature samples	3499
Max (°C)	31.57
Min (°C)	24.35
Mean (°C)	28.07 ±1.27
Start	13/07/18 05:17:27AM
End	05/12/18 11:17:27PM
Days	145

All temperatures reported in Hermitage in 2018 were within the lethal threshold 25°C - 35°C.

Mean temperature was 0.1°C less than the pivotal temperature for 1:1 sex ratios of Hawksbill sea turtles. All mean monthly temperatures were above the pivotal temperatures for 1:1 sex ratios of Hawksbill sea turtles.

Sex ratios of hatchlings produced at this location would be skewed to females.

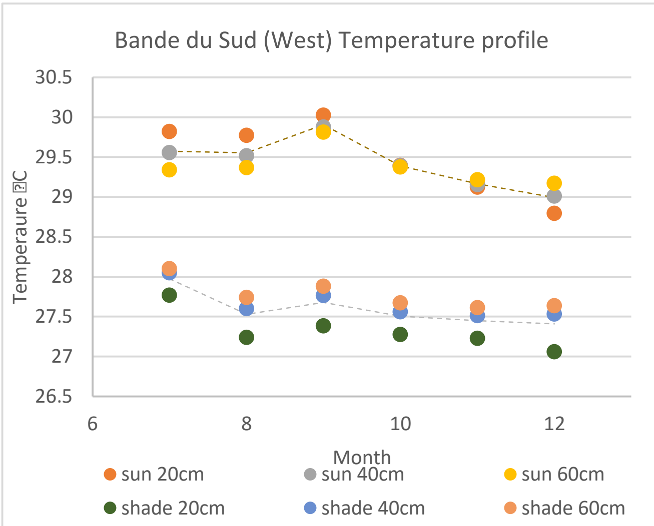
Trinidad Temperature Profiles

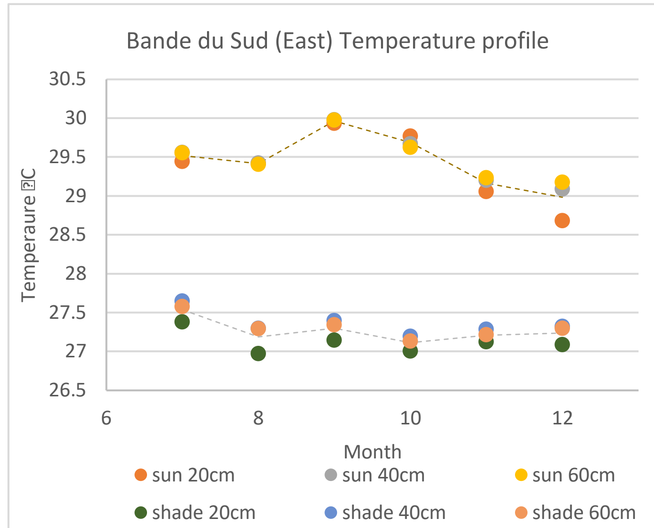
- NORTH-WEST PENINSULA, TRINIDAD

a) Bande du Sud, Chacachacare

Table 4 *TEMPERATURE PROFILES FOR BANDE DU SUD 2018*

		TEMPERATURE PROFILES								
		WEST					EAST			
			20cm	40cm	60cm			20cm	40cm	60cm
SUN	No. of temperature samples	9870	3290	3290	3290		9873	3291	3291	3291
	Max (°C)	36.40	36.40	32.91	30.96		34.59	34.59	31.27	30.96
	Min (°C)	26.10	26.10	27.08	27.96		26.59	26.59	27.96	28.36
	Mean (°C)	29.48	29.55	29.46	29.42		29.53	29.50	29.55	29.55
	Std Dev	1.12	1.59	0.96	0.56		0.89	1.28	0.65	0.54
	Start	22/07/2018 13:49					22/07/2018 11:36 AM			
	End	06/12/2018 14:51					06/12/2018 1:37 PM			
	Days	138					138			
			20cm	40cm	60cm			20cm	40cm	60cm
SHADE	No. of temperature samples	9876	3292	3292	3292		9873	3291	3291	3291
	Max (°C)	28.56	28.26	28.46	28.56		28.66	28.66	28.36	27.76
	Min (°C)	25.61	25.61	26.78	27.17		25.81	25.81	26.59	26.68
	Mean (°C)	27.56	27.47	27.64	27.75		27.23	27.08	27.32	27.27
	Std Dev	0.39	0.45	0.30	0.25		0.36	0.46	0.29	0.23
	Start	22/07/2018 11:36					22/07/2018 11:38 AM			
	End	06/12/2018 13:37					06/12/2018 1:38 PM			
	Days	138					138			





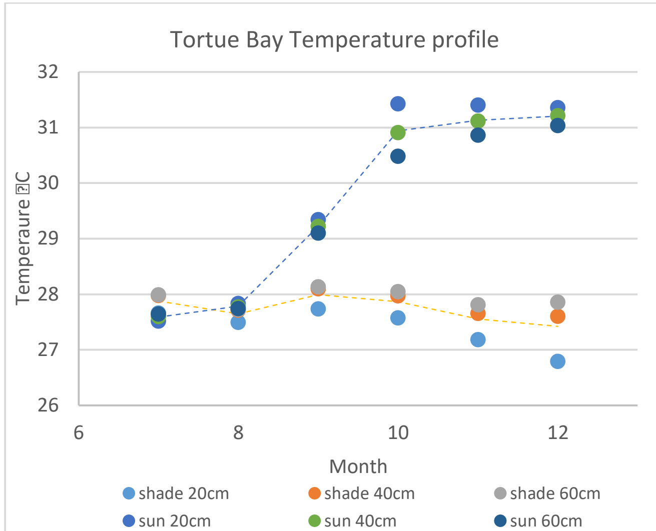
Mean monthly temperatures in shaded locations were all lower than pivotal temperatures for 1:1 sex ratios of all species. Sex ratios of nests in these locations would be skewed to male hatchling production.

Mean monthly temperatures in in sun exposed locations were all higher than pivotal temperatures for 1:1 sex ratios in Hawksbill sea turtles which are the nesting species at that location. Sex ratios of nests in these conditions would be skewed to female hatchling production.

The West of the beach and also the 20cm depth showed the highest variability with the highest temperature recorded was West sun 36.40°C while the lowest temperature recorded was West shaded at 25.61°C.

Mean monthly temperatures decreased from July to December. There was a spike in mean monthly temperatures at all locations in September.

b) Tortue Bay, Huevos



All temperatures reported for Tortue Bay, Huevos in 2018 were within the lethal threshold 25°C - 35°C.

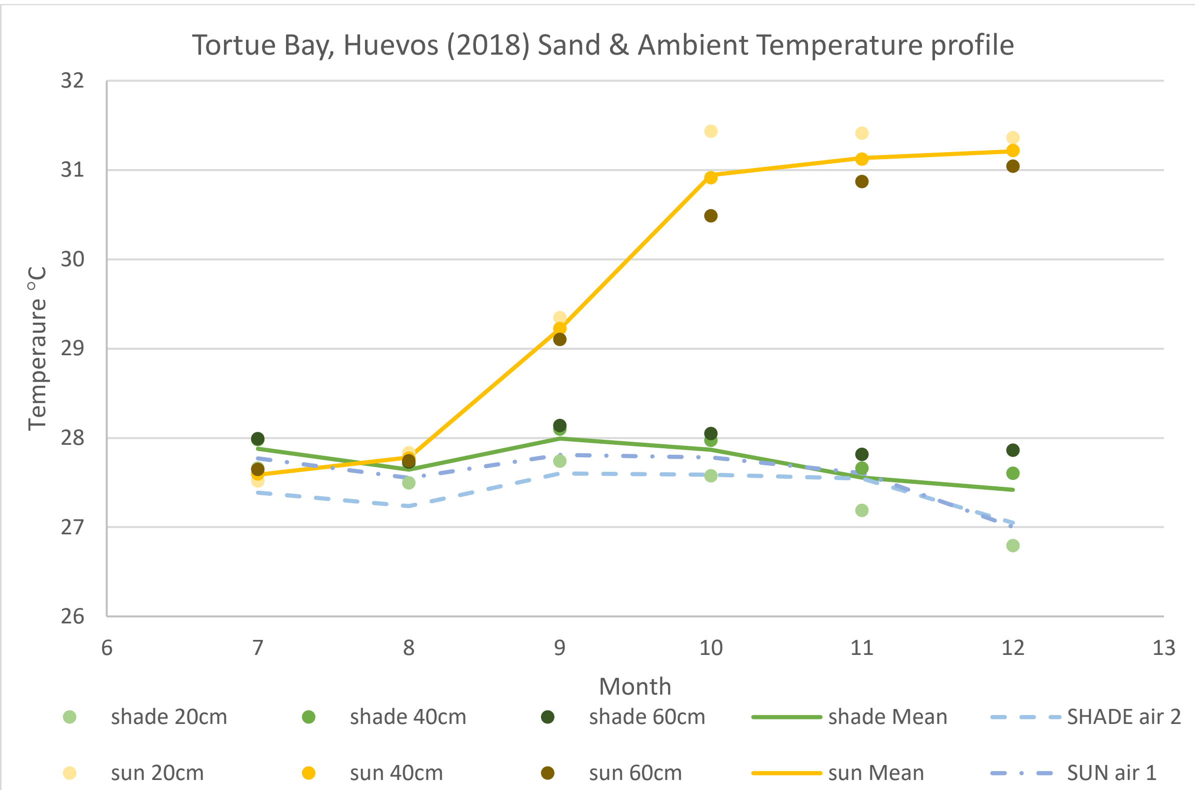
Mean monthly temperatures under shade conditions and from July to September in the sun exposed location were all lower than pivotal temperatures for 1:1 sex ratios of all species. Sex ratios of nests in these conditions would be skewed to male hatchling production.

Mean monthly temperatures in the sun exposed location from October to December were all higher than pivotal temperatures for 1:1 sex ratios in Hawksbill sea turtles. Sex ratios of nests in these months would be skewed to female hatchling production.

Table 5 *TEMPERATURE PROFILES FOR TORTUE BAY, HUEVOS 2018*

		TEMPERATURE PROFILES (°C)					
		JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER
	Depth	7	8	9	10	11	12
SHADE	20cm	27.66	27.49	27.74	27.58	27.19	26.80
	40cm	27.98	27.71	28.10	27.97	27.66	27.61
	60cm	27.99	27.73	28.14	28.05	27.82	27.86
	Mean	27.88	27.65	27.99	27.87	27.55	27.42
	air 2	27.39	27.24	27.60	27.59	27.54	27.05
	Depth	7	8	9	10	11	12

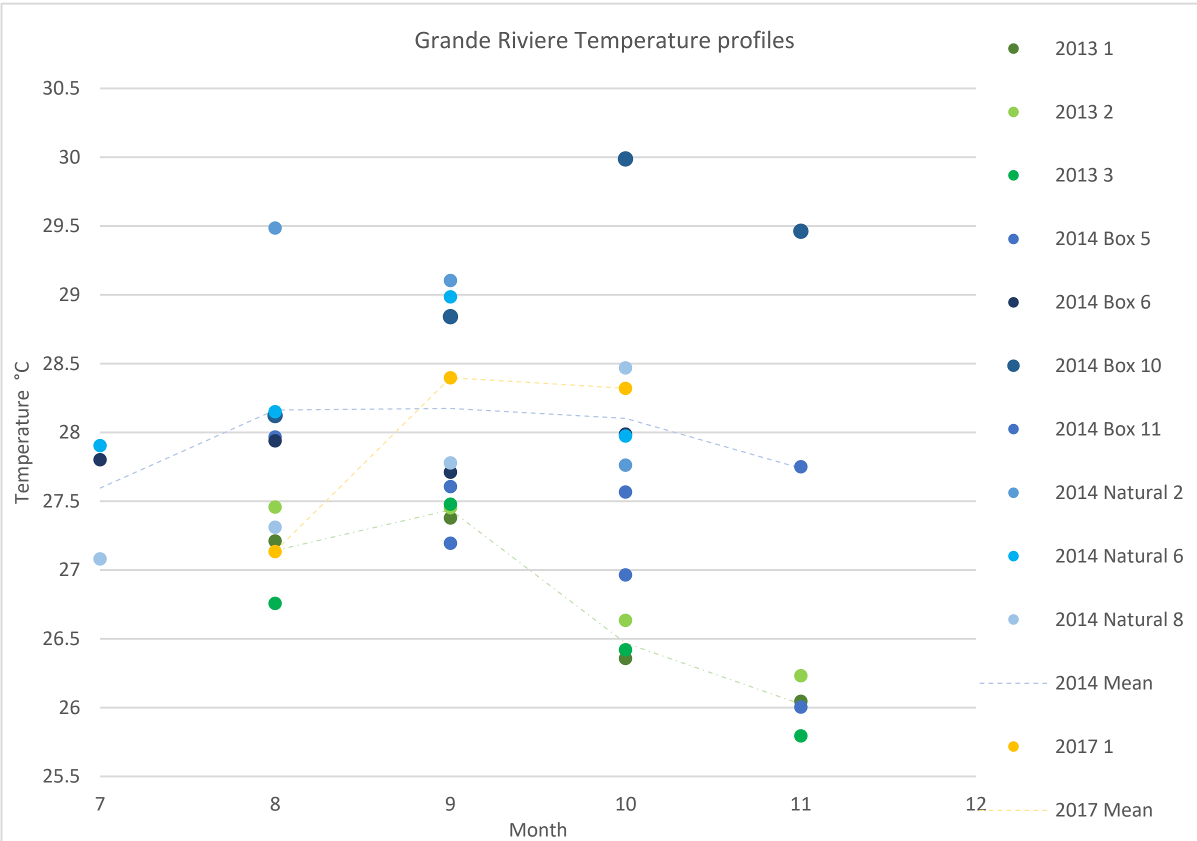
SUN	20cm	27.52	27.83	29.35	31.43	31.41	31.36
	40cm	27.60	27.77	29.22	30.91	31.12	31.22
	60cm	27.65	27.74	29.10	30.49	30.87	31.04
	Mean	27.59	27.78	29.22	30.94	31.13	31.21
	air 1	27.77	27.55	27.81	27.78	27.61	27.00



Temperature data loggers at Tortue Bay, Huevos recorded temperature profiles for all beach conditions (sun, shade), at varied sand depths (Hawksbill average nest depth- at surface (20cm), mid-nest (40cm) and maximum nest depth (60cm)) and also ambient air temperature for the period July to December 2018.

- NORTH-EAST, TRINIDAD

a) Grande Riviere



Mean monthly temperatures in Grande Riviere for 2013, 2014 and 2017 were all lower than pivotal temperatures for 1:1 sex ratios of all species.

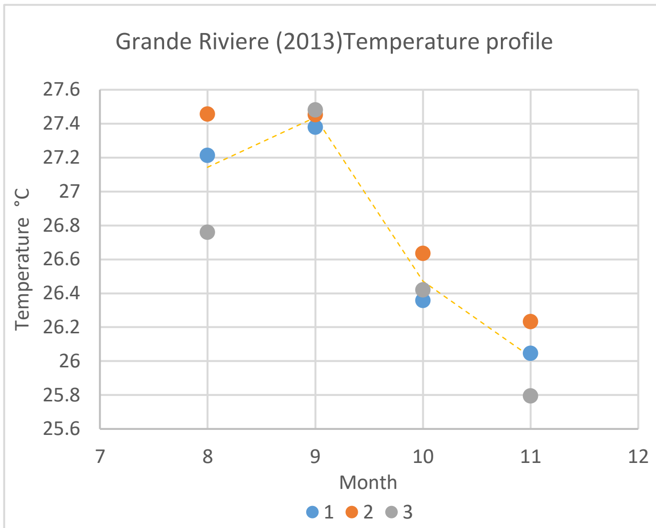
Mean monthly temperatures in Grande Riviere for 2013 was lower than mean monthly temperatures in 2014 and 2017.

Highest temperature recorded in Grande Riviere was October 2014 at 38.49°C while the lowest temperature recorded was August 2014 at 22.53°C.

Table 6 *TEMPERATURE PROFILES FOR GRANDE RIVIERE 2013-2017*

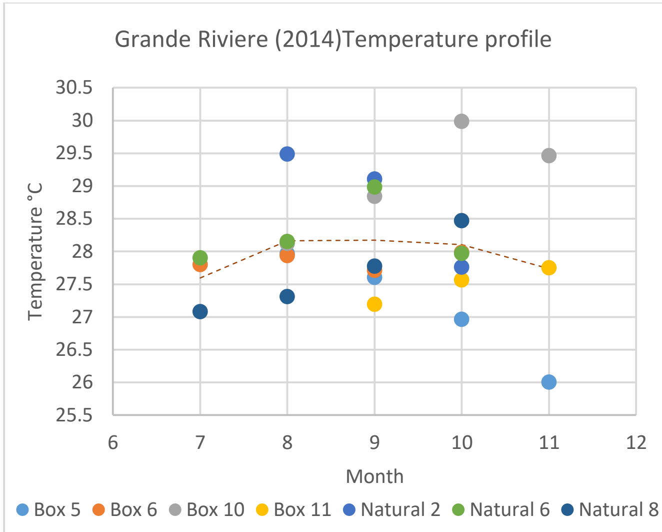
YEAR		TEMPERATURE PROFILES						
		1	2	3				
2013	No. of samples	5854	5853	5914				
	Max (°C)	32.70	32.50	33.64				
	Min (°C)	24.16	24.93	24.74				
	Mean (°C)	26.68	26.86	26.70				
	Std Dev	0.94	0.75	0.87				
	Start	29/08/13 03:02:58	29/08/13 02:56:14	29/08/13 03:25:00				
	End	18/11/13 09:53:38	18/11/13 09:36:14	18/11/13 09:36:14				
	Days	82	82	82				
2014		Box 5	Box 6	Box 10	Box 11	Natural 2	Natural 6	Natural 8
	No. of samples	6063	6055	6226	4437	5376	5659	6246
	Max (°C)	33.01	32.91	33.54	31.68	38.49	35.12	34.37
	Min (°C)	22.53	23.87	24.45	24.26	24.45	23.58	24.74
	Mean (°C)	27.35	27.86	29.06	27.48	28.99	28.43	27.73
	Std Dev	1.84	1.13	1.67	0.96	1.19	1.22	0.93
	Start	22/08/2013 17:20	27/07/2014 14:44	07/08/2014 11:11	03/09/2014 21:54	15/08/2013 12:23	26/07/2014 19:48	26/07/2014 7:48
	End	02/11/2013 6:54	19/10/2014 16:44	01/11/2014 10:11	19/11/2014 23:28	10/10/2013 12:08	13/10/2014 9:48	21/10/2014 13:28
	Days	72	84	86	77	56	79	87
2017		1						
	No. of samples	6216						
	Max (°C)	32.807						
	Min (°C)	25.416						
	Mean (°C)	27.93294981						

	Std Dev	0.997401034
	Start	01/08/2017 18:59
	End	27/10/2017 4:23
	Days	87



Mean monthly temperatures in Grande Riviere for 2013 were lower than pivotal temperatures for 1:1 sex ratios of all species.

All profiles sampled in 2013 recorded temperatures below lethal threshold 25°C. None of the profiles reported temperatures above lethal threshold 35°C. Maximum temperature recorded was 33.64°C.



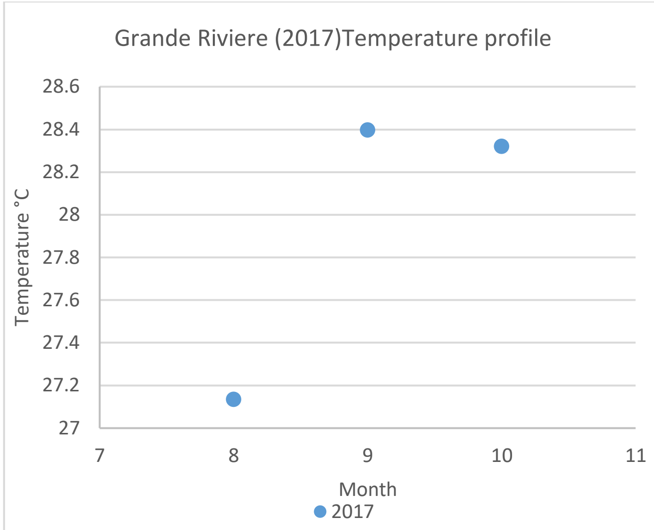
Mean monthly temperatures in Grande Riviere for 2014 were lower than pivotal temperatures for 1:1 sex ratios of all species.

Hatchery boxes were found to have less extreme temperature fluctuations than natural *in situ* beach locations.

All sampled locations recorded temperatures below lethal threshold 25°C. Box 5 reported the lowest minimum temperature in 2014 at 22.525°C and also recorded temperatures below lethal threshold for the entire monitoring period August to November 2014.

Natural sites 2 and 6 reported temperatures above lethal threshold 35°C. Both sites recorded high temperatures in October and Natural 2 also recorded lethal high temperature in August 2014. Natural 2 reported the highest maximum temperature in 2014 at 38.49°C.

Box temperatures, except Box 10, were lower than the mean monthly temperature. Boxes therefore have the greater potential for skews towards male hatchlings.



Mean monthly temperature in Grande Riviere for 2017 was lower than pivotal temperatures for 1:1 sex ratios of all species.

The sampled location recorded temperatures within the lethal threshold 25°C - 35°C.

b) Rincon, Matura

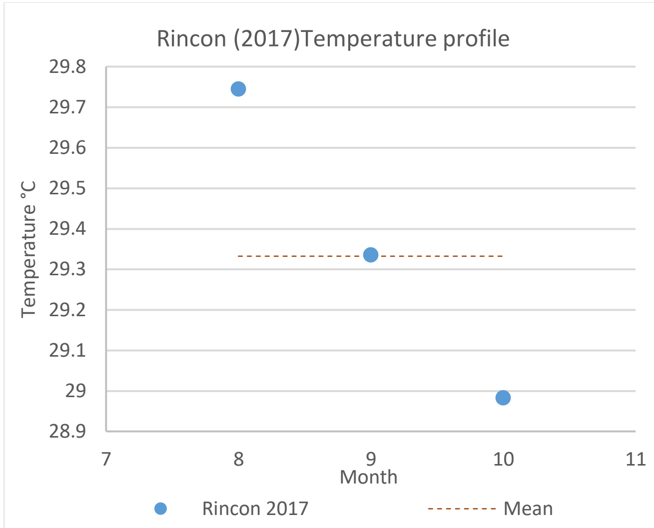


Table 7 *TEMPERATURE PROFILES FOR RINCON 2018 (27.47-31.17)*

	TEMPERATURE PROFILE
No. of temperature samples	4672
Max (°C)	31.17
Min (°C)	27.47
Mean (°C)	29.33 ±0.78
Start	16/08/17 02:45:57AM
End	19/10/17 11:45:57PM
Days	64

All temperatures reported in Rincon in 2018 were within the lethal threshold 25°C - 35°C.

Mean temperature was 0.1°C than the pivotal temperatures for 1:1 sex ratios of Hawksbill sea turtles. All mean monthly temperatures were above the pivotal temperatures for 1:1 sex ratios of Hawksbill sea turtles.

Sex ratios of hatchlings produced at this location would be skewed to females.

Sea Turtle Nesting Data

METHODOLOGY

DATA COLLECTION AND TAGGING

Nocturnal beach patrols involve tagging of nesting turtles, collection of morphometric information as well as the documentation of mortality sources, assessment of nesting trends and behavioural patterns, supervision of eco-tourism and education of the public.

Patrols operate on average time from 7:00pm and end around 3:00am. Morning counts are conducted in the early dawn period when the shadows made by nests and disturbed sand are more easily viewed.

The monitoring effort is achieved by patrol teams, the numbers of teams are based on the size of the beach and the number of turtles expected (based on the past records of turtle sighting). When nesting turtles are found, trained patrol members follow the standard protocols for tagging the turtles and collecting data on the beach, zone, landmark, date, time, weather, species and activity. All such information is recorded on a standard data sheet.

Turtles that successfully excavate a nest chamber and deposit their eggs are measured (length and width of carapace in centimetres), checked for physical damage or distinct markings, their flipper tags read and recorded and passive-integrated transponder (PIT) tags scanned and recorded from each turtle's shoulder or neck area. If flipper or PIT tags are not present, patrollers would fit these to the turtle. Tags allow for the unique identification of individuals and therefore analysis of their individual nesting history and the national population estimation. Patrollers remain with the turtle to confirm the nesting event outcome. The numbers of persons present at the nesting event are also recorded and whether or not the turtle was disturbed by the presence or activities of persons and artificial lighting.

MORNING COUNT AND CENSUS MONITORING

Since an accurate and complete count of uniquely identified females is often logistically and financially demanding, count types can be used as proxies for total population abundance. Counts of the number of nesting events (crawls, tracks, body pits) are also sufficient to estimate the abundance and trends over time once the monitoring protocol is sufficient and consistent over time. Counts can be converted using specific formulas and with additional data to give estimates of abundance. Important to note, conversion factors introduce additional error to abundance estimates.

While every effort is made to witness all nesting activities, turtles are occasionally missed. This might be because taggers remained with a nesting turtle until she returns to the sea for her protection or when several turtles emerged simultaneously, data collection on one may cause another to be missed. High density nesting sites have more nesting events than can be individually witnessed so a Census Count is used. Nesting outside of the patrol hours, including the occasional daytime nesting event, could also be missed. The individual female would not be identified in these instances but the tracks could be identified to species and recorded.

Nest counts are done on all high-density nesting beaches at least every 48 hours. Any indication of turtle activity is documented and characterised by species and the estimated outcome eg. egg-laying or false crawl. These counts are advised to be conducted in the early dawn period (4 to 8am) when the shadows made by nests and disturbed sand are more easily viewed and are thus termed Morning Counts.

NEST EXCAVATION AND HATCHING SUCCESS

Nests are excavated 70 days after incubation or up to 5 days after emergence. Nests which are marked or triangulated at nesting are monitored 45 to 70 days after nesting for emergence activity. If no emergence occurs, the contents of the nest are exhumed 70 days later by relocating the nest using triangulation markers and measurements. A count of eggs deposited at the time of laying is needed to evaluate these nests properly.

Once determined that a nest has emerged, by seeing hatchlings or finding the hatchling tracks, the emergence location has to be identified. Tracing the tracks back to their source, being careful not to walk on any of the tracks which will disguise them, is the easiest was to locate the nest. This nest can be marked for future exhumation in the daylight hours, if emergence occurs at night.

The emergence location is usually a bowl-shaped depression, approximately 8 inches in diameter that usually has all tracks departing in a fan-shaped pattern away from the depression and generally toward the sea. It is not always possible to detect individual tracks but the depression will remain. The sand around the depression is usually more firm so probing with fingers or digging in the depression can help determine if it is the emergence location.

Digging up nests of Leatherbacks is often more challenging than other species, since the average depth of a Leatherback nest is 70 cm. Leatherback beaches are often quite uneven due to the large body pit left by the turtle after nesting and such beach disturbance often makes finding the emergence site difficult.

Latex examination gloves are not optimal as they are too fragile and sand is so abrasive. Rubber dishwashing gloves are better suited and can be scrubbed clean with sand and sea water after the excavation and re-used. Digging into the nest is done in a manner very similar to the method used by the turtle in creating a nesting cavity. Initially a single vertical hole about the width of one hand is dug directly to the egg chamber. Once eggs are encountered at the top of the nest, the hole can be gradually widened by running the hand around the inside of the emergence column.

All the contents of the nest are removed and examined. The nest materials are sorted by categories and each category is tallied separately. Live hatchlings are counted and released as a priority. All unopened eggs are torn open to evaluate their stage of development. Samples of dead hatchlings, undeveloped eggs are collected for genetic analysis.

DATA COLLECTION & ANALYSIS

For the Project period 2013-2018: >25, 000 tagging records of 3 sea turtle species (Leatherback *Dermochelys coriacea*, Hawksbill *Eretmochelys imbricata* and Green Turtle *Chelonia mydas*) were collected from 53 beaches around Trinidad & Tobago.

This nesting activity represents 11007 individuals from across 53 beaches.

Four Index beaches represent approximately 77% of all nesting activity. For each site with high density nesting there was a series of lower density nesting sites in the vicinity.

The distribution of sea turtle nesting in Trinidad and Tobago has been broadly surveyed. However, the data at each of the numerous rookeries relative to the dynamics of the nesting population have had incompletely surveyed leading to gaps on turtle nesting on individual beaches.

Table 8 shows the Nesting Activity across Rookeries which is summed for the period 2013-2018, the Mean Annual Number of nests for each species and for each site was determined. Beaches were ranked based on the total number of nests by each species.

During the beach monitoring over the period 2013 to 2018 there were 141 individuals with (212) foreign tags-Of these 86 individuals turtles were recorded with WIDECAST tags and 32 individuals with Canadian Sea Turtle Network tags. Also tags were recorded from Florida (Archie Carr Centre for Sea Turtle Research), French West Indies including Guadeloupe.

Table 8 *NESTING ACTIVITY ACROSS ROOKERIES 2008 to 2018*

Nesting beach	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Grande Riviere	2985	2179	1301	1630	1993	3984	4919	5507	6113	6447	5361
Matura	1607	2217	1717	1758	1283	1766	1137	469	1491	5749	3545
Fishing Pond	1546	761	493	1094	1336	1427	3779	1793	1613	1396	1164
Tobago (SOS)						353	503	284	684	275	311
Sans Souci-Big Bay						119	156	290	53	67	53
Marianne (Blanchisseuse)						101	618	811	664	434	154
Manzanilla						282	205	191	316	186	116
Grand Tacarib						88		124	213	158	
Star Wood						16	1	45		13	
Hermitage						41	83		15	165	146
Madamas						13			143	69	
Las Cuevas						230	323	104	519	79	63
Tyrell's Bay/ Lucy Vale, Lover's Bay						27		23	27	12	
Paria Beach						7		56	288	110	
La Foret								38	51	45	112
Balandra						46					
King Peter's Bay/ Moriah Big Bay						29	3	20		27	4
Charlotteville (Dead Bay, Cambleton)						43	40		153	40	55
Charama								35	85	56	
Lysae								14	39	34	
Mission						12			4		
Patience						35		31	18	92	
Red Sand								10	26		
Salybia						12		2			
Guayamare/Tompire						38					
Minister's Bay (Bacolet)							16				15
Kendal/Argyle/Roxborough						1	2	2	5		
Iguana/ Pirate's Bay/ Man-O-War						7	2		44	35	
Arnos Vale/Celery Bay						19				3	
Buccoo								1			
TOTAL	6138	5157	3511	4482	4612	8696	11790	9850	12564	15492	5332

Table 9 NESTING ACTIVITY ACROSS ROOKERIES (RECORDED THROUGH TAGGING)

	Leatherback				Hawksbill				Green				All species			
Nesting Beach	Total	Annual Mean	% Total Species Nesting	Rank	Total	Annual Mean	% Total Species Nesting	Rank	Total	Annual Mean	% Total Species Nesting	Rank	Total	Annual Mean	% Total Species Nesting	Rank
Back Bay, Mount Irvine	155	25.83	0.73	13	21	3.50	1.50	10	9	9.00	21.95	2	185	25.07	0.81	13
Bacolet	9	4.50	0.04	29				42				13	9	4.50	0.04	37
Balandra	17	17.00	0.08	24	8	8.00	0.57	22	2	2.00	4.88	5	27	9.00	0.12	27
Bande du Sud, Chacachacare Island				46	164	27.33	11.69	3				13	164	46.00	0.72	14
Cotton Bay (Big Bay) - Moriah				46	4	4.00	0.29	29				13	4	2.67	0.02	45
Big Bay - Sans Souci	734	122.33	3.44	7	21	4.20	1.50	10				13	755	105.58	3.31	8
Biscayen Bay				46	6	2.00	0.43	25				13	6	2.75	0.03	41
Buccoo				46				42				13				53
Cambleton	201	33.50	0.94	11	190	31.67	13.54	2	1	1.00	2.44	10	392	51.14	1.72	10
Charama	21	7.00	0.10	22				42	1	1.00	2.44	10	22	6.29	0.10	29
Crompston's Bay	8	2.67	0.04	31	9	3.00	0.64	20				13	17	4.25	0.07	35
Dead Bay	24	6.00	0.11	20	7	2.33	0.50	23				13	31	8.29	0.14	25
Fishing Pond	5176	862.67	24.25	2	2	1.00	0.14	35				13	5178	946.75	22.72	2
Goldsborough	46	9.20	0.22	17				42				13	46	12.50	0.20	21
Grafton	2335	389.17	10.94	3	6	3.00	0.43	25	3	3.00	7.32	4	2344	425.18	10.29	3
Grand Tacarib	75	15.00	0.35	15	7	7.00	0.50	23				13	82	22.57	0.36	17

Nesting Beach	Leatherback Total	Leatherback Annual Mean	Leatherback % Total Species Nesting	Leatherback Rank	Hawksbill Total	Hawksbill Annual Mean	Hawksbill % Total Species Nesting	Hawksbill Rank	Green Total	Green Annual Mean	Green % Total Species Nesting	Green Rank	All species Total	All species Annual Mean	All species % Total Species Nesting	All species Rank
Grande Riviere	7824	1304.00	36.65	1	24	6.00	1.71	8	2	2.00	4.88	5	7850	1094.67	34.44	1
Grange	3	3.00	0.01	40				42				13	3	1.50	0.01	46
Guayamare	17	4.25	0.08	24	1	1.00	0.07	39	1	1.00	2.44	10	19	3.43	0.08	32
Hermitage	466	77.67	2.18	8	459	76.50	32.72	1				13	925	136.83	4.06	5
Iguana Bay	17	17.00	0.08	24	15	15.00	1.07	13				13	32	16.00	0.14	24
Kendall	1	1.00	0.00	44				42				13	1	0.67	0.00	52
King Peter's Bay	4	2.00	0.02	38	5	2.50	0.36	28				13	9	3.00	0.04	37
La Foret	160	32.00	0.75	12	147	29.40	10.48	4				13	307	51.17	1.35	12
La Tinta, Chacachacare Island				46	34	6.80	2.42	6				13	34	10.83	0.15	23
Lambeau	30	10.00	0.14	19	29	14.50	2.07	7				13	59	19.50	0.26	19
Lambeau (Magdalena Hotel)	24	8.00	0.11	20	23	7.67	1.64	9				13	47	11.75	0.21	20
L'Anse Fourmi	11	5.50	0.05	28	9	4.50	0.64	20				13	20	6.67	0.09	30
Las Cuevas	406	67.67	1.90	9	14	3.50	1.00	15	10	2.50	24.39	1	430	51.07	1.89	9
Lovers Bay				46				42				13				53
Lysea	6	6.00	0.03	35	4	4.00	0.29	29	2	2.00	4.88	5	12	4.00	0.05	36
Madamas	6	6.00	0.03	35				42				13	6	4.00	0.03	41
Manzanilla	322	53.67	1.51	10	12	6.00	0.86	16				13	334	71.89	1.47	11

	Leatherback				Hawksbill				Green				All species			
Nesting Beach	Total	Annual Mean	% Total Species Nesting	Rank	Total	Annual Mean	% Total Species Nesting	Rank	Total	Annual Mean	% Total Species Nesting	Rank	Total	Annual Mean	% Total Species Nesting	Rank
Maracas	5	2.50	0.02	37				42				13	5	2.50	0.02	43
Marianne Bay	783	130.50	3.67	6	2	1.00	0.14	35				13	785	163.00	3.44	7
Matura	1374	229.00	6.44	4	4	1.33	0.29	29	2	1.00	4.88	5	1345	188.69	5.90	4
Minister's Bay	8	8.00	0.04	31	18	6.00	1.28	12				13	26	8.67	0.11	28
Mission	36	12.00	0.17	18	4	2.00	0.29	29				13	40	11.17	0.18	22
Morris Bay, Monos Island				46	2	2.00	0.14	35				13	2	1.00	0.01	48
Paria	61	15.25	0.29	16	6	6.00	0.43	25	6	6.00	14.63	3	73	15.88	0.32	18
Patience	9	9.00	0.04	29	10	10.00	0.71	19				13	19	9.50	0.08	32
Pigeon Point	8	2.67	0.04	31	12	4.00	0.86	16				13	20	5.00	0.09	30
Red Cliff Bay, Chacachacare Island				46	3	3.00	0.21	33				13	3	2.00	0.01	46
Red Sand	15	15.00	0.07	27	15	15.00	1.07	13				13	30	15.00	0.13	26
Roxborough	2	2.00	0.01	42				42				13	2	1.33	0.01	48
Salybia	2	2.00	0.01	42				42				13	2	1.00	0.01	48
Sans Souci	7	3.50	0.03	34	1	1.00	0.07	39				13	8	3.20	0.04	39
Sena				46				42				13				53
Star Wood	4	2.00	0.02	38	3	1.50	0.21	33				13	7	2.33	0.03	40
Tompire	18	6.00	0.08	23				42				13	18	6.00	0.08	34

Nesting Beach	Leatherback Total	Leatherback Annual Mean	Leatherback % Total Species Nesting	Leatherback Rank	Hawksbill Total	Hawksbill Annual Mean	Hawksbill % Total Species Nesting	Hawksbill Rank	Green Total	Green Annual Mean	Green % Total Species Nesting	Green Rank	All species Total	All species Annual Mean	All species % Total Species Nesting	All species Rank
Tortue Bay, Huevos Island				46	87	17.40	6.20	5				13	87	27.33	0.38	16
Turtle Beach	792	132.00	3.71	5	12	3.00	0.86	16				13	804	138.80	3.53	6
Tyrrel Bay	1	1.00	0.00	44	1	1.00	0.07	39				13	2	1.00	0.01	48
Man-o-War	3	3.00	0.01	40				42	2	2.00	4.88	5	5	2.00	0.02	43
(blank)	119	19.83	0.56	14	2	2.00	0.14	35				13	121	26.43	0.53	15
Total	21346				1403				41				22790			

Carapace Measurements

Morphometric measurements were taken of the maximum length- Standard Curved Carapace Length (CCL) and width- Curved Carapace Width of 16, 968 nesting sea turtles from 2013 to 2018.

Table 10 *MEAN AND RANGE FOR THE CARAPACE LENGTH AND WIDTHS FOR TAGGED NESTING GREEN, HAWKSBILL AND LEATHERBACK SEA TURTLES*

		GRN	HWK	LBK
	n=	23	771	16174
MEAN (cm)	CCL (max)	92.25 ±3.49	87.05 ±1.58	154.27 ±12.42
	CCW	72.17 ±7.69	114.00 ±2.43	72.17 ±14.73
MODE (cm)	CCL (max)	92	85	156
	CCW	71	78	114
MAX. (cm)	CCL (max)	114	196.5	196
	CCW	98	176	214
MIN. (cm)	CCL (max)	35	33	53
	CCW	32	24	40

Nesting Ecology of Sea Turtles in Trinidad and Tobago

From the data collected for the period 2013- 2018, highlighted in the table above (Table 9), we firstly look at the nesting ecologies of each of the 5 species known to nest in Trinidad and Tobago.

Nesting Ecology of the Leatherback Turtle, Dermochelys coriacea

The data collected indicates that 9891 individual Leatherback turtles nested in Trinidad and Tobago.

Tagging Events by Species, Location and Year

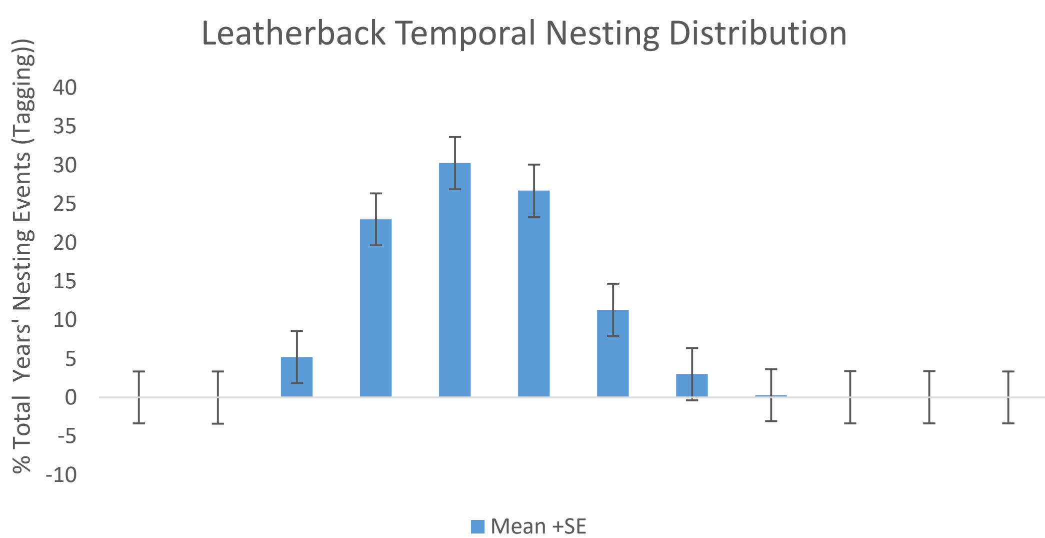
	Leatherback						
	year						
Nesting Beach	2013	2014	2015	2016	2017	2018	Total
Back Bay, Mount Irvine	17	16	11	52	3	56	155
Bacolet			1			8	9
Balandra		17					17
Bande du Sud, Chacachacare Island		2	6			1	9
Big Bay - Moriah							
Big Bay - Sans Souci	243	134	92	179	43	43	734
Biscayen Bay							
Buccoo							
Cambleton	35	27	28	60	23	28	201
Charama			5	9	7		21
Crompston's Bay		2		1		5	8
Dead Bay	3	8	4	9			24
Fishing Pond	2781	534	23	3	968	867	5176
Goldsborough	17	8	12	8		1	46
Grafton	11	15	1	1	12	2295	2335
Grand Tacarib	6	4	42		22	1	75
Grande Riviere	2554	221	52	166	4008	823	7824
Grange	3						3
Guayamare	13	2	1			1	17
Hermitage	103	41	48	68	133	73	466
Iguana Bay				17			17
Kendall				1			1
King Peter's Bay				2		2	4
La Foret		11	21	22	50	56	160
La Tinta, Chacachacare Island							

Lambeau	1	16		13			30
Lambeau (Magdalena Hotel)		14		1	9		24
L'Anse Fourmi		1		10			11
Las Cuevas	92	111	35	75	40	53	406
Lovers Bay							
Lysea				6			6
Madamas		6					6
Manzanilla	21	88	16	26	62	109	322
Maracas			4	1			5
Marianne Bay	103	14	118	8	387	153	783
Matura	237	85	2	79	639	297	1339
Minister's Bay		8					8
Mission	13	17		6			36
Morris Bay, Monos Island							
North Manzanilla						1	1
Orosco		28		3		3	34
Paria	19	3	12		27		61
Patience				9			9
Pigeon Point			1	2		5	8
Red Cliff Bay, Chacachacare Island							
Red Sand				15			15
Rincon				1			1
Roxborough		2					2
Salybia	2						2
Sans Souci		4	3				7
Sena							
Star Wood		2		2			4
Tompire	12	5				1	18
Tortue Bay, Huevos Island			1	1			2
Turtle Beach	219	63	2	174	130	202	790
Tyrrel Bay				1			1
Man-o-War		3					3
UNSPECIFIED	55	3	10	7	25	3	103
Total	6560	1515	551	1038	6588	5087	21339

Temporal distribution

99.51% ±12.33% of nests recorded annually were laid during the months 1st March to 31st August.

May- June accounts for 63.98% of the annual totals.



Nesting status

Of observed nesting attempts (n= 20,016) in 2013-2018, 75.7% resulted in successful oviposition while 1.63% of nests were aborted.

		LEATHERBACK						
		2013	2014	2015	2016	2017	2018	% of Total Outcomes
Nesting Outcome	Confirmed Lay	67.70	55.90	81.37	83.68	60.95	59.11	63.60
	Estimated Lay	3.14	6.88	7.78	9.84	17.08	19.52	12.13
	False Crawl	0.48	3.81	2.36	1.94	0.14	1.39	0.91
	False Crawl With Body Pit	0.38	2.99	1.18	1.68	0.14	0.85	0.66
	Abandoned	0.08		0.71	0.65			0.06
	Dead		0.22		0.13	0.02	0.08	0.04
	Poaching							
	Stranding	0.02	0.07			0.03		0.02
	Unknown	28.20	30.12	6.60	2.07	21.64	19.06	22.58
	n=	6297	1338	424	772	6358	4827	20016

Spatial distribution

Nesting occurs across 43 beaches over the period 2013-2018.

10 beaches account for 94.52% of nesting events: (in order of prominence) Grande Riviere, Fishing Pond, Grafton, Matura, Turtle Beach, Marianne Bay, Big Bay - Sans Souci, Hermitage, Las Cuevas, Manzanilla

Nesting Beach Fidelity

Nesting Leatherback turtles exhibit high fidelity to the same nesting beach. Over the study period, 2013-2018, 93% of Leatherback sea turtles nested at the same beach repeatedly within a season and over the entire period. Only 6.77% selected to nest at more than 1 nesting beach.

Of these,

2 individuals nested at 4 beaches in the period: a turtle nested once at Big Bay, Sans Souci- Fishing Pond- Grande Riviere- Matura and a turtle nested once at each of Back Bay, Mt Irvine- Fishing Pond- Matura and 4 times at Turtle Beach.

29 individuals nested at 3 beaches in the period

> *It is worth noting that 9 individuals nested at the protected beaches of Fishing Pond- Grande Riviere- Matura in the same season and 2 individuals nested at Grafton –Back Bay, Mt Irvine- Turtle Beach in the same season, showing the need to continue pursuit in making these beaches protected. It should also be noted that these 3 Tobago beaches can be considered as a single nesting rookery.*

628 individuals nested at 2 beaches in the period

Of turtles which nested exclusively at non-Index sites, 2 turtles nested at Guayamare and Tompire.

Nesting Beach Fidelity for Leatherback turtles nesting on 2 beaches within the recording period

Nesting Beaches		Overlap between nesting beaches: Index							with Index Supplemental sites							
		Fishing Pond	Grande Riviere	Matura	Back Bay, Mt Irvine	Grafton	Turtle Beach	**% Index beach overlap**	Grand Tacarib	Manzanilla	Marianne Bay	Big Bay, Sans Souci	**% Index+ Sup. site beach overlap**	**% Overlap with non-Index beaches**	Nesting Beach	# turtles
	Fishing Pond		99	246	1		1	**92.29**	4	8	11	4	**98.43**	**1.57**	Balandra Cambleton Charama Las Cuevas	1 1 2 2
	Grande Riviere	99		30			19	**58.11**	3	1	20	52	**92.40**	**7.60**	Dead Bay Grange Las Cuevas Paria Roxborough Salybia	2 3 12 1 1 1
	Matura	246	30			1	2	**96.84**		2	5	2	**100.00**	**0.00**		
	Back Bay, Mt Irvine	1				2	17	**100.00**					**100.00**	**0.00**		
	Grafton			1	2		19	**71.43**				1	**97.78**	**2.22**	Balandra Cambleton Charama Las Cuevas	1 1 2 2
	Turtle Beach	1	19	2	17	19		**82.35**			1	6	**95.28**	**4.72**	Balandra Cambleton Charama Las Cuevas	1 1 2 2
	Grand Tacarib	4	3								1	2	100.00	0.00		
	Manzanilla	8	1	2									100.00	0.00		
	Marianne Bay	11	20	5			1		1			2	85.42	14.58	Las Cuevas Maracas Mission	3 2 2
	Big Bay, Sans Souci										2		100.00	0.00		

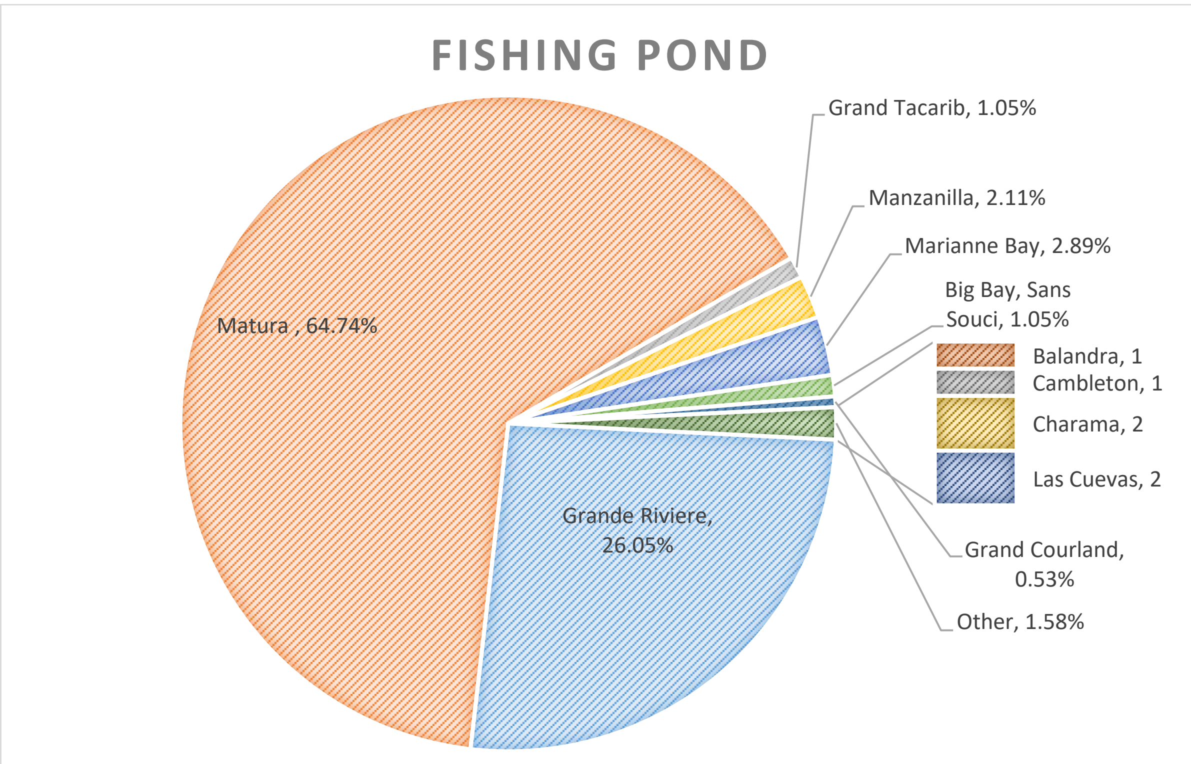
Index beaches have the highest nesting and include Fishing Pond, Grande Riviere, Matura, Back Bay, Mt Irvine, Grafton, Turtle Beach.

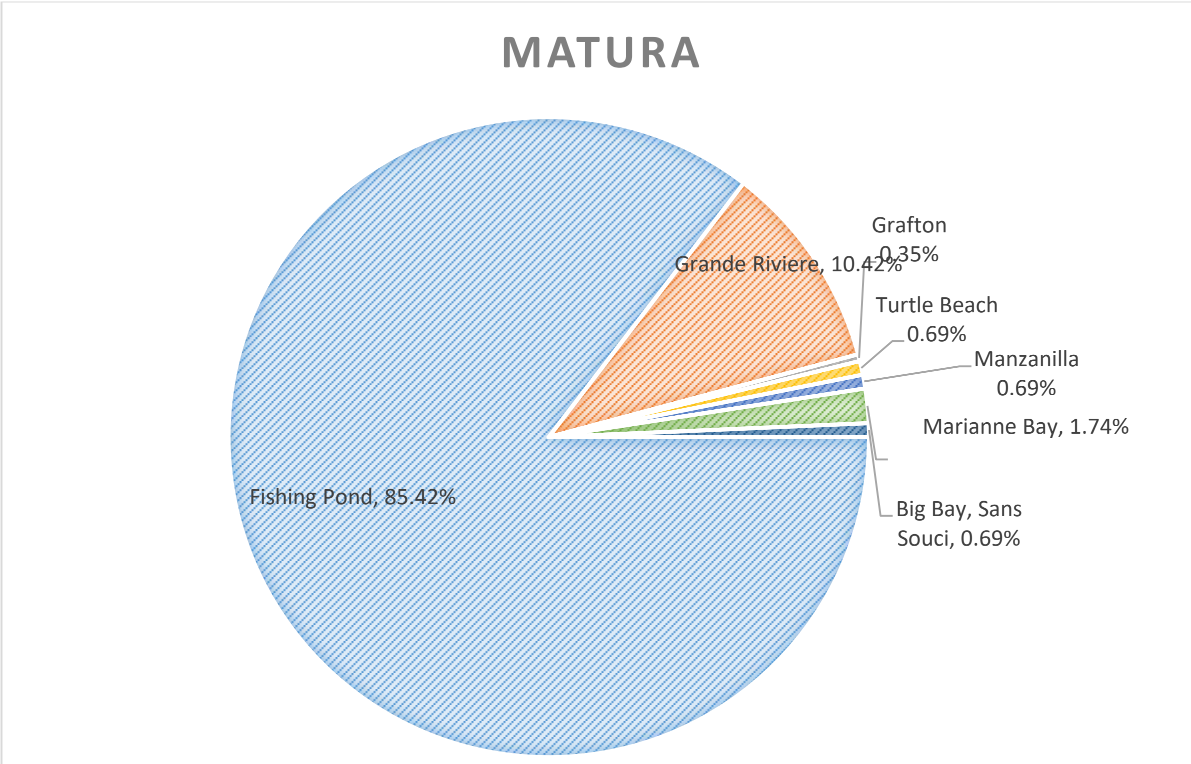
The Project identified beaches that based on nesting data should also be considered Index sites going forward and the table above are identified as Supplementary sites. These include: Grand Tacarib, Manzanilla, Marianne Bay and Big Bay, Sans Souci.

% Index+ Index Sup. Site beach overlap calculation includes nesting on Index beaches and Additional Supplementary beaches

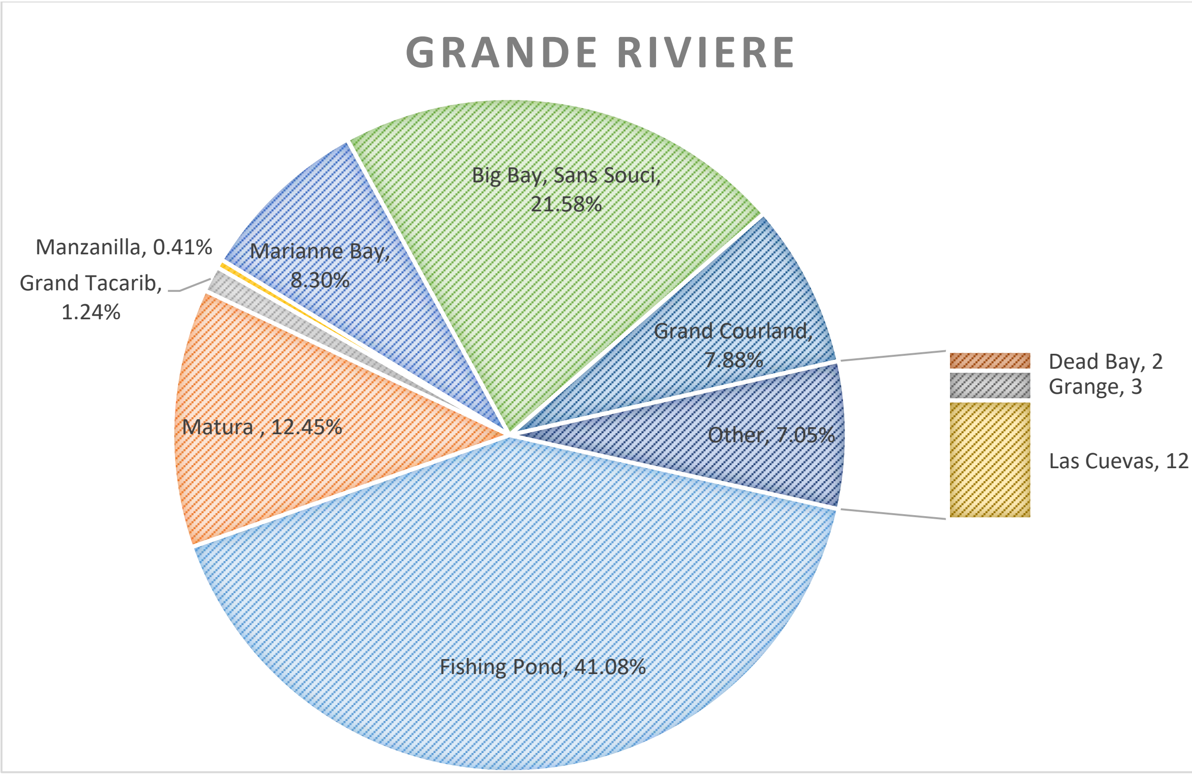
The greatest overlap among Index beaches is turtles nesting at both Matura and Fishing Pond.

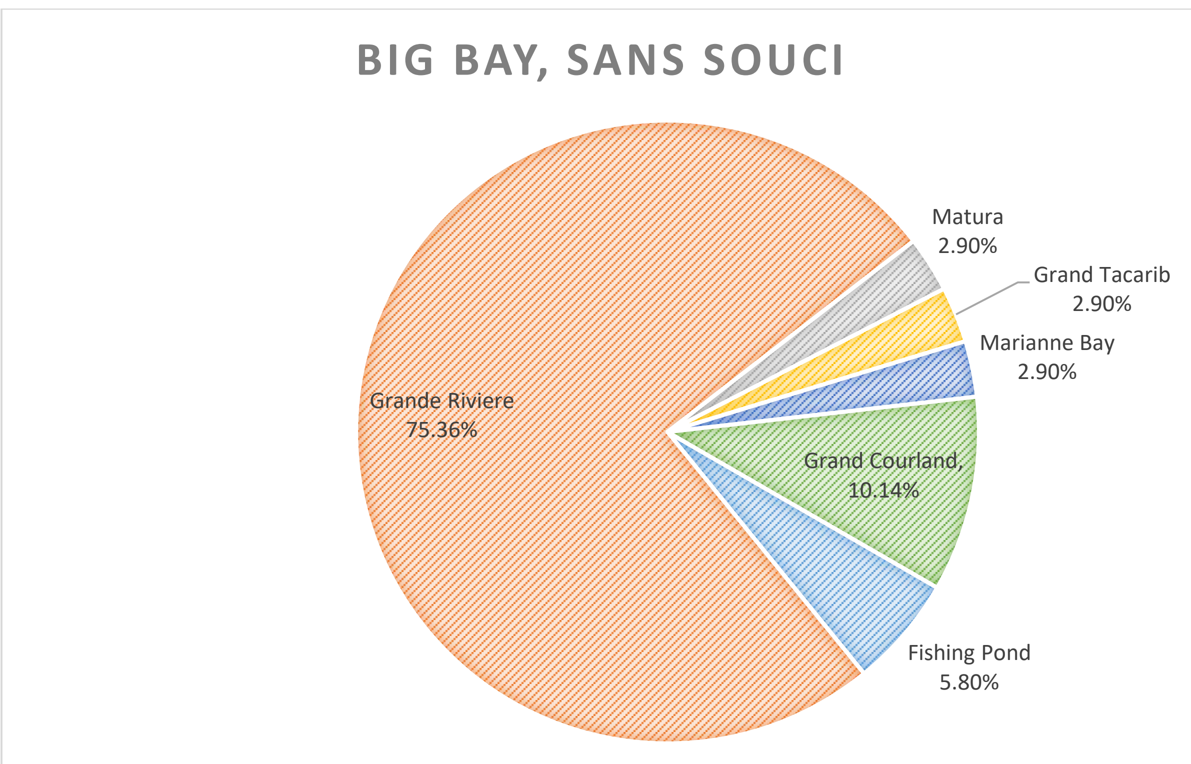
246 Turtles nested in both Matura and Fishing Pond. (It should be noted, that Matura and Fishing Pond geographically are the same stretch of beach separated only in access to the site by the North Oropouche River.)





Turtles nesting at Grande Riviere show the lowest fidelity to nesting exclusively at Index beaches (58.11%). Of note, nesting overlap of Grande Riviere with Big Bay, Sans Souci accounts for 21.31% and nesting at Index and this supplementary beach is (79.42%).

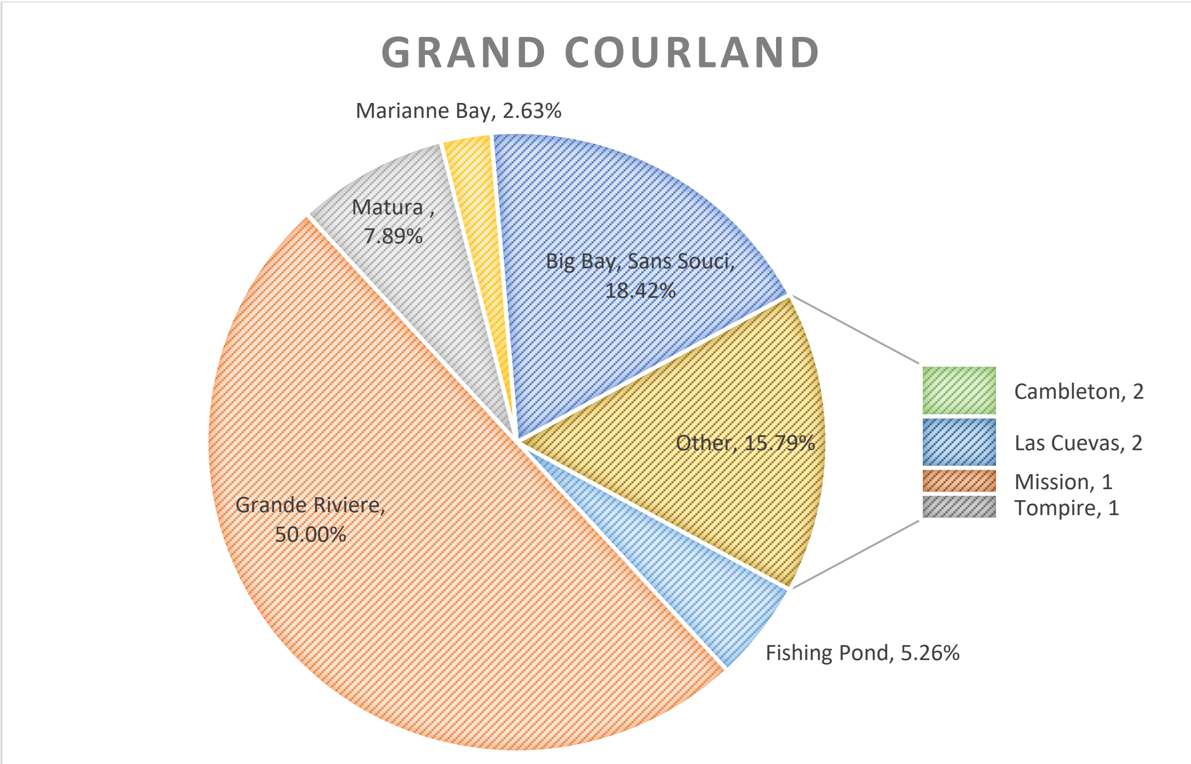

GRANDE RIVIERE
Big Bay, Sans Souci, 21.58%
Manzanilla, 0.41%
Marianne Bay, 8.30%
Grand Tacarib, 1.24%
Grand Courland, 7.88%
Dead Bay, 2
Grange, 3
Matura , 12.45%
Other, 7.05%
Las Cuevas, 12
Fishing Pond, 41.08%


BIG BAY, SANS SOUCI
Matura 2.90%
Grand Tacarib 2.90%
Marianne Bay 2.90%
Grande Riviere 75.36%
Grand Courland, 10.14%
Fishing Pond 5.80%

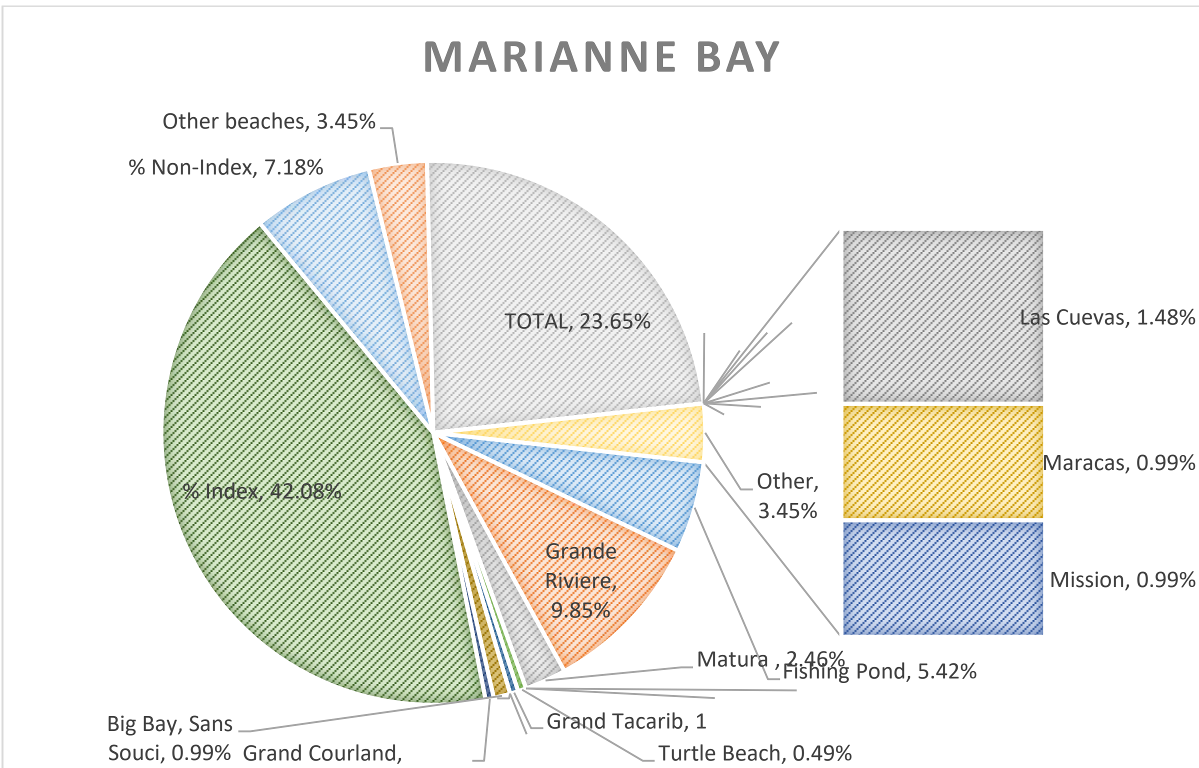
Of the survey beaches, Las Cuevas, Charama and Cambleton were most selected by turtles which also nested at an Index beach.

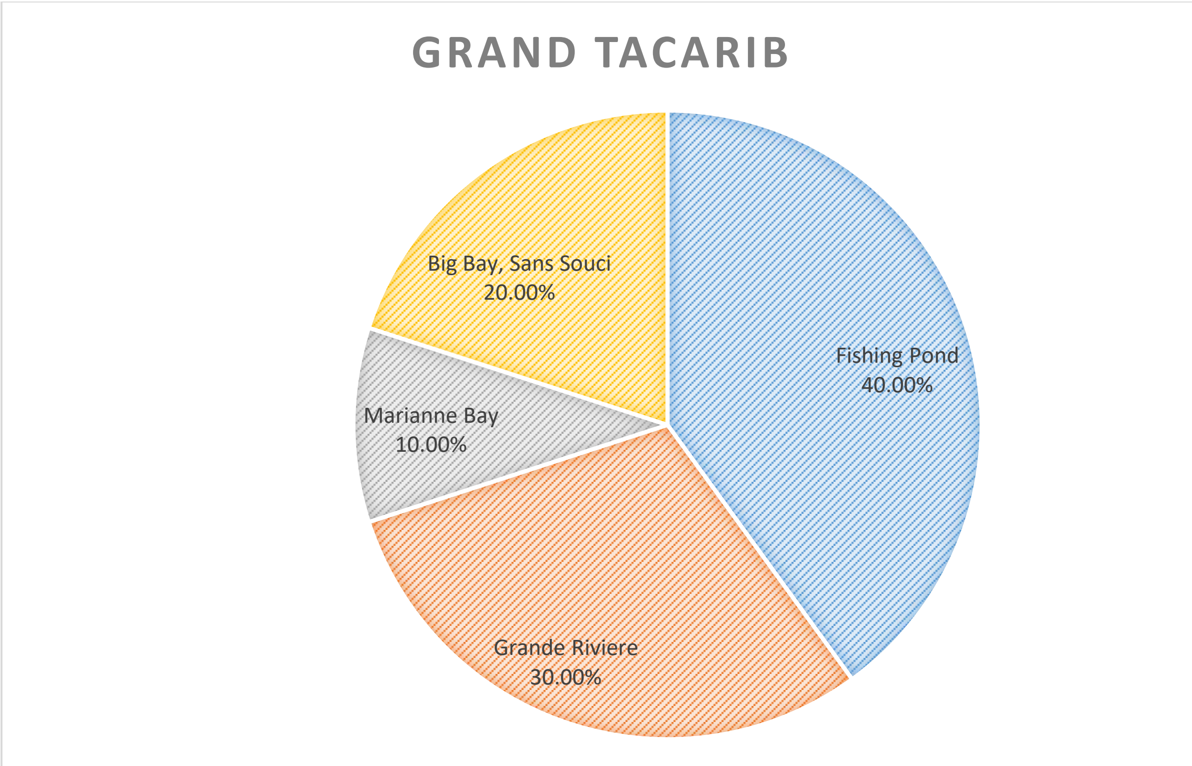
While the turtles may be protected on Index sites (3 of which are Prohibited), turtles nesting there are also nesting on Supplemental and Survey beaches which by virtue of their designation have low nesting levels. What this shows is while a focus on protecting key nesting areas must continue to be a priority, if some extent of monitoring and protection is not also afforded on these Supplemental and Survey sites there could invariably be losses in the nesting population. (In Grande Riviere for example, we see 7.60% (n=20) of turtles nesting at Grande Riviere and another beach, selected a non-Index beach. 14.58% (n=7) of turtles nesting at Marianne Bay and another beach, selected a non-Index beach.)

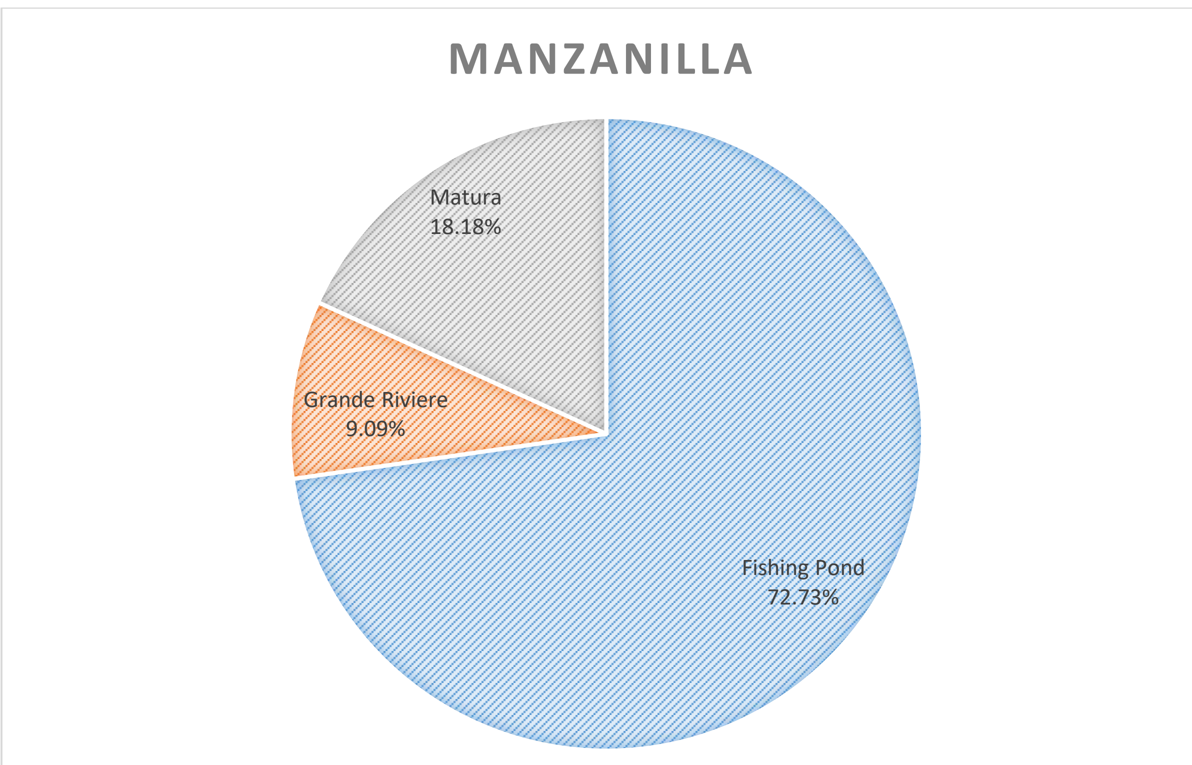
Grand Courland Bay describes nesting at three adjacent nesting beaches in Tobago. These are Back Bay (Mt Irvine), Grafton, Turtle Beach. The data shows an overlap of nesting with the Northern Coast nesting rookeries (Grande Riviere, Big Bay (Sans Souci) and Marianne Bay 71%). This is possibly due to the geographical proximity of Trinidad's North Coast with these South-West Tobago beaches.


GRAND COURLAND
Marianne Bay, 2.63%
Matura , 7.89%
Big Bay, Sans Souci, 18.42%
Other, 15.79%
Grande Riviere, 50.00%
Fishing Pond, 5.26%
Cambleton, 2
Las Cuevas, 2
Mission, 1
Tompire, 1

__Nesting Beach Fidelity for Leatherback turtles which nested on 2 beaches__




GRAND TACARIB
Big Bay, Sans Souci
20.00%
Fishing Pond
40.00%
Marianne Bay
10.00%
Grande Riviere
30.00%


MANZANILLA
Matura
18.18%
Grande Riviere
9.09%
Fishing Pond
72.73%

Observed Clutch Frequency (the number of observed or inferred clutches laid by an individual female during a nesting season)

The Mean Observed Clutch Frequency over the period 2013-2018, was 1.98 ±0.19 clutches per female per year.

Observed Internesting period (the period between two nesting by an individual turtle within a season)

The Mean number of days between observed (Confirmed Lay) or inferred (Estimated Lay) laying by an individual female was 18.59 days.

	n=	Mean Observed Inter-nesting Interval (days)		
2013	2086	15.85	±	21.07
2014	271	8.02	±	16.47
2015	119	8.24	±	18.89
2016	205	11.26	±	21.15
2017	1749	24.52	±	28.09
2018	1136	19.41	±	21.62
Total	5566	18.59	±	23.88

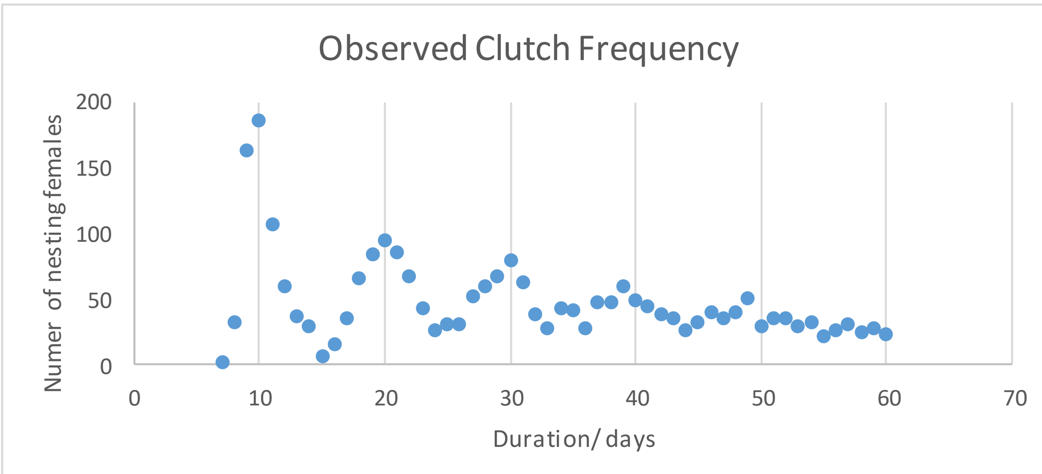
The Mean above was calculated from data with a range in inter-nesting interval between 7 to 211 days, where the Minimum Internesting period was 7 days.

Based on the Minimum Inter-nesting Interval of 7 days, we can assume that the period between the first nesting and the second nesting does not exceed 14 days (Where the time of the initial nesting and subsequent nesting was greater than 14 days, we can infer that nesting of this turtles was missed by our field teams).

Observed Inter-nesting Interval (days)			
7-22	36.42	9	5.53
7-37 days	59.44%	10 days	6.31
7 - 12 days	18.68%	11	3.63
7-50	77.48	14	1.02

7-64	90.06		

When the Observed Clutch Frequency data is plotted, the data shows spikes at durations of 10 days.



When Observed Internesting period was limited to between 7 and 14 days, since greater than 14 days was considered as including unobserved nestings, the *adjusted* Mean Observed Internesting interval was 10.36 days.

6- 14 day interval

	n=	Adjusted Mean Observed Inter-nesting Interval (days)		
2013	253	10.40	±	1.61
2014	20	10.70	±	1.72
2015	7	10.43	±	1.27
2016	19	11.11	±	1.73
2017	187	10.35	±	1.44
2018	132	10.14	±	1.27
Total	618	10.36	±	1.50

Remigration Interval

In the period 2013-2018, the data showed that only 4.73% (n=468) of Leatherback turtles were reported nesting over multiple years.

Number of recurrences over the period	Number of individuals
4	3
3	15
2	451

Most remigrant turtles returned in the fourth year, 47.01% (n=212). Of these individuals, 36% (n=164) that nested in 2013 were again recorded nesting in 2017.

There were several instances of turtles nesting in consecutive years 2013-2014, 2016-2017 and 2017-2018 (0.44% - 5.76%; n= 2-26 turtles), with turtles of 2017-2018 having the highest overlap.

It can be inferred from the data, that if after 6 nesting seasons, only about 5% of females were recorded in more than one season, the remigration period may be longer than 6 years. This warrants the need for longer term monitoring efforts.

Nesting Ecology of the Hawksbill Turtle, Eretmochelys imbricata

The data collected over the period 2013-2018 indicates that 1075 individual Hawksbill turtles nested in Trinidad and Tobago.

Tagging Events by Species, Location and Year

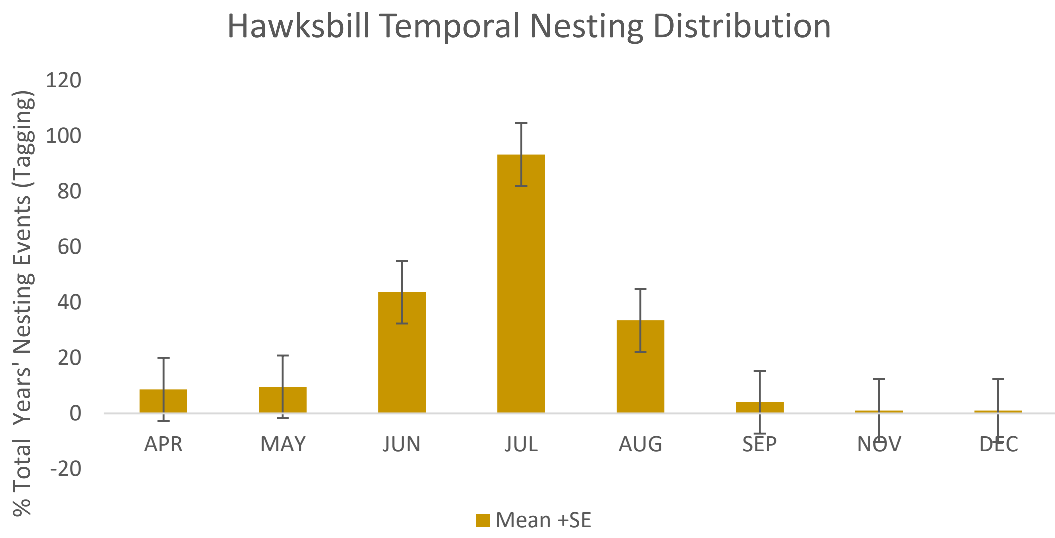
	Hawksbill						
	year						
Nesting Beach	2013	2014	2015	2016	2017	2018	Total
Back Bay, Mount Irvine	2	2	4	4	2	7	21
Bacolet			1			7	8
Balandra		8					8
Bande du Sud, Chacachacare Island	6	71	49	20	17	1	164
Big Bay - Moriah					4		4
Big Bay - Sans Souci		3	4	3	1	10	21
Biscayen Bay	1	4		1			6
Buccoo							
Cambleton	33	23	23	61	22	28	190
Charama							
Crompston's Bay		2		1		6	9
Dead Bay	1		1	5			7
Fishing Pond	1					1	2
Goldsborough							
Grafton		1				5	6
Grand Tacarib			7				7
Grande Riviere	10			1	3	10	24
Grange							
Guayamare	1						1
Hermitage	105	40	49	62	124	79	461
Iguana Bay				15			15
Kendall							
King Peter's Bay				3		2	5
La Foret		10	17	22	40	58	147
La Tinta, Chacachacare Island	3	16	3	6	6		34
Lambeau		16		13			29
Lambeau (Magdalena Hotel)		14		1	8		23
L'Anse Fourmi				8		1	9
Las Cuevas	2	2		1		9	14
Lovers Bay							

Lysea				4			4
Madamas							
Manzanilla		4				8	12
Maracas							
Marianne Bay			1			1	2
Matura		1			2	1	4
Minister's Bay		8	3			7	18
Mission		1		3			4
Morris Bay, Monos Island	2						2
North Manzanilla							
Orosco							
Paria					6		6
Patience				10			10
Pigeon Point			2	6		4	12
Red Cliff Bay, Chacachacare Island					3		3
Red Sand				15			15
Rincon							
Roxborough							
Salybia							
Sans Souci			1				1
Sena							
Star Wood		2		1			3
Tompire							
Tortue Bay, Huevos Island	10	50	2	10	15		87
Turtle Beach	1	1		4		6	12
Tyrrel Bay				1			1
Man-o-War							
(blank)	1		2	3	3	1	10
Total	151	137	105	227	213	229	1062

Temporal distribution

88.37% ±7.26% of nests recorded annually were laid during the months 1st April to 31st September.

June - August accounts for 78.39% of the annual totals.



Nesting Status

Of observed nesting attempts (n= 1, 337) between 2013-2018, 82.3% resulted in successful oviposition while 12.54% of nests were aborted.

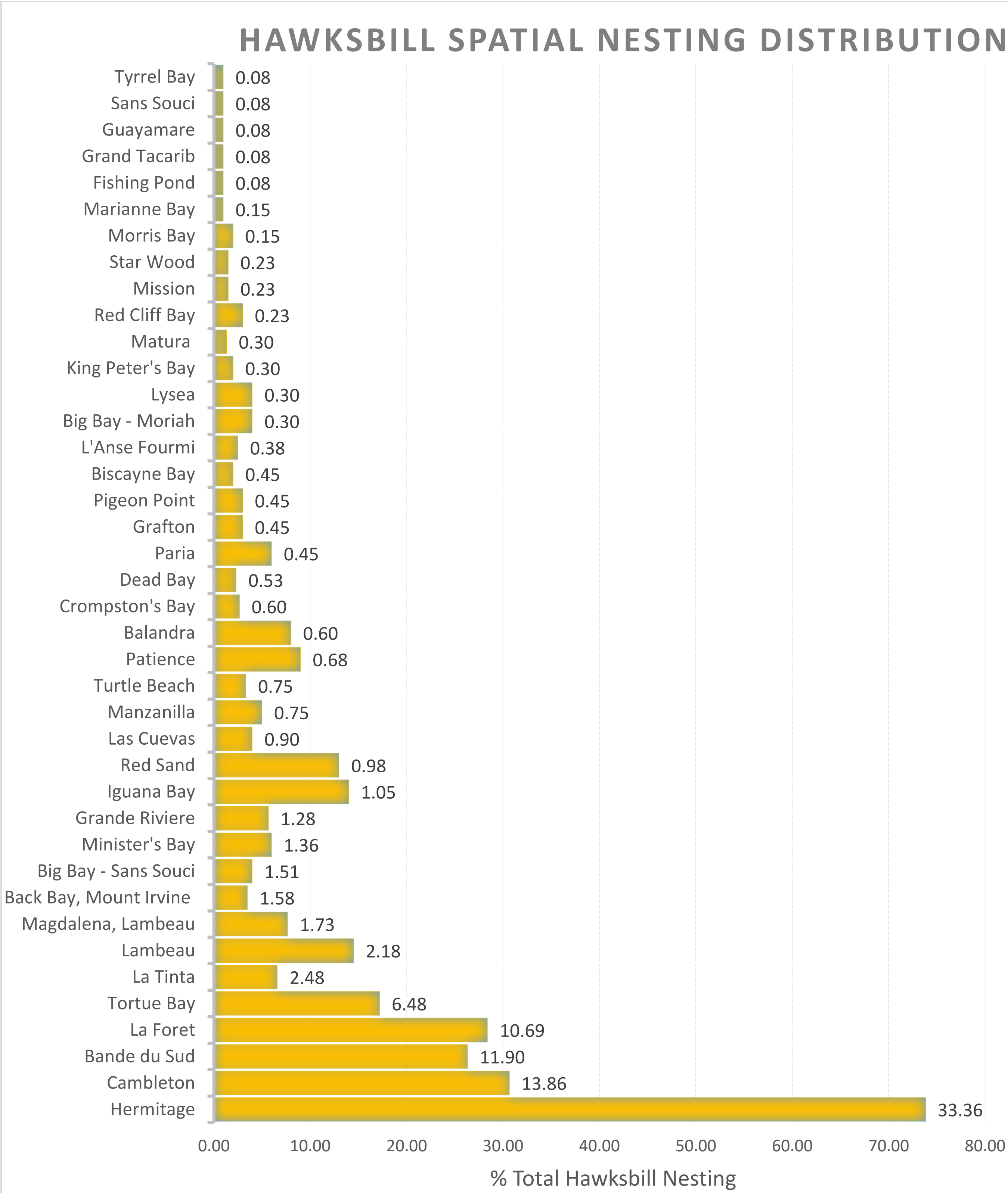
		HAWKSBILL						
		2013	2014	2015	2016	2017	2018	% of Total Outcomes
Nesting Outcome	Confirmed Lay	82.02	68.10	80.12	75.18	85.83	57.96	74.15
	Estimated Lay	6.74	5.73	1.81	7.80	1.57	23.27	8.12
	False Crawl	3.93	12.90	3.01	6.03	7.87	6.53	7.19
	False Crawl With Body Pit	2.25	12.19	4.82	2.84		4.90	5.34
	Dead						0.41	0.07
	Poaching				1.06		0.41	0.28
	Stranding							4.34
	Unknown	3.93				0.39	6.53	
	Total Annual Outcomes	178	279	166	282	254	245	1404

Spatial distribution

Nesting occurs across 53 beaches

7 beaches account for 82.68% of nesting events: (in order of prominence) Hermitage, Cambleton, Bande du Sud, La Foret, Tortue Bay, La Tinta, Lambeau including the beach adjacent to Magdalena Hotel, Lambeau

Out of the 7 referenced above, 3 remote beaches of North-West, Trinidad Bande du Sud, Tortue Bay, La Tinta, are only monitored using a peak survey and therefore nesting in this area is expected to be underreported.


HAWKSBILL SPATIAL NESTING DISTRIBUTION
Tyrrel Bay 0.08
Sans Souci 0.08
Guayamare 0.08
Grand Tacarib 0.08
Fishing Pond 0.08
Marianne Bay 0.15
Morris Bay 0.15
Star Wood 0.23
Mission 0.23
Red Cliff Bay 0.23
Matura 0.30
King Peter's Bay 0.30
Lysea 0.30
Big Bay - Moriah 0.30
L'Anse Fourmi 0.38
Biscayne Bay 0.45
Pigeon Point 0.45
Grafton 0.45
Paria 0.45
Dead Bay 0.53
Crompston's Bay 0.60
Balandra 0.60
Patience 0.68
Turtle Beach 0.75
Manzanilla 0.75
Las Cuevas 0.90
Red Sand 0.98
Iguana Bay 1.05
Grande Riviere 1.28
Minister's Bay 1.36
Big Bay - Sans Souci 1.51
Back Bay, Mount Irvine 1.58
Magdalena, Lambeau 1.73
Lambeau 2.18
La Tinta 2.48
Tortue Bay 6.48
La Foret 10.69
Bande du Sud 11.90
Cambleton 13.86
Hermitage 33.36
0.00 10.00 20.00 30.00 40.00 50.00 60.00 70.00 80.00
% Total Hawksbill Nesting

Nesting Beach Fidelity

Nesting Hawksbill turtles exhibit high fidelity to the same nesting beach with only 1.86% (n= 20, number of individuals) selecting to nest at more than 1 nesting beach.

Of these,

the greatest overlap was among adjacent Charlotteville beaches, Hermitage-Cambleton (n= 13)

Lambeau area: Lambeau and the beachfront of the Magdalena Hotel (n= 2)

Great Courland Bay: Grafton-Turtle Beach (n=1)

	Nesting Beaches			n=	Mean Internesting Interval (days)	Mean Remigration Interval (years)
	Hermitage	-	Dead Bay	1		1.2
	Hermitage	-	L'Anse Fourmi	1	34.0	
North-East, Tobago	Hermitage	-	Cambleton	13	20.7	3.2
	Lambeau	-	Magdalena, Lambeau	2	28.7	
	Grafton	-	Turtle Beach	1	18.0	
South-West, Tobago	Minister's Bay	-	Crompston's Bay	1		1.9
North-West, Trinidad	Bande du Sud	-	La Tinta	1		2.9

Observed Clutch Frequency

The Mean Observed Clutch Frequency was 1.44 ±0.19 clutches per female per year (n=80).

The Maximum number of observed clutches per female was 5 clutches.

Based on the this, the Estimated Clutch Frequency is higher than the mean Observed Clutch Frequency which essentially is telling us that nesting events were missed.

Observed Internesting period (the period between two nesting by an individual turtle within a season)

The Mean number of days between observed (Confirmed Lay) or inferred (Estimated Lay) laying by an individual female (n=181) was 25.28 days.

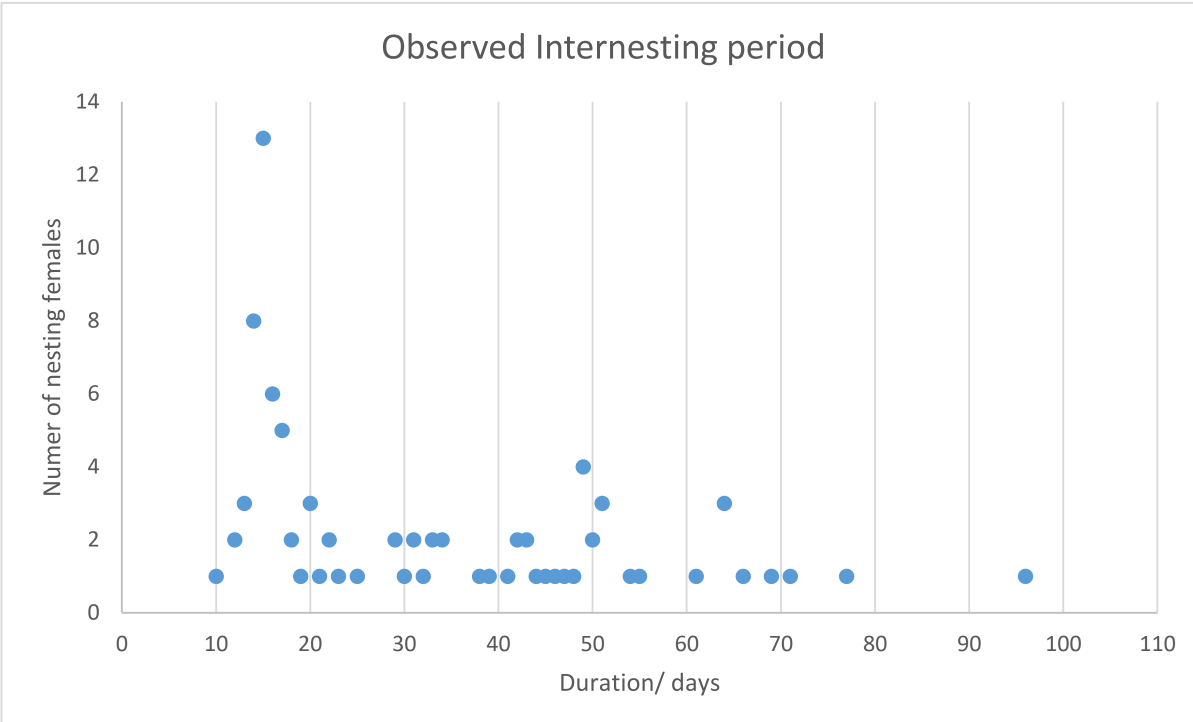
	n=	Mean Observed Inter-nesting Interval (days)		
2013	46	21.39	±	10.07
2014	14	29.57	±	16.31
2015	18	32.50	±	68.96
2016	40	27.43	±	45.83
2017	48	22.46	±	10.86
2018	15	18.33	±	9.69
Total	181	25.28	±	4.94

The Mean above was calculated from data with a range in inter-nesting interval between 10 to 308 days, where the Minimum Internesting period was 10 days.

Based on the Minimum Inter-nesting Interval of 10 days, we can assume that the period between the first nesting and the second nesting does not exceed 20 days (Where the time of the initial nesting and subsequent nesting was greater than 20 days, we can infer that nesting of this turtles was missed by our field teams.).

Observed Inter-nesting Interval (days)		
Range	10 - 308 days	
Most Frequent	14 days	[17.68%)
14 - 17 days	60.77 %	

When the Observed Clutch Frequency data is plotted, the data shows spikes at durations of 14 days.



When Observed Internesting period was limited to between 10 and 20 days, since greater than 20 days was considered as including unobserved nestings, the adjusted Mean Observed Internesting interval was 15.35 days.

10 – 20 day interval

	n=	Adjusted Mean Observed Inter-nesting Interval (days)		
2013	32	15.41	±	1.50
2014	7	16.14	±	1.07
2015	15	16.27	±	2.09
2016	29	14.83	±	1.10
2017	31	15.32	±	1.33
2018	13	14.92	±	2.36

Total	127	15.35	±	1.59

Observed Inter-nesting Interval (days)		
Range	10 – 20 days	
Most Frequent	14 days	[25.2%]
14 - 17 days	86.61%	

Remigration Interval

In the period 2013-2018, the data showed that only 7.46% (n=80) of Hawksbill turtles were reported nesting over multiple years.

Number of recurrences over the period	Number of individuals
3	9
2	71

Most remigrant turtles returned in the third year 37.5% (n=30).

3.75% (n=3) of individuals nested in 2015-2017-2018

2.50% (n=2) of individuals nested in 2013-2016-2017

Of turtles recorded nesting twice,

21.25% (n= 17) of individuals nested in 2014-2017

11.25% (n= 9) of individuals nested in 2014-2016

10% (n= 8) of individuals nested in 2013-2015 and also 2016-2018

It can be inferred from the data, that if after 6 nesting seasons, only about 7% of females were recorded in more than one season, the remigration period may be longer than 6 years or the efforts mainly in remote sites need to be increased as we believe that there may be nesting outside the current survey period (September-February). Further based on the temporal distribution graph above there seem to be a greater reduction in September where nesting may not be caught due to the monitoring ceasing on 50 beaches (only Grande Rivere, Matura and Fishing Pond continue monitoring in September

Genetic Analysis

A preliminary gender study was conducted by the Marine Sciences at The University of Trinidad and Tobago in conjunction with Turtle Village Trust. Tissue biopsies were taken from nesting Green and Hawksbill females (including those in which the nest was relocated to the hatchery and satellite-tagged individuals), failed embryos from nest excavations and tagged individuals from the Offshore Programme for genetic analysis.

Isolation of mitochondrial DNA (mtDNA) for mixed stock analysis was conducted on samples collected to determine the natal origins of turtles that forage in our offshore environment, the distinct genetic stocks and rookeries in Trinidad & Tobago and the contribution of these rookeries to the greater Caribbean foraging area. Haplotypes are stretches of consecutive nucleotides that lie on a specific chromosome. Determining the identity and relative frequency of haplotypes to control region sequences or haplotypes for Caribbean sea turtles from the National Center for Biolotechnology Information (NCBI) can be used to infer the relative connectivity of the genetic stocks.

DNA extraction and amplification using polymerase chain reaction (PCR) were successful in 42 samples, collected. Sequencing and analysis with turtle specific mtDNA primer pairs, known mtDNA control region sequences and haplotypes for Caribbean sea turtles was done to determine haplotype identities and their frequencies in the samples extracted.

Nine distinct haplotypes were identified in the sample population. The most common haplotype was EiA-09, present in all sample locations except Matura, closely followed by EiA-11. These haplotypes are generally the most commonly observed haplotypes in the Caribbean.

Table 11 *DISTRIBUTION OF HAPLOTYPES AT DIFFERENT LOCATIONS AROUND TRINIDAD AND TOBAGO*

Location	**EiA-01**	**EiA-02**	**EiA-03**	**EiA-09**	**EiA-11**	**EiA-12**	**EiA-27**	**EiA-43**	**EiA-63**	**Total**
Bande du Sud				2	1	1			1	5
Hermitage	1		1	8	5					15
Matura						1				1
Unknown	2	1		6	8	1	1	2		21

Haplotypes identified were compared with those previously identified from the Tobago Hawkbill population (Cazabon-Mannette 2016).

Table 12 *COMPARISON OF HAPLOTYPES FROM CAZABON-MANNETTE (2016) AND THE PRESENT STUDY*

	EiA-											
	1	**2**	**3**	**9**	**11**	**12**	**27**	**28**	**43**	**45**	**63**	**72**
Cazebon-Mannette (2016)	X		X	X	X	X	X	X	X	X	X	X
Current study	X	X	X	X	X	X	X		X		X	

Twelve unique haplotypes have been determined thus far for the localised hard-shell sea turtle population of Trinidad and Tobago. Haplotype EiA-09 being the most dominant, closely followed by EiA-11in the current sample.

Nesting Ecology of the Green Turtle, Chelonia mydas

The data collected over the period 2013-2018, 41 individual Green turtles nested in Trinidad and Tobago.

Tagging Events by Species, Location and Year

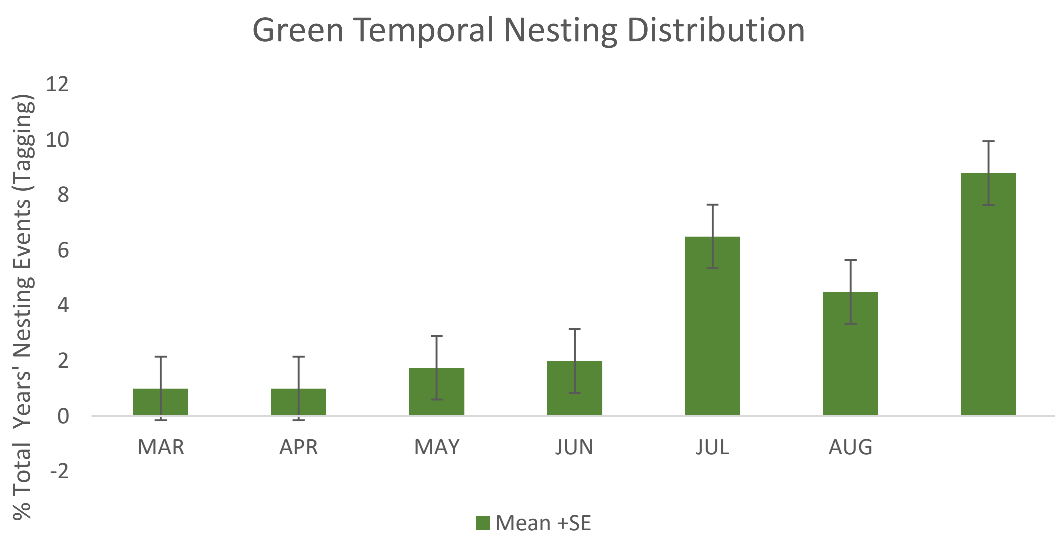
	Green						
	year						
Nesting Beach	2013	2014	2015	2016	2017	2018	Total
Back Bay, Mount Irvine						9	9
Bacolet							
Balandra		2					2
Bande du Sud, Chacachacare Island							
Big Bay - Moriah							
Big Bay - Sans Souci							
Biscayen Bay							
Buccoo							
Cambleton				1			1
Charama					1		1
Crompston's Bay							
Dead Bay							
Fishing Pond							
Goldsborough							
Grafton						3	3
Grand Tacarib							
Grande Riviere						2	2
Grange							
Guayamare						1	1
Hermitage							
Iguana Bay							
Kendall							
King Peter's Bay							
La Foret							
La Tinta, Chacachacare Island							
Lambeau							
Lambeau (Magdalena Hotel)							
L'Anse Fourmi							
Las Cuevas		4		3	2	1	10
Lovers Bay							
Lysea				2			2

Madamas							
Manzanilla							
Maracas							
Marianne Bay							
Matura			1		1		2
Minister's Bay							
Mission							
Morris Bay, Monos Island							
North Manzanilla							
Orosco							
Paria					6		6
Patience							
Pigeon Point							
Red Cliff Bay, Chacachacare Island							
Red Sand							
Rincon							
Roxborough							
Salybia							
Sans Souci							
Sena							
Star Wood							
Tompire							
Tortue Bay, Huevos Island							
Turtle Beach							
Tyrrel Bay							
Man-o-War		2					2
(blank)							
Total		8	1	6	10	16	41

Temporal distribution

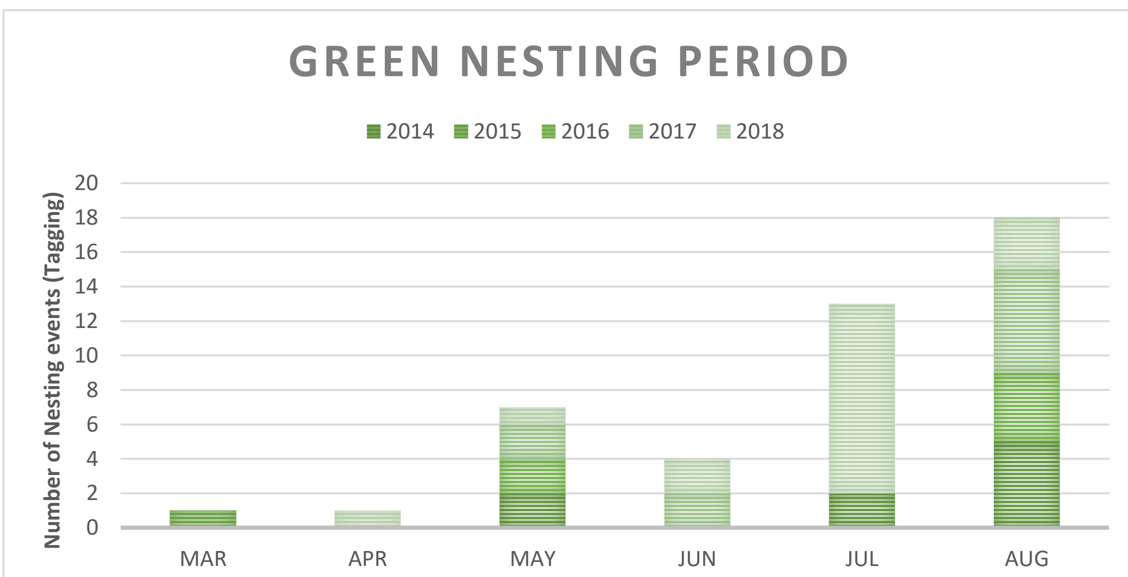
All nests recorded were during the months 1st March to 31st August.

July accounts for 73.86% of the annual totals.



May and August are the months represented in 4 of the 5 years in which nesting records are reported.

Records of Green nesting do describe a typical, bell-shaped temporal nesting distribution.



Nesting Status

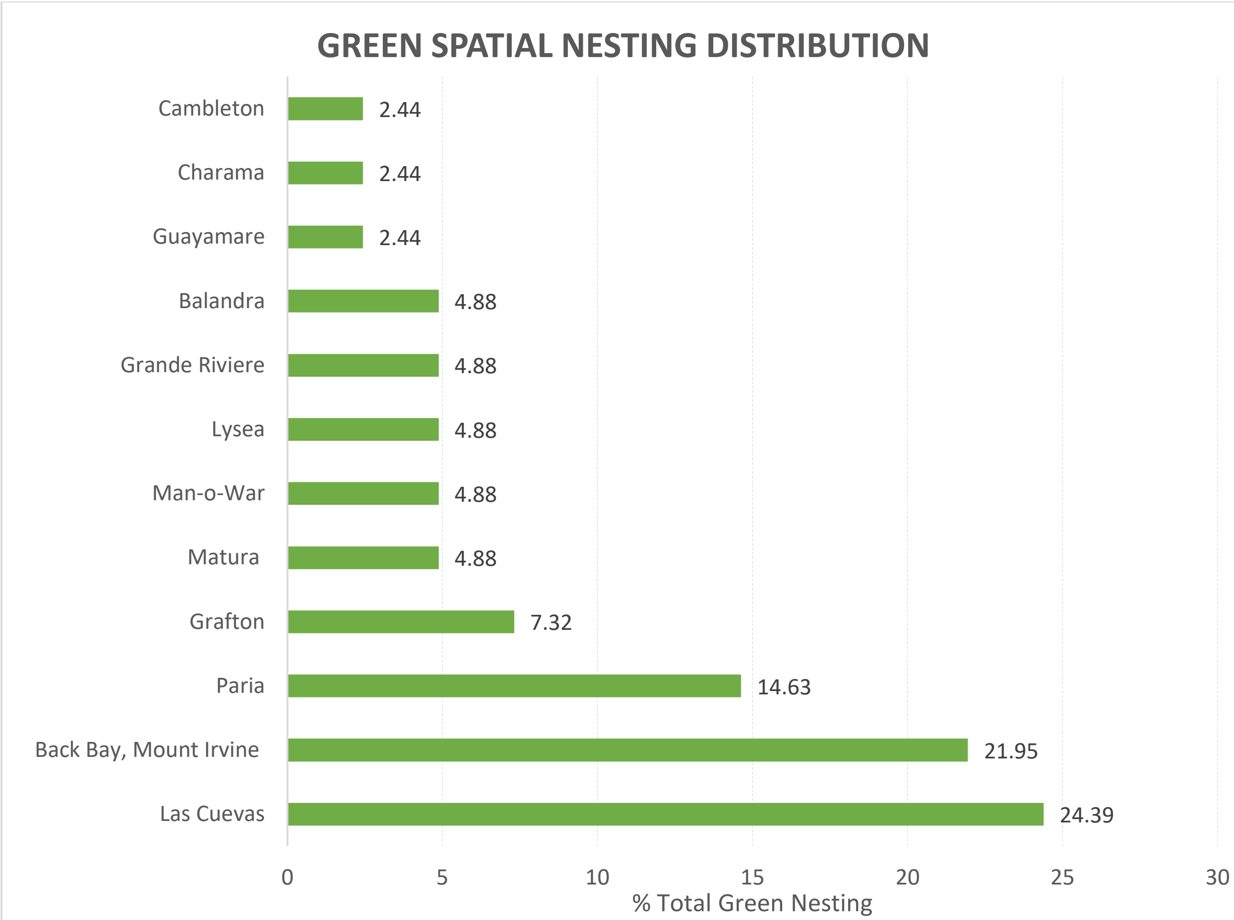
Of observed nesting attempts (n= 41) between 2013-2018, 90.3% resulted in successful oviposition while 2.4% of nests were aborted.

Nesting Outcome	GREEN 2014	2015	2016	2017	2018	Total Outcomes
Confirmed Lay	3	1	6	10	7	27
Estimated Lay	1				9	10
False Crawl						
False Crawl With Body Pit	1					1
Dead						
Poaching						
Stranding						
Unknown	3					3
Total Annual Outcomes	8	1	6	10	16	41

Spatial distribution

Nesting occurs across 12 beaches.

4 beaches account for 68.29% of nesting events: (in order of prominence) Las Cuevas; Back Bay, Mt Irvine; Paria and Grafton



Nesting Beach Fidelity/ Observed Clutch Frequency / Observed Internesting period / Remigration Interval

Each turtle was only reported once in the monitoring period (2013-2018), therefore it was not possible to analyse the following nesting parameters:

Nesting Beach Fidelity

Observed Clutch Frequency

Observed Internesting period

Remigration Interval

Nesting Ecology of the Loggerhead Turtle, Caretta caretta

There were no nesting records of Loggerhead sea turtles from 2013 to 2018.

There was however a single stranding event.

On the afternoon of 30th June 2017, a female Loggerhead sea turtle was found stranded on Manzanilla beach by passersby. The community group in the area, Wildlife Watch Environmental Group, were among those assisting in her rescue. Since she appeared dehydrated and exhausted, she was taken for further examination upon which it was discovered that she had issues with buoyancy and balance control.

At the El Socorro Wildlife Rehabilitation Centre, the rarely encountered Loggerhead underwent 10 weeks of rehabilitative care under guidance from Dr. Phillips of UWI Mt Hope. Volunteers from community groups, including Grande Riviere Nature Tour Guide Association, Las Cuevas Eco-Friendly Association, Blanchisseuse Environment Community Organisation and Wildlife Watch Environmental Group assisted with tube feeding and other rehabilitative care. This was a great opportunity for skills training and learning rehab techniques.

Despite a few medical setbacks including a rectal prolapse and a gastrointestinal blockage, Sammy got progressively stronger and showed interest in fresh feed. By week 8, she was able to pass faeces and feed on her own so her release was planned.


Sammy at release from Manzanilla beach

Sammy got her final review by the veterinary team and was released on Sunday 10th September, 2017 at the approximate location where she was recovered in Manzanilla.

Nesting Ecology of the Olive Ridley, Lepidochelys olivacea

There was a single nesting record of Olive Ridley sea turtles from 2013 to 2018.

A confirmed Olive Ridley nesting was recorded on Grande Riviere beach in May 2013.

The Olive Ridley (Lepidochelys olivacea) during nesting at Grande Riviere.

This is only the second nesting recorded at this site, the other being almost two decades earlier in 1995. The Olive Ridley is the least commonly observed nesting sea turtle in Trinidad & Tobago with only 25 nestings recorded since 1981 and the last nesting sighted in 2003 (*STRAP, 2010*).

The Olive Ridley encountering a Leatherback Turtle (Dermochelys coriacea).

Anthropogenic Mortality and Disease

There had been substantial, though undocumented, harvest in the past of the turtle eggs and meat taken for food and carapaces for jewellery and crafts. Harvest has not been permitted under any legislation since 2011. However, there has been a reported increase in frequency of unintentional interactions between human activities and sea turtles, many of which can be detrimental to the individual turtles and their populations.

Between 2013 and 2018, records of strandings, fisheries bycatch, poaching and other mortality for sea turtles has been part of the data captured by community conservation groups in Trinidad and Tobago. Given that some carcasses will be destroyed by predators or decay before they strand, not all sea turtle mortality will be recorded.

Sources of injury and mortality from human-related activity that have been identified for the period 2013-2018 include;

- Entanglement in fishing equipment (net, line, rope)
- Boat strike
- Ingestion of synthetic material (plastic, fishing hooks)
- Disease (fungal infection of nests, low frequency of Fibropapilloma tumours on Green sea turtles)
- Meat and egg harvest
- Disorientation from altered light horizons

Discarded head of a poached Green Sea Turtle in Rampanalgas July 2015

Decomposing sea turtle body parts at Star Wood, Speyside from June 2017

The table (Table 13) below highlights the reported numbers of dead sea turtles for the period 2013-2018 for each of the species of turtles at nesting sites throughout Trinidad and Tobago.

There were almost three times as many deaths of Leatherback sea turtles recorded than Hawksbill and only 1 dead Green sea turtle was recorded.

It is suggested by community persons, that the majority of deaths of Leatherback may be due to drowning after incidental capture in fishing nets. The deaths of hard-shell turtles are mainly due to capture for meat.

Of note in Tobago, during kayak surveys at the Bon Accord site in September 2016, high levels of poaching was noted in the area with a number of Greens shells observed within the mangrove on the Pigeon Point beach.

Table 13 *DEAD TURTLES OF EACH SPECIES PER YEAR*

	2013			2015			2016			2017			Total LBK	Total HWK	Total GRN
BEACH	LBK	HWK	GRN	LBK	HWK	GRN	LBK	HWK	GRN	LBK	HWK	GRN			
Arnos Vale, Celery, Moriah Big Bay											4			4	
Balandra		1												1	
Big Bay, Sans Souci	1			6									7		
Charama				2									2		
Grand Tacarib				1									1		
King Peters Bay											1			1	
Las Cuevas	1									3			4		
Manzanilla	2			6									8		
Marianne				1						1			2		
Mission	1												1		
Paria				11						2			13		
Red Sand					2									2	
Roxborough															
Speyside		1												1	
Star Wood		1	1								1			2	1
Toco (Salybia)		1												1	
Turtle Beach															
Total	5	4	1	27	2					6	6		38	12	1

During kayak surveys at the Bon Accord site in September 2016, high levels of poaching was noted in the area with a number of Greens shells observed within the mangrove on the Pigeon Point beach.

Hatchling Hawksbill trapped in a plastic beverage bottle

Dead Leatherback turtles washed ashore in Las Cuevas May 2018 (entangled in fishing net) and Orosco July 2015

FINDINGS & DISCUSSION

FINDINGS

Nesting Rookeries

The distribution of sea turtle nesting in Trinidad and Tobago has been broadly surveyed. However, the size of the population at each of the numerous rookeries have been incompletely surveyed.

It is considered that all higher density nesting sites within the sampled area will have been detected in this Project, however, additional low density nesting sites will be identified with more intense surveys.

The Index beaches Fishing Pond, Grande Riviere and Matura and Turtle Beach, Grafton Beach (Stonehaven Bay) and Mt. Irvine Back Bay are the pre-dominant Leatherback nesting beaches.

For each site with high density nesting there was a series of lower density nesting sites in the vicinity. Marianne Bay, Big Bay and Manzanilla (Cocos) Bay, identified with an estimated more than 50 nesting events annually for Leatherback turtles. They are ranked in the top 10 most abundant Leatherback rookeries. Of the Survey sites, Las Cuevas supports the highest nesting density for Leatherback turtles (9^{th}) while also being selected by turtles which also nested at an Index beach. Las Cuevas also supports the highest nesting density for Green sea turtles of all beaches.

Survey Additional Beaches predominantly support Hawkbill nesting (75% of total Hawksbill nesting), including Hermitage the highest nesting abundance. The adjacent Charlotteville beach, Cambleton is a high density nesting site for Hawksbill turtles (2^{nd}) and Leatherback turtles (11^{th}). Based on nesting data, Hermitage and associated Charlotteville beaches have the highest Hawksbill nesting events in Tobago and capture tag returns from Barbados. Hermitage should be considered for intensive monitoring.

Las Cuevas, Charama and Cambleton were most selected by turtles which also nested at an Index beach.

Remote access beaches predominantly support Hawksbill nesting while the North-West peninsula beaches collectively had the second highest nesting density.

Tagging studies have demonstrated that the adult female displays a high degree of fidelity to her chosen nesting beach, with most females returning to the same beach for oviposition of their successive clutches within a nesting season and in successive nesting seasons.

However, a small proportion of the nesting population interchange among adjacent rookeries up to 115km apart (Fishing Pond to Cambleton) between and within breeding seasons.

Findings on Anthropogenic Mortality

There exists no data prior to 2013 on the number of poached turtles. However, based on historic reports from community persons, poaching particularly of hard-shell turtles was culturally acceptable in coastal communities particularly in Tobago.

While the extent of harvesting has not been completely eliminated, data collected between 2013 and 2018 showed a decline in the reports of these incidences. This may be attributed to a more effective Education & Awareness Programme by Turtle Village Trust and members of communities being involved in conservation efforts.

There is incomplete data available to determine the extent to which these sources of mortality impact the sea turtle population. This information should be collected.

Nesting Beach Temperature Profiling

Beaches differed thermally and different sites on the same beach also differed thermally.

Lethal Threshold

All temperatures reported in **Hermitage, Tortue Bay and Rincon** in 2018 were within the lethal threshold 25°C - 35°C so there should be no deaths of turtles as a result of temperature.

Bande du Sud (max 36.4°C), Grande Riviere (max 38.49°C) recorded temp that were above the lethal threshold 25°C - 35°C so there could be deaths of turtles as a result of temperature.

Sex ratios of hatchlings

Where temperatures are above 29.5 there will be a skew of hatchlings towards females. Therefore the likelihood of temperature-dependant skew towards female hatchlings is probable for all sun exposed sites sampled.

Sex ratios of hatchlings produced at Hermitage, Rincon and Grande Riviere as well as sun exposed nests on Bande du Sud and from October to December on Tortue Bay, would be skewed to females.

Nests at Tortue Bay under shade conditions and from July to September in the sun exposed conditions and shade conditions at Bande du Sud would be skewed to male hatchling production.

Hatchery box temperatures in Grande Riviere, were generally lower than the mean monthly temperature on the beach. Boxes therefore have the potential for male hatchling production.

Temperature profiles in areas shaded by vegetation cover are most similar to ambient air temperatures, lower than temperature profiles of sun exposed areas and show least temperature fluctuations. This demonstrates that the predicted climate change scenarios of increased temperatures leading to sex ratio skew could be mitigated by shading. A possible management action which could be considered is the replanting of a vegetation buffer in the backshore of exposed beaches.

The present study did not provide numerical estimates of sex ratio, does not assess correlation of national meteorological data with site-specific data, and does not examine the mean middle-third incubation temperature or pattern of metabolic heating within the 13 nests.

Genetic Profiling

Based on these gene expressions, it was determined that 83% of all hatchlings were female. This is worrisome given the fact that global temperatures are on the rise, which in turn increase the potential for increased nest temperatures. Nest temperatures have also been shown to be affected by type of sediment and the ability of these sediments to absorb and retain heat. This would either result in female-dominated clutches, or low hatchling success due to in-nest mortality or undevelopment. In time, this will have a domino negative effect on the population's reproductive capabilities and nesting events (Guppy 2018).

Twelve unique haplotypes have been determined thus far for the localised hard-shell sea turtle population of Trinidad and Tobago. Haplotype EiA-09 being the most dominant, closely followed by EiA-11in the current sample (Guppy 2019). There were 4 distinct haplotype groupings for suggesting that there exists discrete sub-populations at each of the locations sampled.

Samples were predominantly nesting female with some hatchlings. While this provides information on the nesting population, it does not adequately represent the offshore foraging population.

Species Representation

Leatherback Turtle, Dermochelys coriacea

- Dominant nesting species
- From 2013-2018, 99.51% of nests recorded were laid between March and the end of August
- 75.7% Successful laying
- Estimated Clutch Frequency – 7 clutches per female in a nesting season (10 day inter-nesting interval)
- High incidence of turtles returning to nest in more than one season
- Mean period between nesting for an individual female was 3 years
- 93.23% of turtles show fidelity to 1 nesting beach
    - Overlap between Index beaches 85.42 - 100%
        - Greatest overlap between Fishing Pond and Matura
    - 7.6% of turtles nesting at Grande Riviere and another beach, selected a non-Index beach (Top beaches: Big Bay, Sans Souci and Las Cuevas)
- Mean Curved Carapace Length 154.27cm ±12.42, Mean Curved Carapace Width 72.17 cm ±14.73

Hawksbill Turtle, Eretmochelys imbricata

- 2nd highest nesting species
- From 2013-2018, 98.8% of nests recorded were laid between March and the end of August
- 82.3% Successful laying
- Estimated Clutch Frequency – 5 clutches per female in a nesting season (15 day inter-nesting interval)
- Low incidence of turtles returning to nest in more than one season
- Mean period between nesting for an individual female was 2 years
- Nesting occurs across a wide range but 7 beaches account for 82.68% of all nesting. The top 3 beaches are remote nesting sites: Hermitage and Cambelton in Charlotteville area and Bande du Sud, Chacachacare Island

- Mean Curved Carapace Length 87.05cm ±1.58, Mean Curved Carapace Width 114.00 cm ±2.43
- From the genetic analysis twelve unique haplotypes have been determined thus far for the localised hard-shell sea turtle population of Trinidad and Tobago. Haplotype EiA-09 being the most dominant, closely followed by EiA-11in the current sample (Guppy 2019). There were 4 distinct haplotype groupings for suggesting that there exists discrete sub-populations at each of the locations sampled.

Green Turtle, Chelonia mydas

- 3rd highest nesting species
- From 2013-2018, all reported nests were laid between March and the end of August
- 90.3% Successful laying
- No incidence of turtles returning to nest in more than one season
- Mean period between nesting for an individual female could not be calculated
- Likely high occurrence of missed nests
- Mean Curved Carapace Length 92.25cm ±3.49, Mean Curved Carapace Width 72.17 cm ±7.69

Records of Green nesting do not describe a typical, bell-shaped temporal nesting distribution. It is likely that there is year-round nesting or that the current monitoring period (March to August) does not cover the Green nesting period. May and August show nesting across all years.

There is an increase in nesting from March to August, so it is likely that extending the monitoring period beyond August will more appropriately describe the nesting behaviour of the Green sea turtle.

Loggerhead Turtle, Caretta caretta and *Olive Ridley, Lepidochelys olivacea*

The dataset does not adequately describe the nesting phenology of the Loggerhead or Olive Ridley sea turtles as neither are represented in the data.

This may be due to:

- Species misidentification by data collectors (including crawl patterns)
- Missed nesting events:
  - Timing of monitoring:
    - Turtles may be nesting outside of March-August monitoring period

    - There may be year-round low levels of nesting

- Areas of nesting: turtles may be nesting outside of the current Project boundaries. Fishermen and community residents in Mayaro describe Loggerhead turtles offshore in that area.

DISCUSSION

Leatherback turtles are the most numerous sea turtle species nesting in Trinidad in Tobago with Hawksbills a distant second.

The main procedure for evaluating the status of the sea turtle species populations is through surveys of activity at nesting beaches. Leatherback nesting trends in the North-West Atlantic regional nesting has been documented to be statistically measurable regional-scale declines, particularly in the past decade (*Northwest Atlantic Leatherback Working Group, 2018*).

While some of the site-level Caribbean Leatherback nesting populations appear to be increasing or at the very least stable, in the long-term (>30 years), these site-level trends were nearly all negative in the short-term (last decade) (*Northwest Atlantic Leatherback Working Group, 2018*), suggesting a rapid contraction of the regional population could be imminent.

The most important Leatherback nesting sites in Trinidad are Matura Bay, Fishing Pond, and Grande Riviere.

In Tobago, low density nesting occurs on most beaches and has been reported from both the Caribbean and Atlantic coasts. In Tobago, activity for this species alone accounts for 59% of all recorded sea turtle nesting and related activity that occurred in 2013-2018 on beaches surveyed.

The most important beaches (those with the most nesting events) are Turtle Beach, Grafton Beach and Mt. Irvine Back Bay, accounted for 79% of all recorded Leatherback nesting activity in 2013-2018, with the remaining 21% of this species activity scattered throughout the remaining non-index beaches surveyed

Leatherbacks show less breeding philopatry or site fidelity to nesting beaches than other sea turtles and sometimes use several beaches within a region to nest (Law et al, 2009). Several turtles marked as “Returns” were previously tagged while nesting on beaches located on other Caribbean islands and South America.

Leatherbacks, like most other species of sea turtles, regularly migrate vast distances between foraging grounds and nesting beaches. Leatherback turtles nesting in T&T migrate throughout the tropical and sub-tropical Atlantic before returning to nesting beaches.

Leatherbacks are found in the tropics, as well as in cold Canadian and European waters. This species has the most extensive range of any sea turtles reinforcing the need for collaborative resource management and legal protections.

Hawksbill populations continue to decline in many parts of the world. Direct exploitation has had a particularly significant impact on many turtle populations in the Caribbean. Inhabiting easily accessible near-shore coastal areas, means Hawksbills are particularly vulnerable to exploitation such as poaching, overharvesting and habitat destruction. Turtles and their eggs have been exploited since time immemorial by virtually all Caribbean peoples (CITES). Turtle meat and eggs have provided a supplemental source of protein for subsistence fishing and coastal communities in the Caribbean (CITES).

With the low numbers of nesting Green turtles, the Hawksbill has become the most targeted and caught species of sea turtle in Tobago.

Until September 2011, persons were allowed under legal amendment, the “Protection of Sea Turtles and Turtle Eggs Regulations” of the Republic of Trinidad and Tobago Fisheries Act 1975, to legally hunt ALL species of sea turtles in the territorial waters surrounding T&T from October – February annually, despite this species global status listed as critically endangered by the IUCN.

After years of consistent lobbying by local and international conservation groups, this legal loophole was closed by a change in the above amendment.

The amendment now “prohibits the killing, harpooning or selling of turtle”. It further states: “No person shall, at any time, kill, harpoon, catch or otherwise take possession of any turtle, or purchase, sell, offer or expose for sale or cause to be sold or offered for sale any turtle or turtle meat” effectively implementing a year-round ban on hunting of ALL species of sea turtles, turtle eggs or associated products in Trinidad and Tobago. It is important to note that while this amendment can be easily reversed through existing regulatory authority held by the line Minister responsible as it is not a legally binding act passed by majority through the Houses of Parliament of Trinidad and Tobago, the 2014 declaration of sea turtle species as Environmentally Sensitive Species under the Environmental Management Act (2000) further serves to support conservation protection for these species. .

Despite this positive legislative step on the part of the Government of the Republic of Trinidad and Tobago, without the proper enforcement of new or existing legislation, sea turtles will continue to be harvested year-round, albeit illegally.

It is important to note that deficiencies in the surveillance of this species do occur. Nesting sites for Hawksbill, Green and other hard-shelled species of sea turtles are often located on small inaccessible, isolated beaches, sometimes associated with shallow offshore reefs. This combination of factors makes monitoring of these species on a regular basis difficult. Surveys usually comprise track counts rather than actual encounters with turtles on nesting beaches.

Activity for this species accounts for 5% all sea turtle nesting activity recorded during the 2013-2018 nesting season on surveyed beaches.

Previous data collected in 2007 indicated that the distribution of Hawksbill nesting activity, were primarily located in the northeast of Tobago (SOS Tobago, unpubl. data). Greater surveillance of this species nesting activity in 2013-2018, has shown that the distribution of Hawksbill nesting sites on the island of Tobago is geographically wider than previously known. This shows that there are Hawksbills nesting on almost all beaches on the island, with most nesting sites located along the Caribbean coastline.

Further analysis of the data collected in 2013-2018 shows that nesting sites in southwest Tobago (south of Bloody Bay on the Caribbean coast and Roxborough on the Atlantic coast) account for over 12% of recorded activity for this species. Most of this nesting activity is concentrated at Big Bacolet, Buccoo Bay, Grafton Beach, King Peters Back Bay, Lambeau Beach, Mt. Irvine Back Bay, Pigeon Point, Sandy Point, and Turtle Beach. The most active nesting beaches for northeast Tobago were Cambelton Bay, Celery Bay, Dead Bay, and L'Anse Fourmi.

While errors in determination of activity outcomes do occur occasionally, particularly because of deterioration of tracks, and/or body pits (from weather, pedestrian or vehicular traffic) and surveyor inexperience, these errors are not frequent enough to significantly affect the results of surveys carried out.

Reports of sea turtles nesting in increased numbers at previously unrecorded sites could indicate a migration of females in response to environmental conditions at historical nesting sites. This census will allow for an assessment of the entire potential nesting area to account for a spatial shift in nesting areas due to geomorphological processes. Severe erosion at nesting beaches has reduced the area suitable for nesting and consequently the probability of success. If a spatial shift is apparent, adjustments to the boundaries of the monitoring programme will need to be made to accommodate this.

As described in the Report, there are several potential drivers for these trends, including anthropogenic threats. Identified conservation actions, to further support recommendations by STRAP (referenced in italic font below), to address these drivers include:

- Enhance monitoring on nesting beaches
    - Continue consistent long-term nesting data collection on Index beaches
      "It is a recommendation of this Recovery Action Plan that Index Beaches be monitored for long-term fluctuations in numbers that will reveal the success or failure of conservation efforts.
      It is a recommendation of this Recovery Action Plan that population monitoring should continue for at least one sea turtle generation; that is, about 35 years."
        - → *Nightly Census and Tagging (1st March- 30th November) on Index beaches:*

Leatherback	Turtle Beach Grafton Back Bay, Mount Irvine Fishing Pond Grande Riviere Matura: Orosco-Rincon
Hawksbill	Hermitage Cambleton Bande du Sud, Chacachacare Island Tortue Bay, Huevos Island

→ *Nightly Census and Tagging (1st April - 31st August), Morning Count (March, August, September) on Key Nesting Rookeries*

Trinidad	Manzanilla Big Bay-Sans Souci Marianne Bay Las Cuevas North Manzanilla: Lysea, Charama La Foret Patience Balandra; Sena
Tobago	L'Anse Fourmi Buccoo Pigeon Point Crompston's Beach Lambeau Minister’s Bay, Bacolet

→ *Nightly Census and Tagging on Remote beaches for a minimum of 8 weeks during the peak nesting period*

Bande du sud, Chacachacare La Tinta,Chacachacare Tortue Bay, Huevos Biscayne Bay, Monos	1 count every 15 days for the period November to March
Paria Petit Tacarib Grande Tacarib Madamas Manantial	1 4-day survey per month for April (early nesting) and October (hatchling emergence), 2 4-day surveys per month for May to September (peak)

- Continue to collect tag-return data, including international tags, and analyse population linkages (along with genetic studies) and migration patterns
  “Continue support to the turtle tagging programme on Index Beaches to increase understanding of inter-nesting frequencies, rates of exchange among nesting beaches, and remigration intervals, ensuring that data is archived in the National Sea Turtle Database”

- Increase coverage and tagging of nesting females, to describe the nesting habitat and shifts in nesting range, in "new" beaches, remote areas and particularly unsurveyed areas in Tobago

  "It is a recommendation of this Recovery Action Plan… a three-year, comprehensive survey of nesting habitat

  During the survey, all potential nesting habitat (i.e., the nation's entire sandy coastline) should be foot-patrolled at least weekly from 1 March to 30 November, which encompasses the peak nesting season for the five species of sea turtle known to nest in Trinidad and Tobago."

  To ensure that the monitoring effort and available resources are adequately apportioned to facilitate effective population monitoring.

  → Morning/Census Counts (March- September) 3 counts within a 7-day period:

    TRINIDAD
    La Payalle (Las Cuevas)
    L'anse Martin/ Yara/ Damian (Blanchisseuse)
    Homard
    Textel (Matura)
    Guayamare
    Tompire
    Red Sand (Toco)
    Salybia (Toco)
    Mission
    Mayaro, Guayaguayare

    TOBAGO
    Grange
    Hope,
    Arnos Vale/ Anse Fromager/ Little Bay Celery (Moriah)
    Roxborough,
    Goldsbrough/ Richmond
    Kendal
    Speyside (Lover's Bay, Bateaux)
    Speyside (Tyrell's, Lucy Vale,)
    Charlotteville (Man-O-War)
    Castara

Englishman's Bay

→ Tobago year-round Census including unsurveyed areas eg. Englishman's Bay, Castara

→ National Census in peak nesting (6 weeks)

- Ensure continued work to increase protection and reduce threats to nesting populations
  - Characterise threats (potential magnitude and types eg. habitat loss, of effects of debris, nesting deterrents)
  - Advocate for legal protections of Index beaches and Key Nesting beaches
  - Ensure continued work to eliminate illegal, unreported poaching and harvest of eggs and gravid females

    "It is a recommendation of this Recovery Action Plan that dogs found roaming the nesting beach be collected and impounded, and the owners charged a fee for their release (including the license fine, when applicable)."

- Population Structure Analyses through continued sampling of nesting females, hatchlings and males in-water for population structure analyses will involve the collection of tissue biopsies and genetic material.
  - Samples will be collected from:
    - In-water studies including satellite telemetry (males and juveniles)

      → Priority sample collection from Offshore Programme

    - Nesting females
    - Hatchlings

      → Priority for developing a non-deleterious method of sample collection eg. from egg shells, mucus, etc

    - Sampling females across nesting range will be used to determine the connectivity of females in the population

    - The genetic material retrieved from hatchling turtles will describe the male population and the relative ratios of males to females in the breeding population.

- Describe how migratory and foraging patterns are influenced by oceanographic models of abiotic factors such as currents, temperature and biotic factors such as chlorophyll content etc

    - Characterise potential magnitude of sediment changes on nesting beaches
        - Establish benchmarks along all Index beaches
        - Assess correlation of sediment type (aggregate size and texture) with beach temperatures
        - Investigate the use of aerial photography
    - Design and execute analysis to determine patterns and drivers of hatchling production
        - Make collection of *in situ* nest temperatures
        - Examine the effects of genetics and nest temperatures on sex determination and hatch success
        - Investigate ecotourism impacts on hatch success

          "Mandate control zones (such as has been done at Matura Beach) on high visitation beaches to exclude foot traffic, thereby providing an essential comparison between ecotourism and natural sites and allowing for an evaluation of the effects of ecotourism on sea turtle nesting and hatch success."
    - Characterise potential magnitude of increased sand temperatures
        - Priority to implement nationwide temperature monitoring
        - Assess correlation of meteorological data with beach temperatures

- Advocate for retaining or enhancing resilience in coastal ecosystems, particularly as it relates to infrastructure development, in light of climate change and sea level rise

- Prioritise collaborative data collection and analysis
  - Consolidate Project data in the National Sea Turtle Database

    "It is a recommendation of this Recovery Action Plan that all historical sightings documentation be assembled into a national database, geo-referenced, and serve as a launch point for modernising and continuing a national Sea Turtle Sightings Database."
  - Contribute nesting and tagging data to regional analysis to determine patterns in remigration intervals, clutch frequency and survivorship.
  - Execute collaborative data sharing and analysis with local organisations of existing data on coastal communities and habitats (eg. Department of Natural Resources and Fisheries- Tobago House of Assembly, University of Trinidad & Tobago, Institute of Marine Affairs) as it relates to Beach and Species Management Plans
- Strengthen partnerships among stakeholder towards resource management

    "Conduct an assessment of the ecological and economic values of sea turtles to the country. Seek to preserve these through the development (and implementation) of holistic management plans that take into account the specific recommendations of this Recovery Action Plan and encourage active participation on the part of resource users."

    " …it is a recommendation of this Recovery Action Plan that site-specific management planning involve local coastal zone authorities specify pertinent restrictions, provide for the enforcement of restrictions and other guidelines and encourage public awareness"

    "It is a recommendation of this Recovery Action Plan that Prohibited Area status be afforded to other critical habitats, especially in Tobago."