BERMUDA TURTLE PROJECT

Annual Report for 2021

Dan Evans, Jennifer Gray, Rick Herren, Anne Meylan, Peter Meylan, and Gaëlle Roth

Jessica Kehrli and Everett Van Zanden signaling they have a juvenile green turtle

The Bermuda Turtle Project (BTP) continued in 2021, committed to the goal of promoting the conservation of marine turtles through research and education. BTP is a joint project of the Bermuda Zoological Society (BZS) and the Sea Turtle Conservancy (STC). Project activities during 2021 included field and laboratory research, and outreach via the media and the Bermuda Turtle Project website.

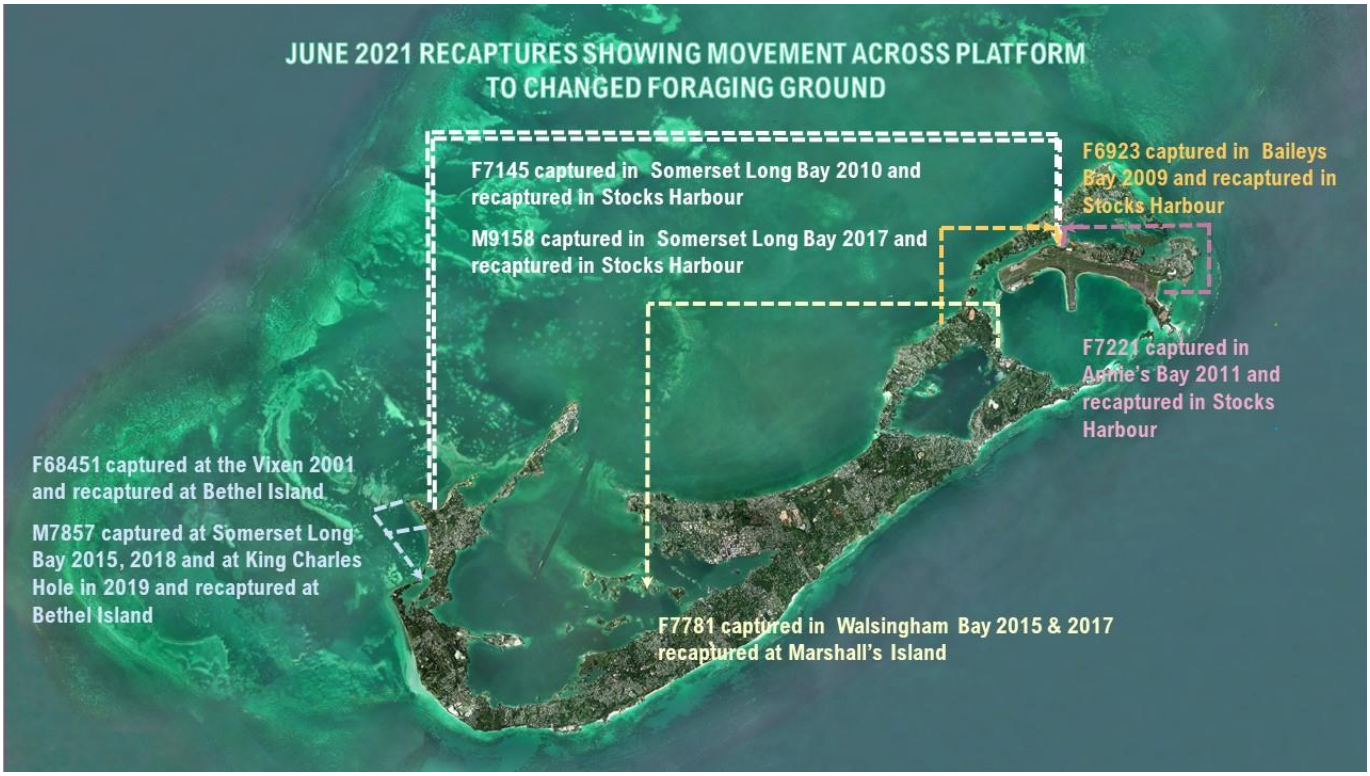
With Bermuda's relaxed Covid-19 Restrictions, the BTP was able to conduct two sampling sessions, a new health assessment of green turtles in June 2021, and an annual sampling of the Bermuda green turtle aggregation in August 2021.

During the period where no sampling occurred due to Covid, it appears there was further significant decline of seagrass beds that has now impacted all BTP standard inshore sampling sites. A paper that will be published shortly shows that the role that Bermuda can play in the life cycle of green turtles in the Atlantic has changed significantly. The Aquarium Wildlife Rehabilitation Centre recorded a significant increase in the number of strandings per year and a decrease in turtle body condition index can be traced back to the 1990s.

A new effort of the BTP, "Health assessment sampling" was carried out for 4 days, June 14–17, 2021, with the entrapment net. The team consisted of Dr. Daniel Evans (Research Biologist, Sea Turtle Conservancy),

Rick Herren (Research Biologist, Sea Turtle Conservancy), Jennifer Gray (BTP Bermuda Director), Dr. Gaëlle Roth (Veterinary Affiliate, Bermuda Aquarium, Museum and Zoo - BAMZ), and Barbara Outerbridge (Registrar, BAMZ). The BZS research vessel, RV Endurance, served as the main vessel and was captained by Nigel Pollard. Chris Burville was the first mate. The catch boat, Chevron, was captained by Jennifer Gray, with Emily Andrew and Cameron Bridgewater as first mates. Snorkeling assistance was provided by BAMZ staff Choy Aming, Kate Cooper and Nesta Wellman and volunteers Lianna Agarwal, Ruskin Cave, Cassandra Roberts and Selena Whitter.

During the June sampling, the team captured a total of 29 green turtles (*Chelonia mydas*) at four sites; most of the turtles were captured in the net, but two were captured by hand. The hand captured turtles were captured in an area where the net could not be set due to poor visibility and numerous hazards (moorings) at the site. The net-captured green turtles ranged in size from 27.6 to 46.6 cm straight carapace length (SCL). Of the 29 green turtle captures, 7 (24%) were recaptures of animals tagged in previous years. Three of the four sites sampled were new locations for BTP. All recaptures were animals previously captured at different sites.



Following the June sampling it was noted the entrapment net was shorter in length. A re-measure of the net determined a length of 1,000 feet resulting in an unexplained 400 feet missing (cut off from one end).

The annual sampling of the Bermuda green turtle aggregation was carried out for 9 days, August 9–20, 2021, with the entrapment net. The team consisted of Dr. Dan 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. Keiron Rushe was the first mate. The catch boat, Chevron, was captained by Jennifer Gray, with Emily Andrew as first mate. Snorkeling assistance was provided by volunteers Camilla Stringer and Ruskin Cave and students participating in the BTP In-Water Course.

During the August sampling, a total of 46 green turtles were captured during 22 sets of the net at 17 sites around the island. Animals ranged in size from 25.1 to 52.2 cm SCL (see sampling log below). Compared to 2017, when 194 turtles were caught in 22 sets at 14 sites, the total number of turtles caught was significantly lower.

All turtles captured in the entrapment net in 2021 were judged to be immature based on previously established shell and tail size criteria. They were tagged and biometric data and samples were collected, then 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 gender and sex ratio, and for stable isotope analysis.

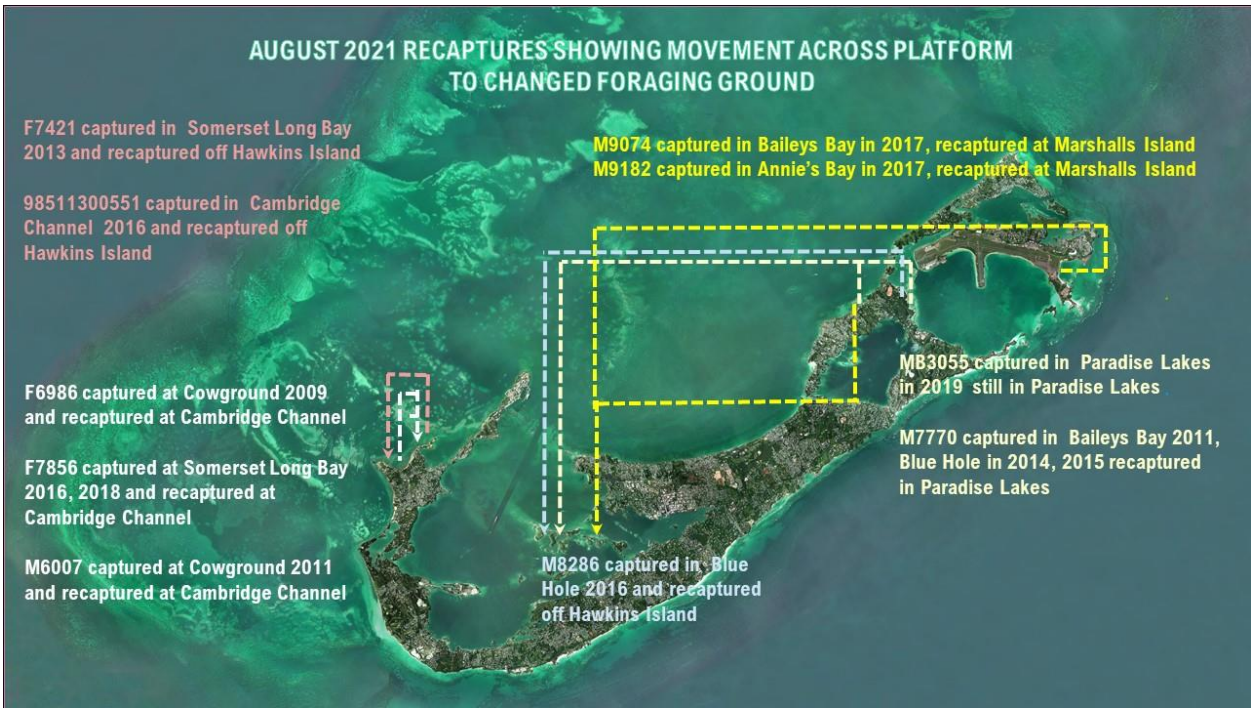
As part of the new health assessment study the research team measured blood values in a sample of 50 captured green turtles in June and August 2021 in order to establish a baseline and detect any changes in the Bermuda green turtle aggregation, due to the continued loss of seagrass. Captured turtles 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 their chemical blood parameters and blood gas values. We manually measured the percentage of red blood cells in the whole blood (manual hematocrit) as well as the total protein in the plasma. The majority of turtles had a manual hematocrit that was lower than the reference range for green turtles. No other significant abnormalities in the blood analyses have been detected so far. The morphometrics measured on each turtle were used to calculate the body condition index per turtle, which varied between 0.89 (emaciated) and 1.62 (very good). No turtles captured in 2021 exhibited signs of the disease fibropapillomatosis.

Sampling Log for Annual Bermuda Turtle Project 2021

Date	Location	Set No.	Latitude	Longitude	Bottom Temp (° C)	No. of Turtles	Depth (ft.)
06/14/2021	Stocks Harbor	1	32.37053	-64.68752	26.0	15	12.9
06/15/2021	Foot of the Lane	Hand	32.29309	-64.77422	27.5	2	9.21
06/16/2021	Marshall Island South	1	32.28431	-64.81166	26.0	5	7.9
06/17/2021	Ely's Harbor	1	32.28584	-64.87845	25.0	7	3.6
08/09/2021	Bailey's Bay	1	32.34937	-64.72640	27.5	0	7.8
08/09/2021	Bailey's Bay	2	32.3503	-64.7243	27.5	1	7.1
08/09/2021	Blue Hole	3	32.34822	-64.70802	29.5	0	5.0
08/10/2021	Scaur Public Dock	1	32.28704	-64.8754	28.5	0	14.1
08/10/2021	Pilchard Bay	2	32.28048	-64.88198	22.5	0	9.9
08/10/2021	Tudor Hill	3	32.26968	-64.88182	27.5	0	7.1
08/11/2021	Outside Daniels Head	1	32.32610	-64.91915	28.0	0	13.6
08/11/2021	Ely's Flat	2	32.31526	-64.90433	30.0	0	11.2
08/11/2021	Ely's Harbor	3	32.28084	-64.88291	29.0	5	9.5
08/12/2021	Mullet Bay	1	32.37481	-64.69091	30.0	7	9.6
08/12/2021	Fort St Catherine	2	32.38607	-64.66940	29.5	0	12.5
08/13/2021	Riddell's Bay	1	32.26382	-64.83101	30.0	4	3.3
08/13/2021	Cambridge N Channel	2	32.30925	-64.86924	30.0	8	8.6
08/16/2021	Paradise Lakes	1	32.28511	-64.82091	29.5	4	10.1
08/16/2021	Marshall Island	2	32.28471	-64.81016	29.5	10	10.8
08/18/2021	Wreck Hill N Channel	1	32.28432	-64.88362	29.5	1	6.1
08/19/2021	Hawkins East Bay	1	32.28630	-64.82387	29.0	1	8.1
08/19/2021	Hawkins Island	2	32.28601	-64.82587	29.5	1	11.0
08/19/2021	Somerset Long Bay	3	32.30446	-64.87620	30.0	2	5.7
08/20/2021	Annie's Bay	1	32.35602	-64.65948	29.0	0	7.4
08/20/2021	Dolly's Bay	2	32.36690	-64.66460	29.0	1	12.4
08/20/2021	Dolly's Bay	3	32.36687	-64.66264	30.0	1	12.2

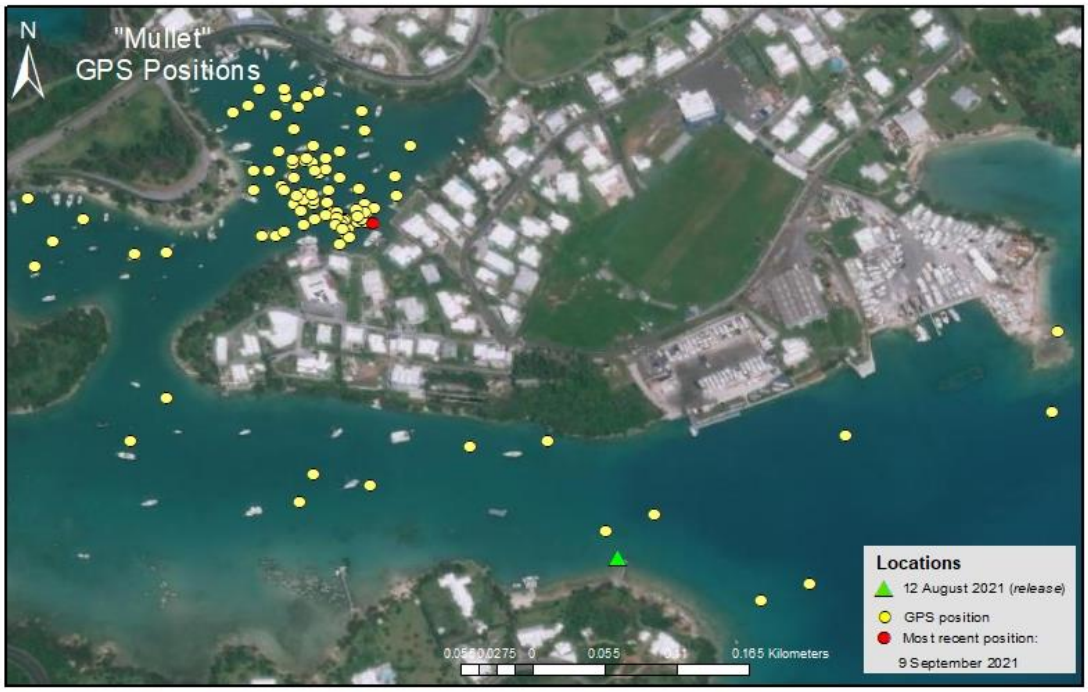
Total # of captures for 2021 75
Total # of Captures since 1992 5,164

Of the 46 green turtle August net captures, 10 (22%) were recaptures of animals previously tagged. This compares with 34% in 2019 and 37% in 2018. A lower recapture rate may suggest a higher mortality, greater mobility of turtles between sites, and/or earlier emigration off of the Bermuda platform.

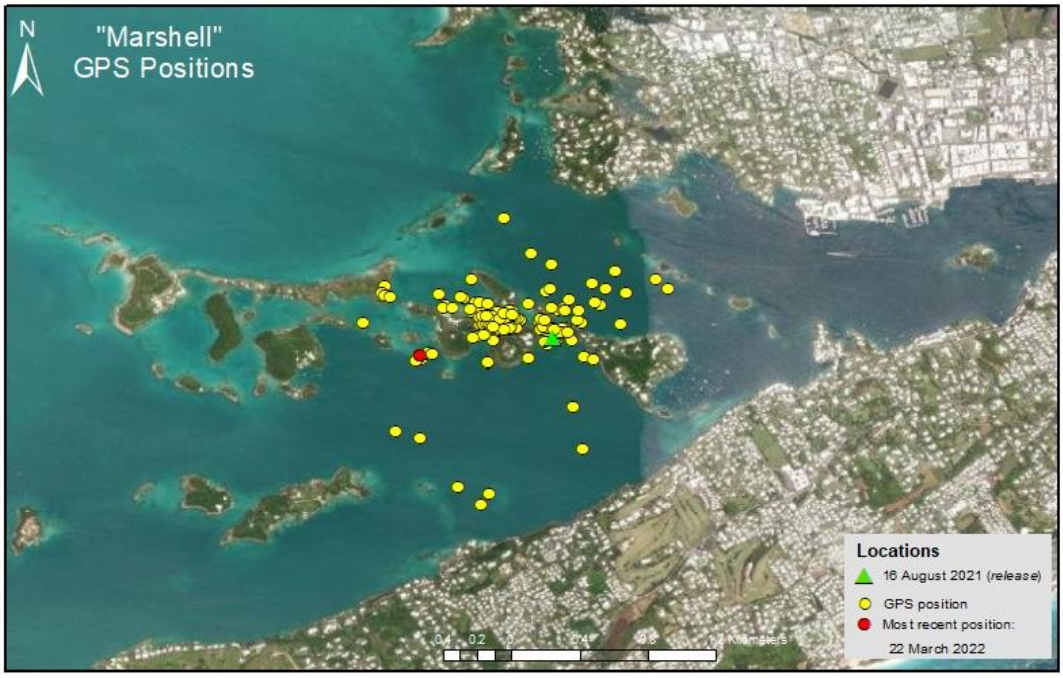


Only one recapture was caught at the site where it was last captured by BTP. All others had moved to an alternate foraging area. Our work has shown two periods of reduced site fidelity, including one that started around 2010 and continues currently. The recent occurrence of lower site fidelity suggests that as seagrass has disappeared, green turtles are moving more often in search of food.

Two satellite transmitters were deployed during 2021. The first was deployed on a green turtle captured with the net at Mullet Bay on 12 August 2021. The transmitter (PTT 221020) was attached to a 45.1 cm SCL turtle nicknamed "Mullet". Since satellite attachment in August, this individual spent its entire time moving around in Mullet Bay. This transmitter stopped sending signals on 22 November 2021 in the inner Mullet Bay area, Bermuda.



The second transmitter was deployed on a green turtle captured with the net at Marshall Island on 16 August, 2021. The transmitter (PTT 221021) was attached to a 48.2 cm SCL turtle nicknamed “Marshell”. Since satellite attachment in August, this individual spent its time moving between the original capture site and around Marshall, Bluck’s and Hinson Islands. This transmitter stopped sending signals on 6 March, 2022, to the west of Marshall Island, Bermuda.



In addition to captures, the research team conducted preliminary sea turtle surveys in June and August 2021 from a 24' Twin Vee with an a-midships tower. The purpose of the surveys was to estimate sea turtle distribution and abundance and determine the practicality of using this method in Bermuda waters. The surveys covered only a portion of sea turtle habitats in Bermuda and were conducted over two days in June in a haphazard fashion and over three days in early August using fixed transect lines. The team of four (including Rick Herren, Gaëlle Roth, Barbara Outerbridge, Ruskin Cave, Roger Hollis, Cameron Rowling-Bridgewater and Jennifer Gray) sighted 17 green turtles in June and 41 sea turtles in August, which covered 80% of the established core netting sites. Because of a number of factors that make it difficult to use surveys to estimate abundance in Bermuda, the research team is weighing the benefits and caveats of continuing them in the future.

BTP's working relationship with the genetics faculty at Eckerd College continued during 2021. Because of Covid limitations, samples were sequenced just during spring semester. Students were able to generate assignable sequences for an additional 44 genetics samples; 36 green turtles were assigned to ten different haplotypes and 8 hawksbills were assigned to six different haplotypes.

Analyses of sex ratios of the Bermuda green turtle foraging aggregation over time continued with help from Jeff Schwenter, South Carolina Department of Natural Resources, Dr. David Owens, emeritus faculty of the College of Charleston, and Dr. Brett Tornwall, a statistician formerly with the Florida Fish and Wildlife Conservation Commission. Collaborations continued in 2021 with Dr. Larisa Avens, NOAA scientist, on a skeletochronology-based study of age and growth of green turtles; on green turtle diet with Dr. Karen Bjorndal and Alexandra Gulick, UF; and on changes in diet using stable isotope analyses with Dr. Simona Ceriani, Florida Fish and Wildlife Research Institute.

One international tag return of a green turtle originally tagged in Bermuda was received during 2021. The return involved a green turtle that was tagged on the feeding grounds in

Bermuda and then subsequently seen in a different country. The turtle (M8149/M8150) was a 43.7 cm turtle captured on 23 June 2021 on the east coast of Florida at Jupiter Inlet. At the time of recapture, the turtle had fibropapilloma tumors (FP), which are common on green turtles found in Florida's bays and lagoons. It had originally been captured on 10 August 2016 at Somerset Long Bay, Bermuda, and had no signs of FP. The coordination of tag returns is handled by the Archie Carr Center for Sea Turtle Research at the University of Florida.

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 48 sea turtles were brought to the WRC, 2 hawksbill and 46 green turtles. There were 29 death-on-arrivals (58 in 2020), two hawksbill and 27 green turtles. Nineteen green turtles died despite treatment efforts (32 in 2020), two of which were from 2020 intakes. Two were euthanized, one due to its extensive injuries involving the spinal cord and a second one because it was a repeated stranding and was in extremely poor condition. Eight green turtles were released (compared to 17 green turtles and 1 loggerhead in 2020).

Necropsies are used to observe abnormalities and to attempt to determine the cause of death of stranded turtles. During 2021, a total of 16 green turtles and 1 loggerhead were necropsied, 70% were female and 30% were male. 76% had macroscopically visible parasites. Four had been tagged by BTP in Bermuda. 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.

We have made substantial progress on the publication of manuscripts involving the work of BTP. Team BTP members collaborated for the last several years with doctoral candidate Alexandra Gulick and Dr. Karen Bjorndal at the University of Florida to investigate the diet of the green turtle in Bermuda by providing gut contents of 47 green turtles that were necropsied at BAMZ after stranding dead. The research was recently published: "Role of ingesta particle size in the green turtle grazing strategy, ontogenetic diet shifts, and responses to seagrass declines." Marine Biology (2021) 168:157 A. G. Gulick, A.B. Meylan, P. A. Meylan, K. M. Hart, J. A. Gray, G. Roth, A. Bolten & K. A. Bjorndal.

An additional paper, describing changes in the green turtle aggregation over 50 years has been accepted by the journal Marine Biology and should appear in the next few months. The paper by Peter Meylan, Robert Hardy, Jennifer Gray and Anne Meylan is titled: "A half-century of demographic changes in a green turtle (*Chelonia mydas*) foraging aggregation during an era of seagrass decline". It shows that the role of Bermuda in the life cycle of green turtles in the Atlantic has changed significantly and also provides evidence that the loss of seagrasses in Bermuda is not due to sea turtles alone, but rather to "synergistic stressors".

In June 2021, we collaborated with Thomas Frankovich (Institute of Water and Environment, Florida International University) to identify diatoms in images of skin and carapace smears from green turtles. The goal is to create a photo library for veterinary pathologists and to be able to compare epizoic communities on sea turtle species. We collected 24 epibiont films from the carapace and skin from 12 green turtles. Tom was able to microscopically examine 10 samples and no distinct or significant diatom community was present in their biofilm. We plan to collect more samples in 2022 to confirm if we can repeat this finding.

Jennifer Gray, Peter Meylan and Anne Meylan prepared a chapter on the sea turtles of Bermuda for the Regional Report of the IUCN Marine Turtle Specialists Group. It will appear in the IUCN Regional Report for 2022.

The Bermuda Turtle Project offered its 24th In-Water Course on the Biology and Conservation of Sea Turtles to Bermudian residents from 8-20 August 2021. 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 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 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. Dan Evans and Rick Herren from STC and Jennifer Gray and Dr. Gaelle Roth from Bermuda.

During the necropsy session, students conducted necropsies of 12 green turtles that had been collected by the Bermuda Sea Turtle Stranding and Salvage Network (BAMZ). Veterinarian, 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, and watercraft collisions.

2021 BTP Team

Environmental education goals of the project were furthered by several presentations in 2021. The Bermuda Zoological Society BTP team of Jennifer Gray and Gaëlle Roth scripted and featured in a short film produced by Method Media Bermuda and titled “Helping Endangered Sea Turtles” In-house video presentations produced by Jennifer Gray included an overview of Bermuda’s sea turtles which aired on World Oceans Day ‘Bermuda’s Nesting Sea Turtles’ and ‘Celebrating 400 Years of Sea Turtle Protection’. All were disseminated by the Bermuda Zoological Society via social media. Written PR included an article by the Bermudian Magazine titled “Climate Change: The Feminization of Sea Turtles. The Royal Gazette featured an article on the collapse of seagrass beds featuring the work of BTP. A BTP presentation, delivered by

Jennifer Gray, was given to the Trunk Island Conservation Camp. Dr. Gaëlle Roth gave an interview for the Youth Climate Summit organized by the Bermuda Underwater Exploration Institute and an interview for an article published by the Bermuda Yellow Pages; "Bermuda's Marine Ecosystem Has a Big Problem. We Can All Be Part Of The Solution. Environmental education happens spontaneously when BTP is conducting field work and interacting with members of the community. As a part of the genetics work done by Eckerd students, Peter Meylan gave a lecture to the genetics classes that highlights BTP and how its work and conservation genetics elucidate the role of Bermuda in the green turtle life cycle.

In November of 2021 Jennifer Gray was the recipient of an Ocean Heroes Award presented at the Bermuda Underwater Exploration Institute during the Youth Climate Summit. The presentation of the award highlighted her work with sea turtles in Bermuda.

A total of approximately 600 volunteer hours were donated to the Bermuda Turtle Project by 7 volunteers in 2021. We are especially grateful for the many hours contributed by team member and veterinarian, Dr. Gaëlle Roth, Ruskin Cave, and Debbie Boyer who produces outreach materials for the project. Students participating in the annual course assisted the team in collecting valuable data and our work would not be possible without their involvement. In 2021, 10 students contributed a total of 772 hours.

Special thanks are offered to Sharon Vesey who provided accommodations to visiting Scientific Director, Rick Herren and his family in 2021.

Information about the Bermuda Turtle Project is available at https://bermudaturtleproject.org which is maintained by the Sea Turtle Conservancy. During 2021, the BTP website received nearly 1,200 unique visitors who accounted for nearly 3,000 page views. In addition, there were nearly 1,100 page visits of Bermuda satellite-tracked turtles in 2021. BTP continues to increase its social media presence through Facebook at https://www.facebook.com/Bermudaseaturtles/.

The work of the Bermuda Turtle Project in 2021 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; and in-kind support from Eckerd College and the Florida Fish and Wildlife Conservation Commission.