

# The Bermuda Turtle Project

## 2023 ANNUAL REPORT



BTP is a joint project of the Bermuda Zoological Society (BZS) and the Sea Turtle Conservancy (STC), and is committed to the goal of promoting the conservation of marine turtles in Bermuda through research and education. Project activities during 2023 included field and laboratory research, and educational outreach via different media outlets and public interactions.

### Sampling session August 2023

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Research boat Endurance captained by Nigel Pollard

The Bermuda Turtle Project offered its 26th In-Water Course on the Biology and Conservation of Sea Turtles to international and Bermudian students from 14-25 August 2023. The two-week course consists of lectures, class discussions of assigned readings, a necropsy session, and ten days of field work aboard the *RV Endurance*. The course is offered each year

by the Bermuda Zoological Society and the Sea Turtle Conservancy and is provided free-of-charge thanks to donor support.

The students learned to capture immature green turtles using the entrapment net. They also gained extensive practical experience in collecting data from the turtles once they were captured and brought on board the research vessel. The course was taught by Dr. Daniel Evans and Rick Herren from STC, and Jennifer Gray and Dr. Gaëlle Roth from Bermuda. This year students came from Australia, Belgium, Bermuda, Chile, Panama, Spain and the USA.

The in-water field work was carried out for 10 days. The team consisted of Dr. Daniel Evans, Rick Herren, Jennifer Gray, Dr. Gaëlle Roth, and Barbara Outerbridge. The BZS research vessel, *RV Endurance*, served as the main vessel and was captained by Nigel Pollard. Miguel Mejías was the first mate. The catch boat, *Chevron*, was captained by Jennifer Gray, with Emily Andrew and Kate Cooper as first mates. Snorkeling assistance was provided by volunteer Ruskin Cave and 9 students in the BTP In-Water Course.

A total of 74 green turtles and 1 hawksbill turtle were captured during 18 sets of the entrapment net at 17 sites around the island. Animals ranged in size from 24.0 to 60.2 cm straight carapace length (SCL; see sampling log below). Compared to 2022, when 53 turtles were caught in 21 sets at 17 sites, the total number of turtles caught was higher, and the overall average green turtle carapace length increased from  $37.6 \pm 7.6$  to  $38.6 \pm 8.9$  cm.

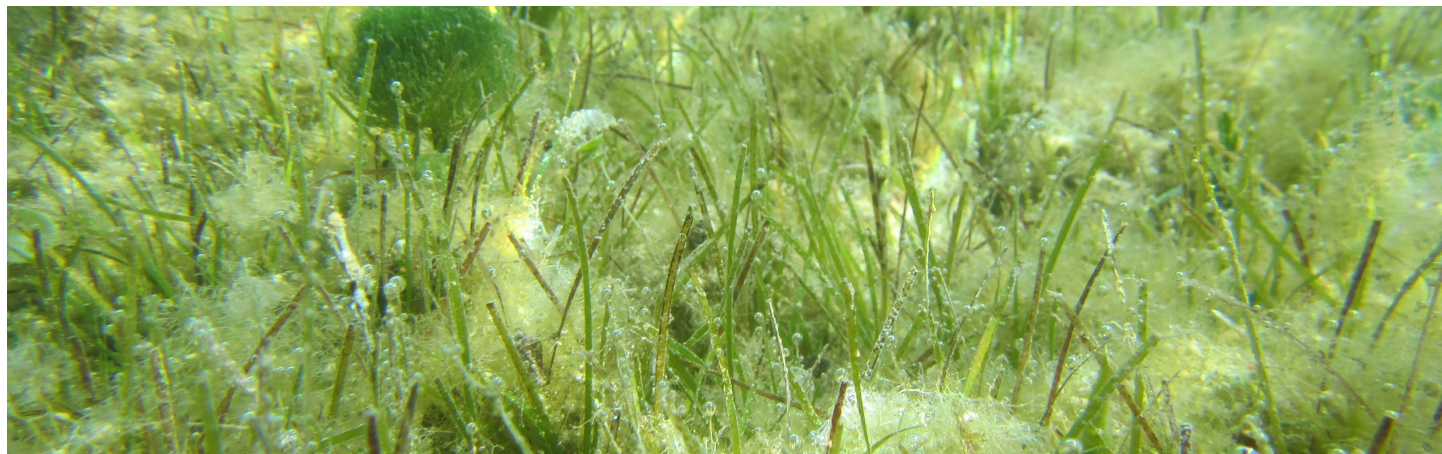
All turtles captured in the entrapment net in 2023 were judged to be immature based on previously established shell and tail size criteria (ref?). They were tagged, biometric data and blood or tissue samples were collected, and the turtles were released at or near their capture site. Blood samples or skin biopsies were obtained for genetic analysis to study nesting beach origins of Bermuda green turtles, for hormone analyses to establish sex, and for stable isotope analysis.



Jennifer Gray hauling of the net into the net boat with Océane Merchiers and Vicente Pena Eisele

As part of a health assessment, the research team measured blood values in a sample of 35 captured green turtles, in order to establish a baseline and detect any changes in the Bermuda green turtle aggregation, including those potentially due to the continued loss of seagrass. Captured turtles were brought on board for a standard work up and small amounts of their blood and plasma were passed through handheld and desktop blood analyzers to document standard blood compounds and blood gas values. Results were generally within the expected ranges for green turtles. We manually measured the percentage of red blood cells in the whole blood (manual packed cell volume) as well as the total protein in the plasma. Most turtles had a manual packed cell volume and total protein that were within the expected range for juvenile green turtles. The morphometrics of each turtle were used to calculate the body condition index per turtle. No turtles captured in 2023 exhibited signs of the disease fibropapillomatosis.

The BTP research team flushed the esophagus of 30 captured green turtles during the 2023 sampling session. This is one of the most common ways to identify recently ingested items and determine the primary food source in the wake of widespread loss of turtle grass (*Thalassia testudinum*). The procedure uses a veterinary stomach tube and double-action pump to flush the contents of the mouth and esophagus with fresh sea water. While these samples will undergo a detailed lab analysis, a preliminary examination revealed that almost all of them contained a mix of manatee grass (*Syringodium filiforme*) and shoal grass (*Halodule wrightii*). Not surprisingly, these seagrasses are common in inshore bays and wind-protected areas and this is where we captured most green turtles in 2023.



Seagrass bed in Stock's Harbour

### **Sampling Log for the Annual Bermuda Turtle Project 2023:**

**Sampling Log for Annual Bermuda Turtle Project 2023**

Date	Location	Set No.	Latitude	Longitude	Bottom Temp (° C)	No. of Turtles	Depth (ft.)
14-Aug-23	Bailey's Bay West	1	32.34966	-64.72627	30.0	0	7.0
14-Aug-23	Bailey's Bay East	2	32.35025	-64.72430	30.0	1	6.1
14-Aug-23	Fort St Catherine	3	32.38800	-64.67154	30.0	1	8.9
15-Aug-23	Stocks Harbour	1	32.37023	-64.68973	30.0	25	5.8
16-Aug-23	Darrell's Island	1	32.27554	-64.81775	30.0	2	8.5
16-Aug-23	Vixen	2	32.30739	-64.88678	30.0	1	8.9
16-Aug-23	Cowground	3	32.31782	-64.86968	30.0	0	9.2
17-Aug-23	Tudor Hill	1	32.27628	-64.88483	30.0	0	7.8
17-Aug-23	Ely's Harbour	2	32.28098	-64.88116	30.0	5	11.8
18-Aug-23	Hospital Bay	1	32.31262	-64.84519	30.0	10	10.7
21-Aug-23	Paradise Lakes	1	32.28451	-64.82111	30.0	3	10.0
21-Aug-23	Marshall Island N	2	32.28487	-64.81065	30.0	1	9.4
22-Aug-23	Mullet Bay	1	32.37494	-64.69064	30.0	7	11.8
22-Aug-23	Blue Hole	2	32.34855	-64.70821	30.0	1	6.8
23-Aug-23	Somerset Long Bay	1	32.30427	-64.87496	29.5	2	5.5
24-Aug-23	Hawkins' Island	1	32.28587	-64.82570	30.0	8	11.6
24-Aug-23	Gamma Island	2	32.28150	-64.82542	30.0	4	13.8
25-Aug-23	Frank's Bay	1	32.25425	-64.85585	30.0	4	10.0

Total # of captures for 2023    75

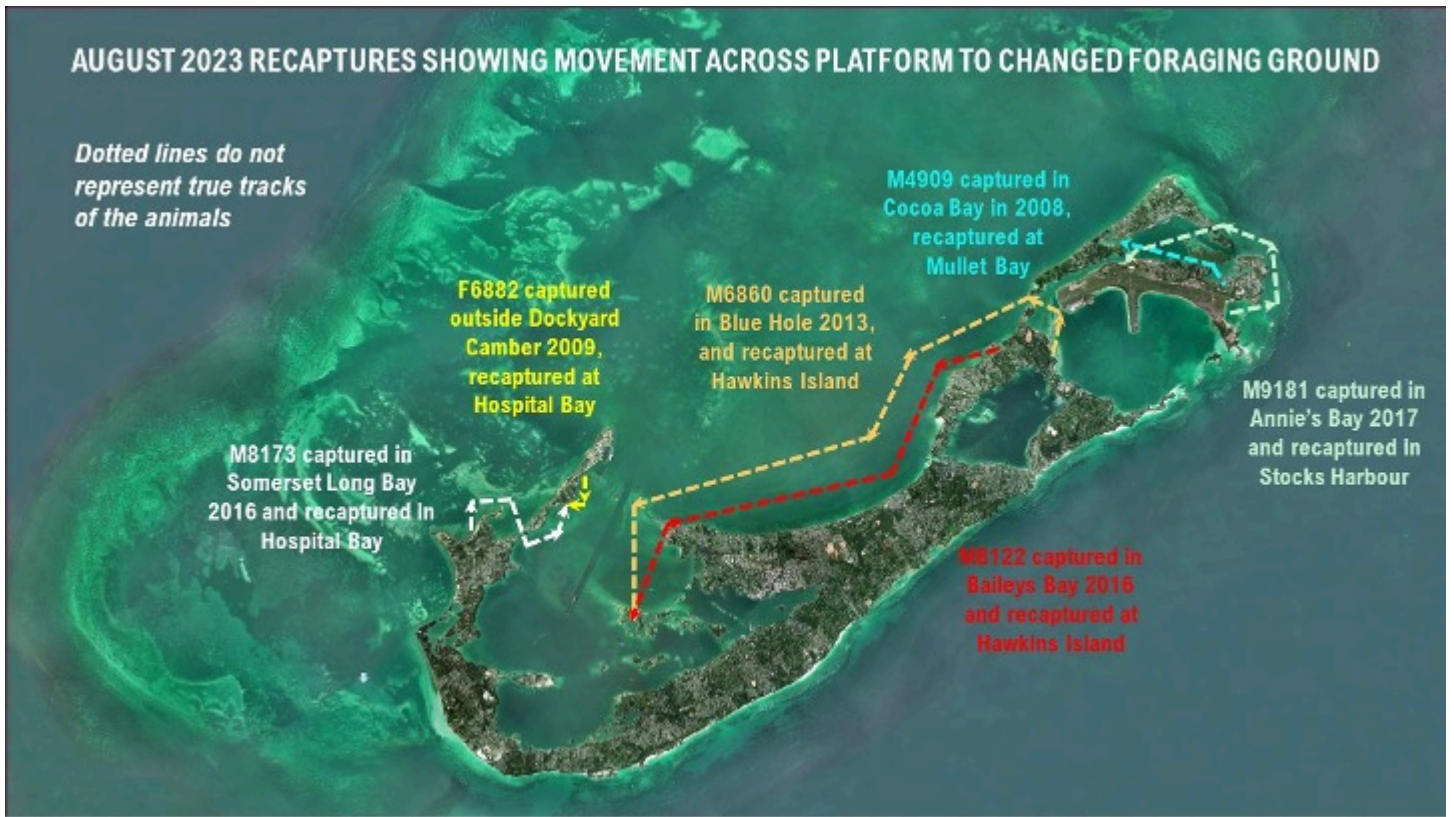
Total # of Captures since 1992   5,313

Of the 74 green turtle net captures made in August, 30 (40%) were recaptures of previously tagged animals. The 2023 recapture rate is the highest of the most recent five years of sampling (23% in 2022, 22% in 2021, 34% in 2019, 37% in 2018) and may suggest that mortality, mobility between foraging grounds, and/or the size before emigration off of the Bermuda Platform is moving back towards what was being observed before the decline in aggregation numbers.

Sixteen of the thirty recaptures were made at the same site where the turtle was last captured. The 14 others had moved to an alternate foraging area. Our work has shown two periods of reduced site fidelity, including one that started around 2010 and continues currently. The recent occurrence of lower site fidelity suggests that as seagrass has disappeared at most sites, green turtles are moving more often in search of food. The increased recapture rate in 2023 may suggest green turtles are adjusting their diet from the declining *Thalassia testudinum* to the relatively more common *Syringodium filiforme*.

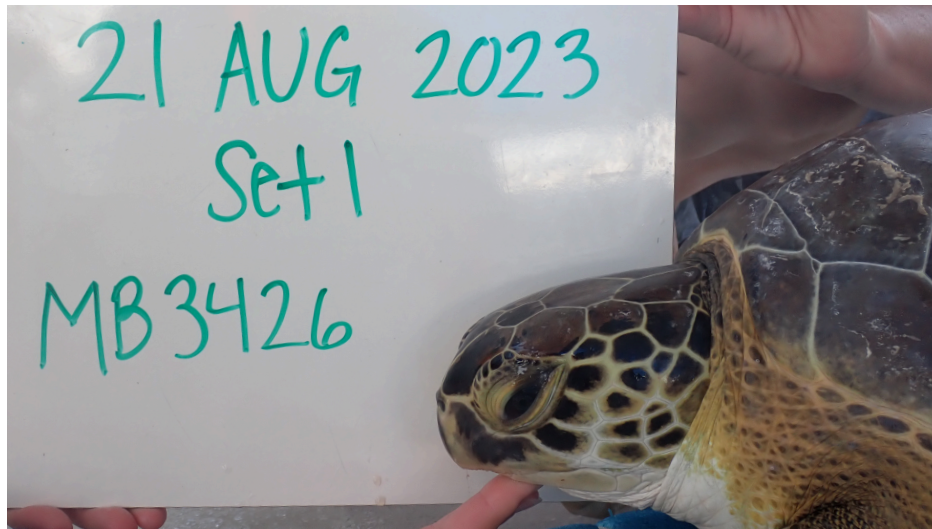
## AUGUST 2023 RECAPTURES SHOWING MOVEMENT ACROSS PLATFORM TO CHANGED FORAGING GROUND

*Dotted lines do not represent true tracks of the animals*



An interesting recapture this year was a green turtle from Hospital's Bay with flipper tag M8913, that was first captured as part of the America's Cup relocation project at Grey's Bridge in May, 2017. This turtle was kept in BAMZ open water pen for approximately 6 weeks before it was released at Clearwater Beach. This turtle was admitted to rehab on 05 May 2020 having stranded on the small beach just before Dockyard with injuries on the carapace and covered in small inshore, intertidal snails. It was released after rehabilitation on 06 Aug 2020 at Clearwater Beach.

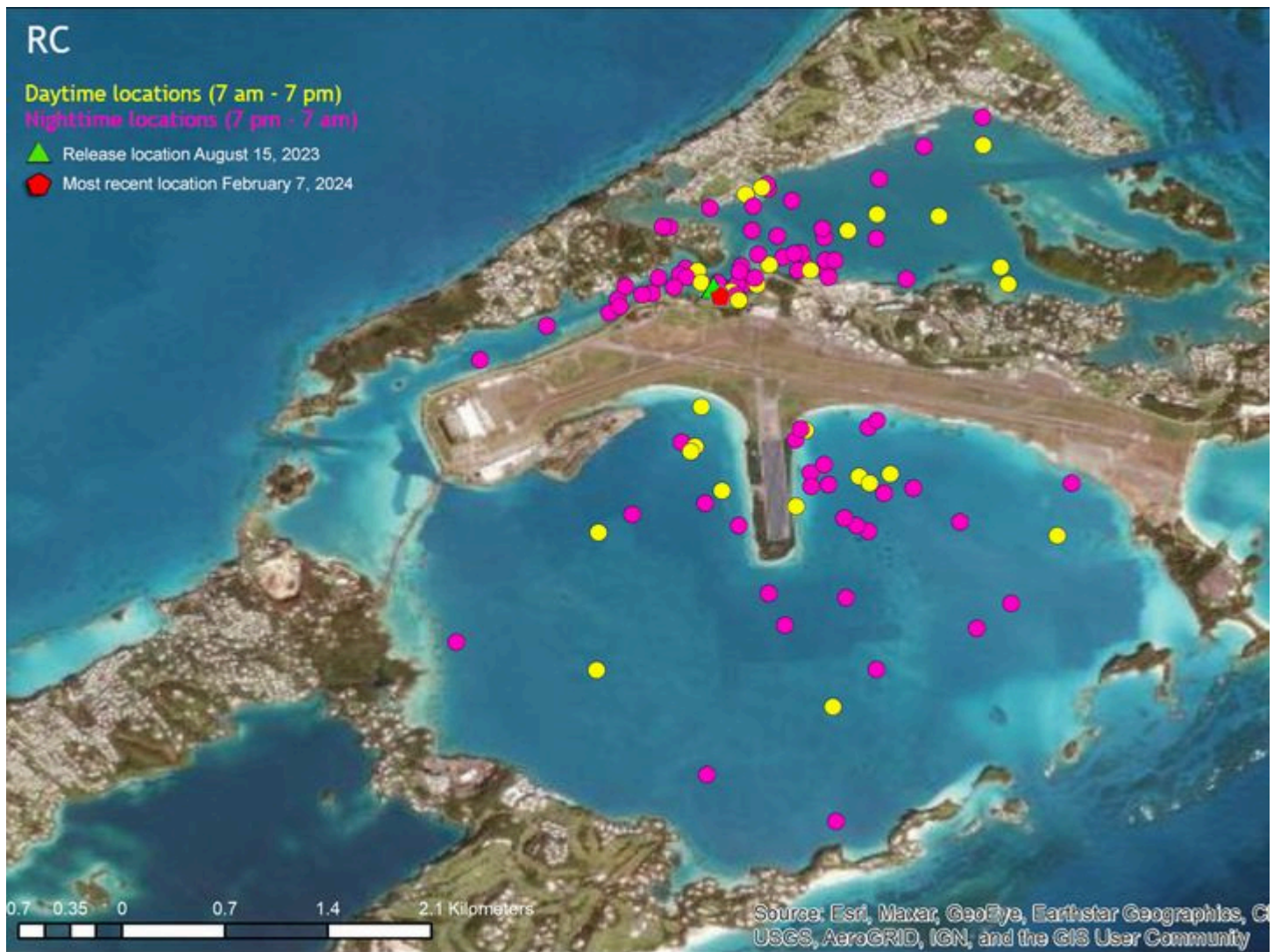
Another recaptured green turtle this year had an interesting BTP history. It was captured in Paradise Lakes and was identified as MB3426, which was our satellite tracked turtle “Sea Biscuit” from our 2022 sampling session in Paradise Lakes. The satellite had tracked for 303 days and had stopped tracking on June 16th, 2023 in Paradise Lakes.



## Satellite transmitters

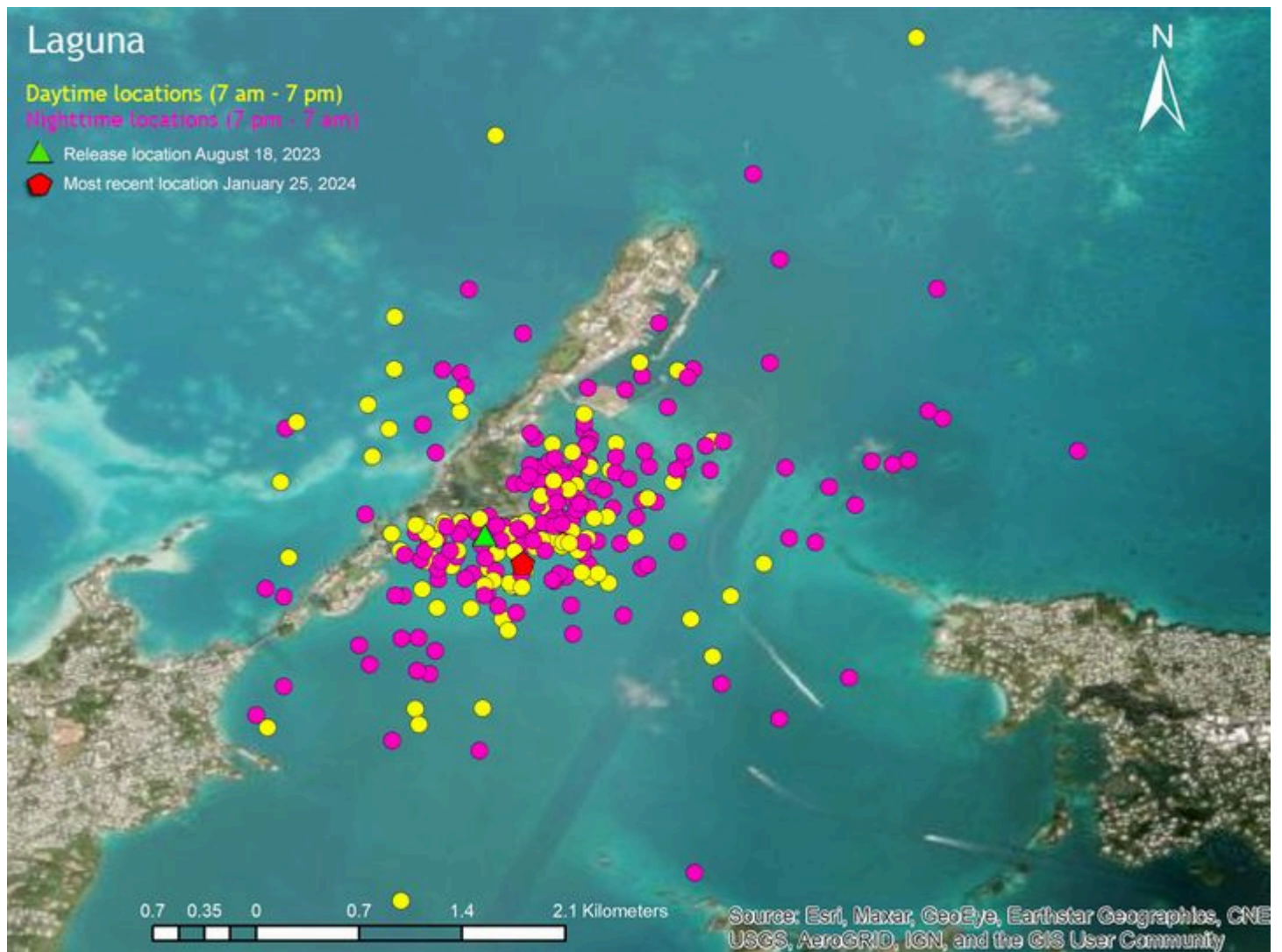
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Two satellite transmitters were deployed during 2023. The first was deployed on a green turtle captured with the net at Stock’s Harbour on 15 August 2023. The transmitter was attached to a 48.8 cm SCL turtle nicknamed “RC”. Since satellite attachment in August, this individual spent the majority of time moving around within Stock’s Harbour, north of St. David’s Island, Bermuda. But, for about a month, RC moved out of Stock’s Harbour and was moving around south of St. David’s Island in Castle Harbour. This transmitter is still sending signals as of February 26, 2024.



<https://conserveturtles.org/stctrackingmap/?id=378>

The second transmitter was deployed on a green turtle captured with the net at Hospital Bay on 18 August, 2023. The transmitter was attached to a 54.2 cm SCL turtle nicknamed “Laguna”. Since satellite attachment in August, this individual spent its time moving along the east coast of Ireland Islands South, Bermuda, moving from the area around Hospital Bay north to Dockyard Camber. This transmitter stopped sending signals on January 26, 2024. Laguna was tracked for 160 days.



<https://conserveturtles.org/stctrackingmap/?id=379>

## Genetics

During 2023, genetics classes at Eckerd College again analyzed Bermuda sea turtle genetics samples during both spring and fall semesters. Students attempted to generate long control region sequences for 51 turtles, mostly hawksbills. Many of these were older samples or tissues recovered at necropsies. Students were able to generate complete sequences for 27 hawksbills and 4 green turtles. The hawksbill sequences were assigned to 12 different haplotypes, one of which is apparently new. The 4 green turtle samples were turtles from which we had international tag returns; they represent 3 different haplotypes. While working with our collection of samples this year, we discovered some older frozen whole-blood samples, and some preserved on DNA preserving FTA cards. In spring 2024, Eckerd classes will be working on these to try generate sequences that could provide additional results for green turtles from the earliest decades of the BTP.

Also, during 2023 we published important results that came from this long-term relationship with Eckerd College and its genetics faculty (<https://rdcu.be/dvSiq>). Based on

more than 600 green turtle sequences, we were able to estimate the level of contribution to the Bermuda foraging aggregation from all relevant Atlantic green turtle rookeries. We were also able to show that contributions from principle rookeries have changed over time.

Collaboration continued in 2023 with Dr. Larisa Avens, NOAA, on age and growth of Bermuda green turtles. We are also working on a hawksbill genetics paper with Alberto Abreu-Grobois and other colleagues that will include the Bermuda aggregation as one of 15 foraging aggregations.

## **Tag returns**

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Three international tag returns of green turtles originally tagged in Bermuda were received during 2023. All three turtles were captured in Nicaragua; two were known to have been recaptured in nets by fishermen and we can infer that the turtles were killed. They had originally been tagged in 2022, 2007 and 2013. The tag returns help identify the countries where Bermuda turtles reside after they depart from the Bermuda Platform, and in some cases, the fates of the turtles. The coordination of tag returns is handled by the Archie Carr Center for Sea Turtle Research at the University of Florida.

## **Stranding Network**

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BTP continues to work closely with the Bermuda Aquarium Museum and Zoo Wildlife Rehabilitation Centre (WRC) providing support, equipment, and tags, and helping with response to the Sea Turtle Stranding Hotline and strandings. A total of 22 sea turtles were brought to the WRC in 2023 (compared to 16 sea turtles in 2022). Twenty were green turtles and two were hawksbill turtles. Both hawksbill turtles were brought in dead; one had died due to severe entanglement in fishing line, the other hawksbill had died likely due to trauma but it was difficult to confirm due to the degree of decomposition. Seven green turtles were brought in dead, 13 green turtles were brought in alive but 4 died during rehabilitation due to their severely injured or debilitated state. Seven green turtles were released after recovery in the rehabilitation center. One of these green turtles in rehab was captured during the BTP sampling course. It has monofilament fishing line coming out of its cloaca. Two green turtles are still recovering in the rehabilitation center.

## **Necropsy**

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During 2023, a total of 14 turtles were necropsied to observe abnormalities and to attempt to determine the cause of death of stranded turtles. BTP students conducted necropsies of 12 green turtles that had been collected by the Bermuda Sea Turtle Stranding and Salvage Network (BAMZ). Two hawksbill turtles were necropsied outside of the 2-week course. During the 2023 necropsy session, Veterinarian and BTP team member, Dr. Gaëlle Roth, performed a detailed demonstration necropsy at the beginning of the session, and then assisted students as they conducted necropsies themselves. In addition to providing an opportunity to learn basic anatomy of sea turtles and an introduction to necropsy techniques, this session enables participants to learn first-hand about some of the mortality factors for sea turtles, such as entanglement in monofilament line, ingestion of hooks used in various fisheries, disease, malnutrition and watercraft collisions.

Of the 12 green turtles, 41.67% were female and 58.33% were male, and all had macroscopically visible parasites. None had been previously tagged by the Bermuda Turtle Project. Samples collected during necropsies performed by Dr. Gaëlle Roth throughout the year are being used by collaborators for multiple purposes, including genetic identification, diet and feeding biology, determination of age-at-recruitment and identification of threats to sea turtles in Bermuda.

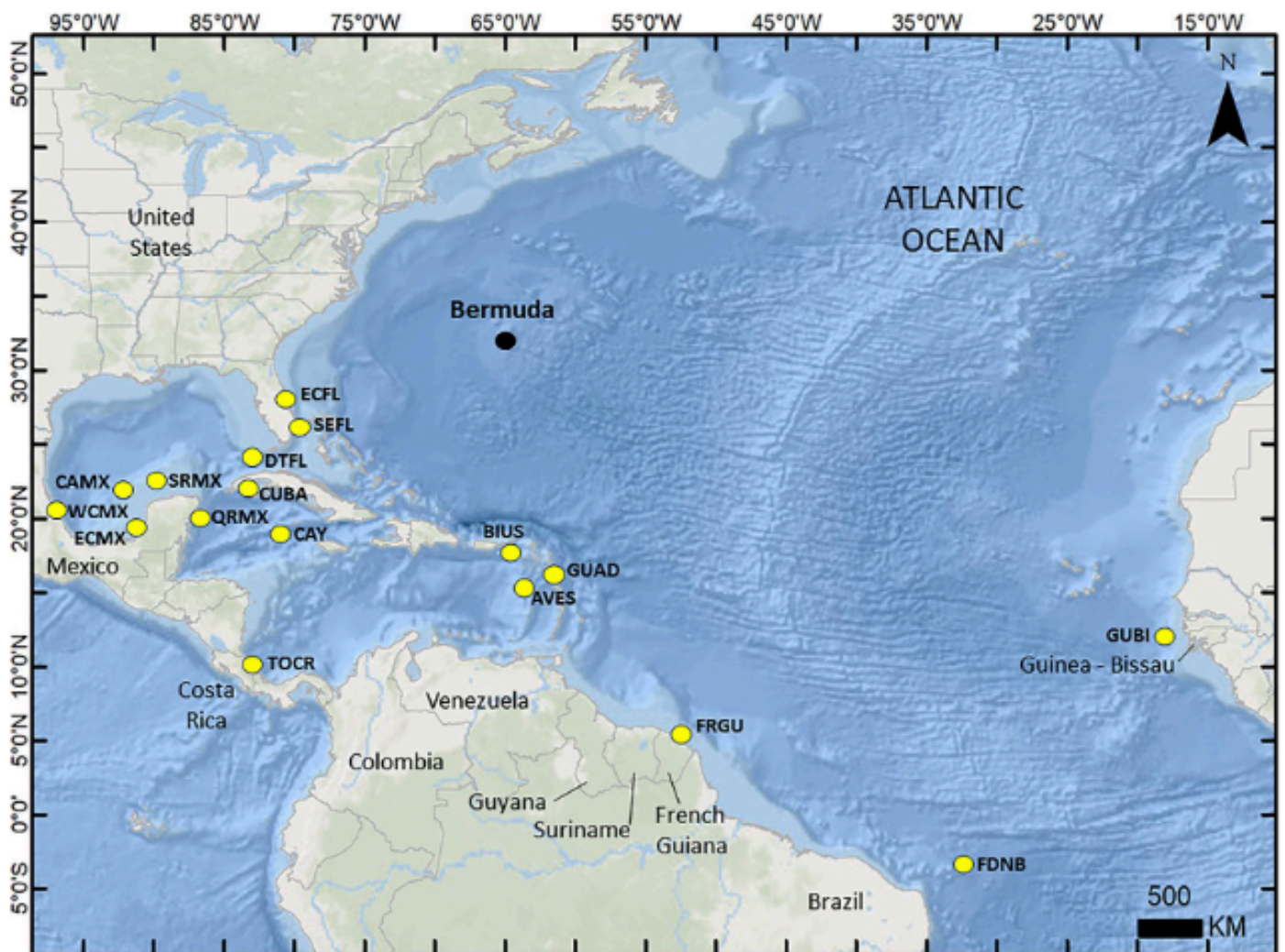


Turtle for necropsy - hit by boat

## Publications

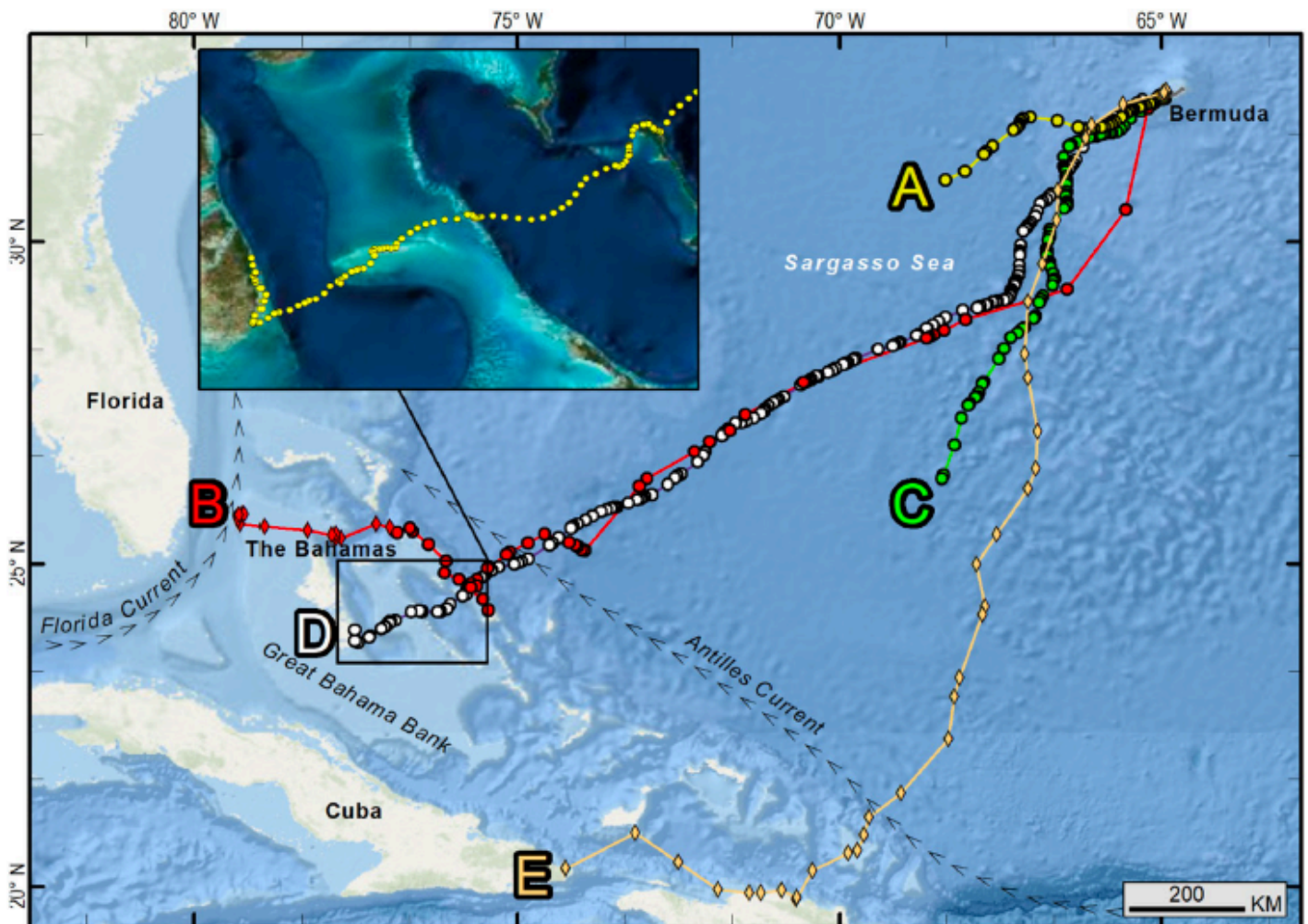
The project published two papers in 2023.

The first paper was “Feminization of a mixed-stock foraging aggregation of immature green turtles (*Chelonia mydas*), 1975–2018”. This study examined the sex ratio of green turtles in a Northwest Atlantic foraging ground (Bermuda) from 1975 to 2018. Researchers used plasma testosterone concentrations found in blood samples to determine the sex of 2,724 turtles and found a significant increase in the sex ratio (F/M) over the course of the study, ranging from 2.8 – 4% for four related data sets. This suggests a potential impact of global warming on temperature-dependent sex determination in marine turtles, leading to concerns about skewed sex ratios. The genetic aspect of this paper showed that 18 different rookeries have made significant contributions to Bermuda’s green turtle aggregation since the 1970s and that there have been changes in rookery contributions over time. These changes and population increases at certain rookeries were considered possible causes for the observed feminization, but the steady decades-long increase in female percentages aligns with the effects of global warming at source rookeries. Read more at <https://link.springer.com/article/10.1007/s00227-023-04320-2>



Rookeries among the ten largest contributions to the Bermuda aggregation. Meylan et al., 2023.

The second publication was “Daily, seasonal, and long-distance movements inferred from Fastloc-GPS telemetry of immature green turtles (*Chelonia mydas*) at a high-latitude, mid-ocean developmental site.” This study focused on juvenile green turtles in Bermuda, using GPS-enabled satellite transmitters. Researchers tracked the movements, habitat use, and seasonal behaviors of 16 different turtles during an 8-year period. The turtles exhibited fidelity to distinct use areas within their habitat, including foraging, resting, and cool weather refugia. Residence area sizes increased significantly over the study, indicating greater foraging effort due to seagrass habitat decline. Seasonal movements suggested an "optional dormancy" strategy, with turtles sometimes taking refuge in deeper water when water temperatures declined but returning to seagrass meadows whenever conditions were suitable. Four of the tracks include directed migration away from Bermuda toward known adult foraging ranges. Read more at <https://doi.org/10.1371/journal.pone.0292235>



Map with developmental migrations from Bermuda. Hardy et al., 2023.

## Educational outreach

Environmental education happens spontaneously when BTP is conducting field work and interacting with members of the community during its research. Public outreach and education also happen through collaborations and presentations. Dr. Gaëlle Roth represented the BTP during Pecha Kucha Bermuda Vol. 31, in June 2023 with a short, dynamic presentation challenging the sea turtles versus seagrass debate and highlighting the scientific findings of 50 years of data collection by the BTP. BTP participates in monthly Wider Caribbean Sea Turtle Conservation Network (WIDECAST) meetings and discussions about turtle conservation and all related topics. These meetings are open to WIDECAST country coordinators and are aimed at the exchange of knowledge and experiences from professionals in the sea turtle conservation community.

BTP collaborated with Dr. Alex Amat, Youth Program Coordinator of BZS, to introduce Cedarbridge Academy students to the research on sea turtles. The BTP provided scientific data collected in Bermuda to be used by the students as part of their practical part in their Field Investigations Methods, that ran through their second semester. A hands-on session was organized to teach the student how to collect data correctly and accurately from green turtles. (<https://bernews.com/2023/04/bzs-cba-works-on-stem-signature-reform/>).

BTP is mentoring an M5 student from Somersfield Academy as part of his “Service and Action” IB Middle Years Programme. Ethan Hochberg chose sea turtle conservation as the subject of his programme and has learned about conducting research on Bermuda sea turtles and their habitat. He has created an educational PowerPoint presentation targeted toward primary school students to raise conservation awareness. He led a classroom-based ART-IVISM activity regarding sea turtle conservation. BTP also assisted in the creation of a public display of the ART-IVISM pieces made by Somersfield Primary students at BAMZ and used the exhibit to promote World Turtle Day on May 23. BTP will continue this student collaboration in 2024 and further enhance student involvement in sea turtle conservation.

(<https://www.royalgazette.com/education/news/article/20230627/somersfield-academy-student-teaches-about-turtles/>)

BTP visited the Bermuda High School for STEAM Projects in both the primary and secondary department. Year 8 and 9 students attended a presentation and participated in a discussion regarding “Turtles Versus Seagrass”. (<https://www.facebook.com/photo/?fbid=936961847493611&set=a.452223752634092>). While primary students from Year 1-3 attended a presentation about ocean conservation and the roles of habitats in Bermuda for marine life and sea turtles specifically. (<https://www.facebook.com/photo/?fbid=925179302005199&set=a.452223752634092>).



BTP students 2023 with Rick Herren, Ruskin Cave and Miguel Mejias.

## Thank you

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The work of the Bermuda Turtle Project in 2023 was made possible by generous support from the Atlantic Conservation Partnership, the Bermuda Zoological Society, the Helen Clay Frick Foundation, and the Sea Turtle Conservancy; in-kind support was received from Eckerd College and the Florida Fish and Wildlife Conservation Commission.

Students participating in the annual course assisted the team in collecting valuable data and our work would not be possible without their involvement. In 2023, students (9) volunteered about 840 hours over 2 weeks, this includes the safety briefing, presentations, the sampling, lab work and the necropsy session.

Special thanks are offered to our volunteers and host families who provided accommodations and transportation to international participants.



Paiton Krebs, from USA.



Kimberly Novak, from USA.



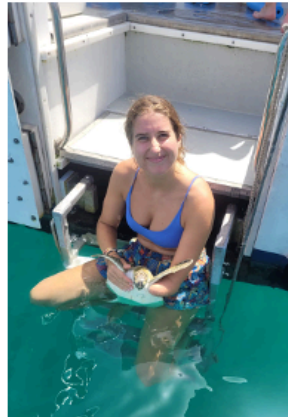
Kailtyn Zavesky, from USA.



Vicente Eisele, from Chile.



Raul Garcia, from Spain but Coordinates the STC project in Panama.



Oceane Merchiers, from Belgium.



Ella Ratteray-Drover, from Bermuda.



Cary Rodriguez, from Panama.

Samuel Treweek-Coleman, Australian working in Bermuda.





## **The Bermuda Turtle Project**

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of the Bermuda Turtle Project, ...

[bermudaturtleproject.org](http://bermudaturtleproject.org)