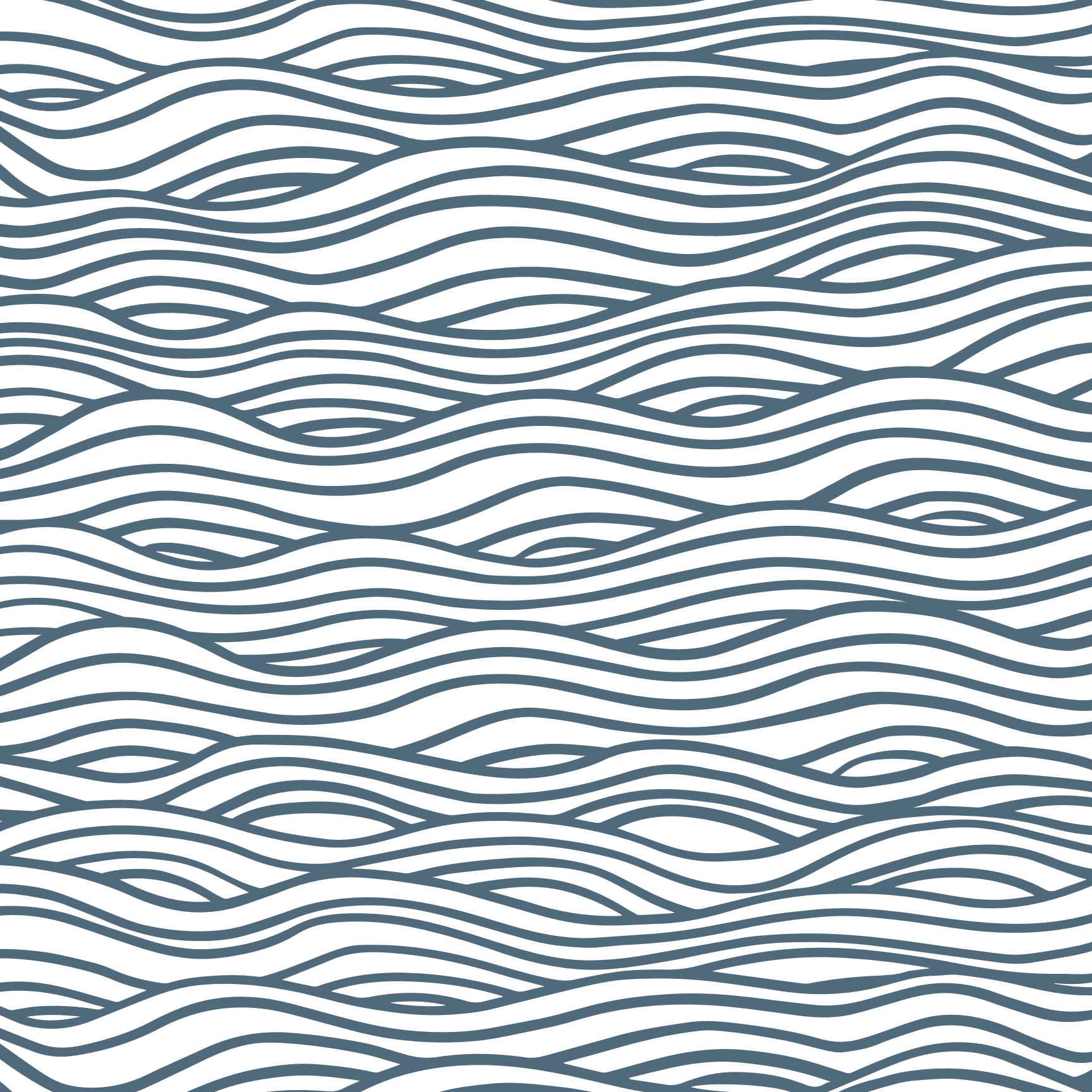




UPWELL



2022 Impact Report



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“For most wild things on earth, the future must depend on the conscience of mankind.”

-Dr. Archie Carr

Upwell’s mission is to protect endangered sea turtles by reducing threats at sea.

Effective conservation relies on conscience and a commitment to work together for the protection of our most imperiled species. Collaborating across cultures and national jurisdictions is an essential part of reducing threats to sea turtles across vast ocean ecosystems.



To protect turtles at sea, Upwell confronts daunting logistics and gaps in marine governance, challenges that can be overcome through strong partnerships. We strive to make science accessible and support decisions to ensure a safe future for sea turtles.



Letter from Upwell's Director

With strong partnerships and your generous support, Upwell made great strides in 2022 to advance protections for turtles at sea. We are pleased to update you on our shared successes and breathtaking progress over the last year.

In 2022, Upwell deployed a record number of satellite tags (117 total) on 4 different species of sea turtles! We are working to mobilize the data generated and devise targeted protections for sea turtles in imperiled populations.

Upwell also offered professional instruction on cold-stunned sea turtle response and provided new acoustic receivers for installation in the Pacific Northwest. These receivers will be able to detect not only leatherbacks but also a variety of other species of special management concern.

A personal highlight for me in 2022 was the opportunity to showcase our work on NBC Nightly News with Lester Holt and on the Today Show. NBC reporter Kerry Sanders joined us to release juvenile turtles on live television!

Thank you for your commitment to ensure sea turtles survive for future generations. Our achievements are made possible by the hard work of our staff, partners and dedicated sea turtle champions like you!

Best regards,

George Shillinger, PhD

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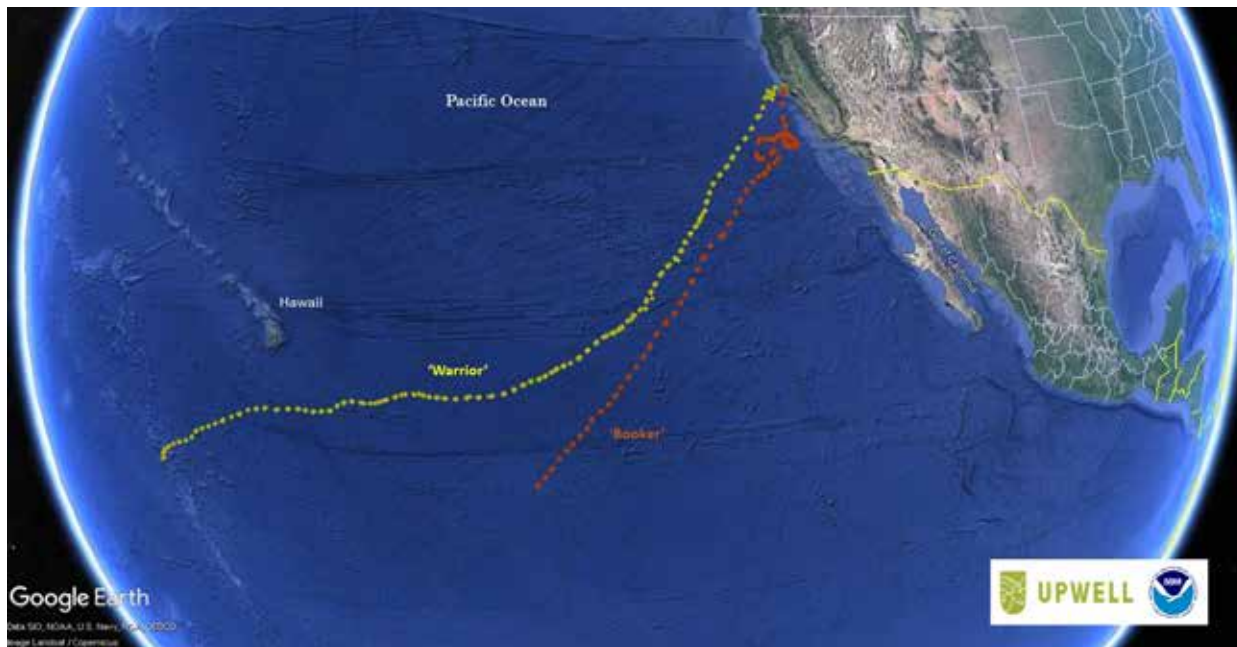
Thomas Jorde, JD
Dr. Charles Betlach

CONSERVATION IN ACTION

Upwell expanded sea turtle monitoring into vast new ocean territories and fostered new partnerships to amplify the impacts of our research. We shared data with fisheries managers to inform decisions to mitigate leatherback entanglements, trained veterinary first-responders on hard-shelled sea turtle strandings, and contributed innovative techniques and tools to assess leatherback health.



Safer seas for West Pacific leatherbacks



Our seasonal West Coast leatherback monitoring with NOAA recommenced in July 2022 with the tagging of a female leatherback. We named her “July” to celebrate our earliest tagging of a leatherback in the California Current foraging zone. After her release, whale watchers spotted July on September 11th in the Gulf of the Farallones National Marine Sanctuary, not far from where we tagged two male leatherbacks. Soon thereafter, the two tagged males dubbed “Warrior” and “Booker” set off at a fast pace back across the Pacific Ocean, presumably seeking mates in marine habitats off nesting beaches in Indonesia, the Solomon Islands and Papua New Guinea.

As in previous seasons, our team provided fisheries managers with updates on the tagged leatherbacks’ movements to assist their protection in California waters.

Upwell expanded both aerial and vessel-based monitoring activities with NOAA to Oregon and Washington, where data on leatherbacks and habitat conditions are scarce.

Our surveys of Pacific Northwest critical habitat yielded important information on the distribution of prey (jellies) and proxy species (large ocean sunfish) within critical habitat and located a leatherback off the coast of Washington. We also invested in building local capacity for detecting the presence of acoustically tagged leatherbacks by providing three acoustic receivers to partners for deployment off the Olympic Peninsula.

While satellite tags typically transmit for around eight months, the three acoustic tags we deployed in 2022 on leatherbacks in West Coast foraging habitats can transmit

for up to 10 years. Upwell's collaborative effort to increase acoustic receiver coverage off Washington enhances opportunities for data collection. Acoustic receivers log reliably accurate location data each time a tagged animal passes within range and can be used for monitoring multiple species of concern, including marine mammals, sharks, and bony fishes.

6 months of satellite tracking capturing 2,980 geopositions



Preparing for climate change impacts on hard-shelled sea turtles

Cold-stunning will likely increase among hard-shelled sea turtles along the US West Coast as climate change brings warmer and more erratic temperature swings to northern latitudes. Upwell's Wildlife Veterinarian Dr. Heather Harris is developing guidelines for treating cold-stunned (hypothermic) sea turtles with members of NOAA's West Coast Stranding Network.

Even when cold-stunning proves fatal, there is important data to be collected. When it was discovered that seven of the deceased turtles in our study were in cold storage, Upwell worked with Turtles Fly Too to organize their transport from Oregon to California for comprehensive postmortem examinations. Dr. Harris led necropsy workshops at the Marine Mammal Center that not only provided valuable data on cold-stunning but also offered

a unique training opportunity for veterinary professionals looking to improve their ability to respond to stranded turtles on the West Coast.



Gentler ways to measure giant leatherbacks

Although leatherbacks may all seem “giant” by human standards, they exhibit a wide spectrum of body condition. Healthy females arrive at the nesting beach with extra fat stored around their necks, but by the end of nesting season their carapaces may appear sunken. We assess the health of nesting females and measure changes over the course of the nesting season and between seasons. These studies can reveal the presence of environmental toxins or changes in food availability within leatherback foraging habitats.

During Florida’s 2022 nesting season, Upwell’s Wildlife Veterinarian Dr. Heather Harris performed health assessments on 14 leatherbacks in collaboration with our partners at the Loggerhead Marinelifelife Center. The team collected blood samples for toxin analysis and deployed tags on a subset of the nesting females, looking to learn more about how interesting behaviors influence body composition.

Advancing non-invasive techniques for assessing leatherback health, Dr. Harris used ultrasound to measure body fat, while Upwell Researcher Derek Aoki used drone imagery to measure the dimensions of 15 nesting leatherbacks. Our collaborators at Digital Life produced an accurate 3D model of a mature leatherback based on the biometric data our team collected with Loggerhead Marinelifelife Center. Upwell commissioned the model as part of our research into how leatherback body condition can help us measure the health of our oceans.

“We’re excited that this 3D model will lead to new ways of thinking about body condition, ideally in a non-invasive way such as using photos and drone images.”

— Dr. Duncan Irschick, Professor - University of Massachusetts, Amherst & Director - Digital Life



NEW FRONTIERS IN RESEARCH

Our collaborations expanded research horizons to generate new findings on sea turtles in Lost Years life history phases, from discoveries in the lab to the open ocean. In 2022, Upwell tagged juvenile sea turtles (aged 3 months to 3 years) from 4 different species (leatherbacks, green turtles, loggerheads, and Kemp's ridleys)!





Upwell Tagged 112 Juvenile Sea Turtles in 2022



Cayman Islands

50 Green Sea Turtles



Florida

12 Leatherbacks
6 Green Sea Turtles
13 Loggerheads

Georgia

7 Kemp's Ridleys



Azores

24 Loggerheads



Connecting the dots on juvenile loggerhead movements

Upwell's groundbreaking research to unravel the "Lost Years" mysteries yielded important findings in 2022. Deploying micro-satellite tags on captive-reared loggerheads and releasing them offshore, our tracking data bolstered hypotheses that juvenile loggerheads dispersing from Florida nesting habitats use the Gulf Stream Current to travel northward and find their way to foraging habitats around the Azores. Our findings corroborated other satellite tracking studies involving larger turtles, mark-recapture data and genetics research, connecting the dots on loggerhead movements during early life history stages.

One of Upwell's most exciting and heartfelt stories in 2022 involved a tenacious little loggerhead turtle named Ember: the sole survivor in a nest ransacked by invasive fire ants on a Georgia beach. Of the 13 juvenile leatherbacks we tagged and released into the Gulf Stream through our collaboration with Florida Atlantic University (FAU) in 2022, Ember's track was the longest. Ember was rehabilitated by our partners at Georgia Sea Turtle Center, outfitted with a micro-satellite tag provided by Upwell and released in October. The telemetry data from Ember's tag provided astonishing insights into how juvenile loggerhead sea turtles disperse across the Atlantic Ocean, with movements closely aligned with currents as Ember traveled up the Eastern Seaboard just off the continental shelf.

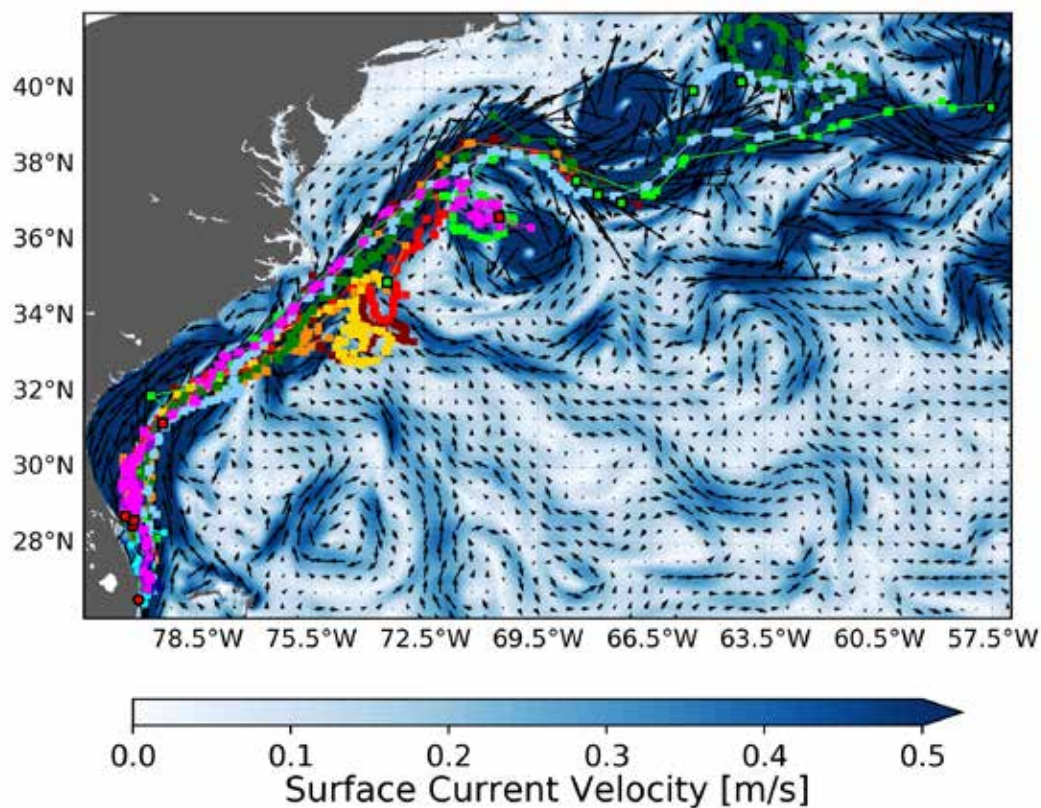
To capture data on the next stage of the turtles' travels along the Azores Current, Upwell Executive Director Dr. George Shillinger partnered with the COSTA Project,



37 micro-satellite tags deployed on juvenile loggerheads with 6,954 satellite positions recorded

Aquário do Porto Pim, and Okeanos Center at the University of the Azores and deployed micro-satellite tags on 24 juvenile loggerheads off the islands of Pico and Faial.

Our work with Lotek and Mercator Ocean International to refine tag design and satellite transmission schedules in 2022 resulted in longer track durations. Solar tags (micro-satellite tags with solar panels) accounted for 14 of the tags we deployed on loggerheads in the Azores Current. These tags excelled at tracking movements of early-stage loggerheads with carapace lengths between 10 and 20 centimeters. Additional 2022 tag upgrades to include dive sensors revealed juvenile loggerheads spent 74% of their time underwater, mostly at depths of 10 meters or less.







Tagging captive-reared green turtles in the Cayman Islands

Upwell's partnership with the Cayman Turtle Centre, in support of our Lost Years research program, facilitated a unique study in 2022. As part of Upwell Researcher Dr. Nicole Barbour's PhD fieldwork, we deployed micro-satellite tags on 50 captive-reared green sea turtles between 1 and 3 years of age, releasing them in 2 different offshore locations (~8 kilometers from shore) during opposite seasons (January and July). Although individuals spread out in different directions after release, for the most part the turtles headed for coastal areas.

Dr. Barbour's analysis showed the juvenile greens swam against currents to maintain their path, swimming more vigorously and concertedly as they neared the coastline. The research demonstrated that captive-reared juvenile turtles released offshore navigated through deeper ocean waters toward preferred nearshore habitats that favor their development (i.e., offering more food and safety from predators).



Tagging rehabilitated Kemp's ridleys in Georgia



When Upwell's Executive Director, Dr. George Shillinger, learned from Dr. Terry Norton that the Georgia Sea Turtle Center was ready to release 8 rehabilitated juvenile Kemp's ridley sea turtles, George recognized a golden opportunity to learn more about how these critically endangered sea turtles use marine habitats during early life history stages.

After the turtles were cold-stunned off Cape Cod, Upwell's partners at Turtles Fly Too transported them to the GSTC facility on Jekyll Island for rehabilitation. This first-ever deployment of micro-satellite tags on rehabilitated juvenile Kemp's ridleys revealed that most of the tagged turtles remained in the lee of the Gulf Stream (potentially foraging within benthic habitats) throughout the tracking period.

A closer look at juvenile leatherback health

Upwell's Laboratory Veterinarian Dr. Samantha Kuschke launched a project and published a paper in September 2022 investigating the microbiota living in and on juvenile leatherbacks and their role in leatherback health, immune function and disease. The project aims to inform conservation and management strategies for both wild leatherbacks and those under veterinary care (e.g., in rehabilitation centers and hatchery or captive rearing facilities).

Dr. Kuschke used her findings to successfully diagnose mycotic (i.e., fungal) dermatitis in captive-reared leatherback hatchlings. Prior to her research, the source and full clinical presentation of this disease was unknown. Through laboratory cultures, Dr. Kuschke identified *Fusarium spp.* as the source of mycotic dermatitis and began

experimenting with topical treatments at the FAU Marine Lab. Her protocol using essential oils to treat mycotic dermatitis resulted in the first recorded improvement of the condition in captive-reared leatherbacks.

Collaborating with University of Tennessee veterinary student Megan Kinsella, Dr. Kuschke cultured samples collected from 14 turtles and eggs from 9 different nests and concluded that nest exposure was the most likely source of *Fusarium spp.* in the captive-reared leatherbacks. The study's findings may also explain why leatherback hatching success is naturally low in the wild.

“By understanding leatherbacks’ skin microbiota we are able to take a deeper dive into what’s a healthy animal. We don’t know if a nest with poor hatching success makes hatchlings that are healthy or less robust. Dr. Sam Kuschke’s work with leatherbacks and skin microbiota is starting to tell us what is normal.”

— Dr. Jeanette Wyneken, Florida Atlantic University - Gumbo Limbo Nature Center



PUSHING TECHNOLOGICAL BOUNDARIES

Upwell empowered stakeholders to identify threats to turtles at sea with greater resolution and resolve. Partnering with tech innovators, we advanced new prototypes for tracking turtles, honed models to predict sea turtle movements, and expanded access to systems for validating bycatch data collection.



Diving into a new dimension with juvenile leatherbacks

Through their tagging and release into the Atlantic, the leatherbacks reared at the FAU Marine Lab provided us with a better understanding of juvenile dispersal patterns. In 2022, we deployed upgraded micro-satellite tags on 12 of the captive-reared juvenile leatherbacks and released them off the coast of Florida.

Upwell's Lost Years team worked with Lotek to upgrade tag technology and software prior to the 2022 field season. The manufacturer's addition of solar panels to the micro-satellite tags doubled transmission strength and significantly improved leatherback tracking durations. Refinements to transmission schedules, made in consultation with partners at Mercator Ocean International, improved the accuracy and reliability of transmissions. These improvements enhanced Upwell's collection of novel datasets on early stage leatherback movements.



Advances in Lotek's tag technology also enabled us to (quite literally) add a whole new (vertical) dimension to our tracking data in 2022! A third of the 12 tags were equipped with dive sensors, which logged the first-ever dataset on juvenile leatherbacks' vertical movements. They spent 71% of their time underwater, mostly at depths of 30 meters or less. The juvenile leatherbacks recorded dives to greater depths than the juvenile greens or loggerheads tagged via Upwell's Lost Years research program.

“Critical to the success of the tag development was the application of scientific expertise regarding species specific physiology and behavior and in conducting controlled in-situ experiments. We appreciate the significance of the conservation issues, the resulting scientific questions, and the strategic importance of Upwell's mission and its synergy with Lotek's.”

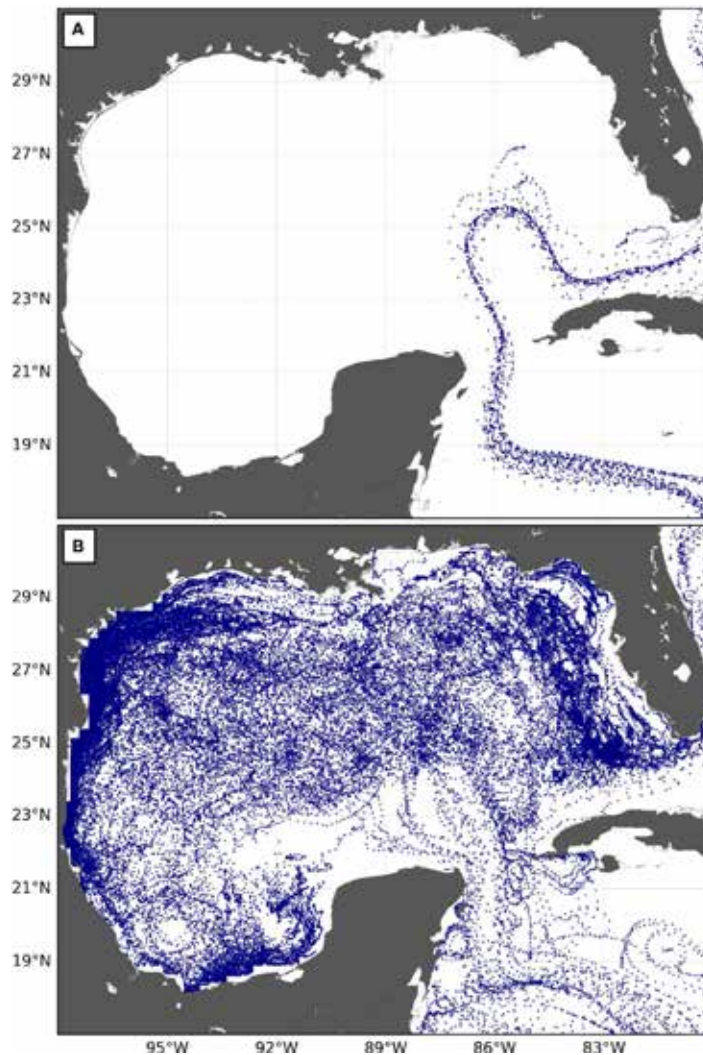
— Donna Kehoe, Director, Marine & Freshwater Segments, Lotek

Predicting juvenile leatherback dispersal patterns across the Atlantic Ocean

Upwell's juvenile leatherback tagging data has helped to refine the Sea Turtle Active Movement Model (STAMM), which can predict how early-stage leatherbacks will disperse from nesting beaches under the combined influences of oceanic currents and habitat-driven swimming motions in real-time oceanographic conditions.

Dr. Philippe Gaspar, STAMM's co-creator and Senior Researcher at Upwell's partner organization Mercator Ocean International, co-authored a paper with Upwell Researcher Tony Candela and Dr. George Shillinger in 2022 using the model to predict juvenile Northwest Atlantic leatherback dispersal from Caribbean nesting beaches. Among several significant findings, the publication recognized the important role of retention areas in the Gulf of Mexico, within the Panama-Colombia Gyre, and along Florida's Atlantic Coast, which can provide optimal habitats for sea turtle foraging and growth. The paper also highlighted the opportunity to use STAMM as a tool for examining the impacts of climate change on sea turtle populations, such as changes in the production of eddies and shifts in the Loop Current within the Gulf of Mexico.

The STAMM approach can be applied to populations of leatherbacks and other sea turtle species. With the improved understanding of sea turtle movements and habitat use afforded by STAMM, Upwell can better advance targeted protections across sea turtle life histories.



Deploying camera technology to quantify fisheries bycatch in Mexico

Of the 70,000+ small-scale fishing boats in Mexico, few report sea turtles accidentally hooked, ensnared or entangled in fishing gear. Reporting sea turtle bycatch can be risky; protected species laws prohibit anyone without a special permit from handling turtles.

In 2022, Upwell Researcher Stephanie Rousso piloted a networked system whereby lead fishers report sea turtle bycatch for their own boat and others. With permits secured by our local partners at Grupo Tortuguero, lead fishers weighed, measured and released the turtles. Short-wave radios provided by Upwell enabled other fishers to report their turtle bycatch to lead boats. Seven networked fishers participating in the pilot program reported and released 20 sea turtles in 2022, providing biometric information for each turtle and details on fishing gear in use, habitat characteristics and GPS coordinates associated with each incidental capture.

Upwell's first-ever crowdfunder launched in 2022 with a generous donor's leadership gift to facilitate the purchase and installation of a new Shellcatch camera on a second lead fishing boat in Sinaloa (Shellcatch generously provided the first camera free of charge). Upwell Researcher Aileen Lavelle developed a remote system for analyzing Shellcatch camera footage uploaded to the cloud through our

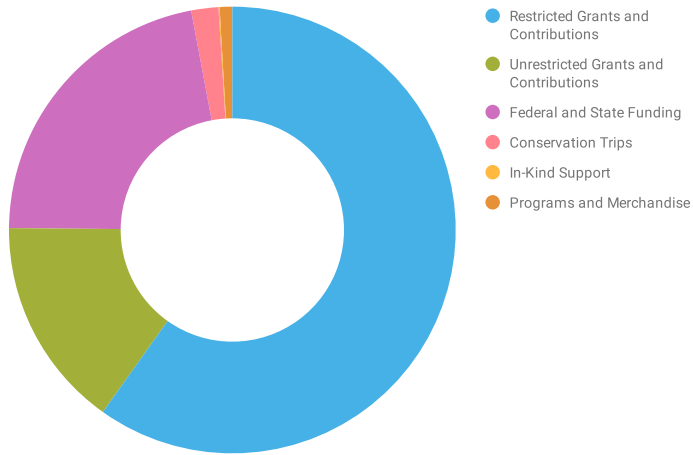
partnership with Dr. Alan Zavala Norzagaray at the Centro Interdisciplinario de Investigación para el Desarrollo Integral Regional Unidad Sinaloa. This project will help validate our bycatch reporting system designed specifically for small-scale fisheries.



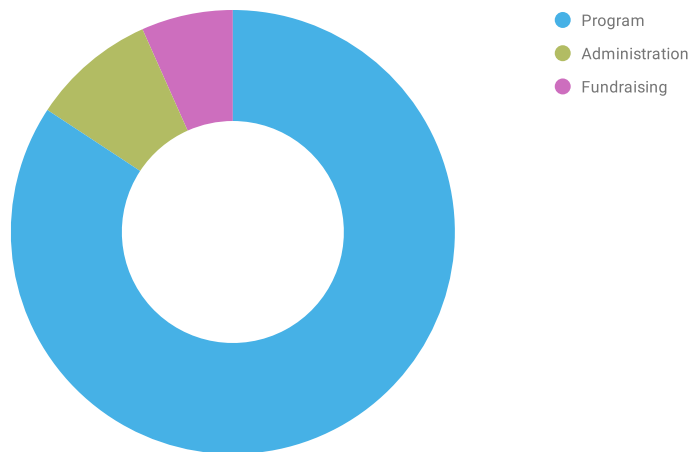
Sea Turtle Spotters at OceanLife Flights in Mexico, documented a total of 2,431 sea turtles from 207 flights in 2022!

2022 Financials

Income



Expenses

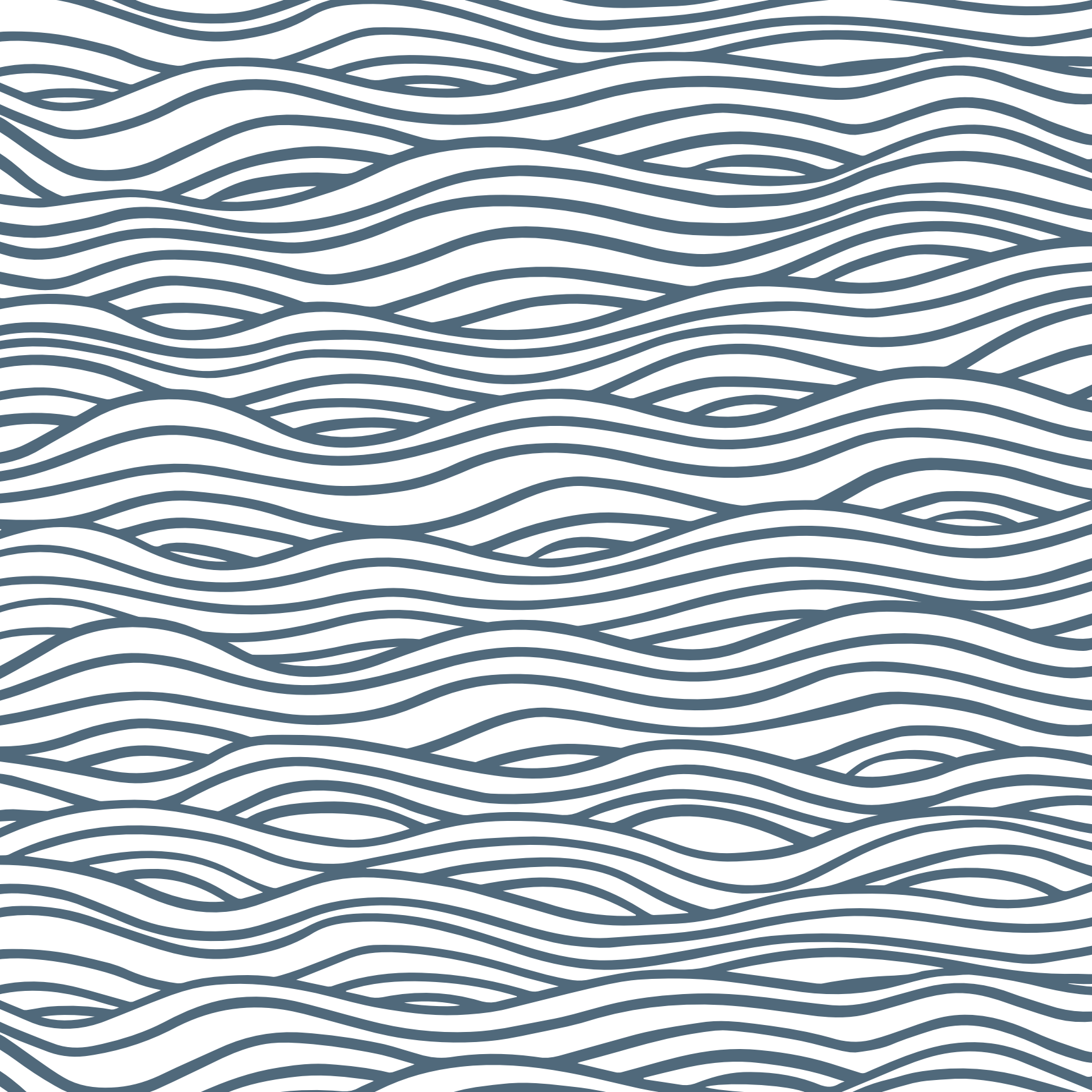


Recent Publications

Gaspar, P., Candela, T., and Shillinger, G.L. 2022. [Dispersal of juvenile leatherback turtles from different Caribbean nesting beaches: A model study.](#) *Front. Mar. Sci.* 9:959366.

Kuschke, S.G. 2022. [What lives on and in the sea turtle? A literature review of sea turtle bacterial microbiota.](#) *anim microbiome* 4, 52.

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