SWOT

report

Volume XIV

The State of the World's Sea Turtles

SPECIAL FEATURE

Sea Turtles *of the* Mediterranean Sea

INSIDE: ATLANTIC LOGGERHEADS | RED TIDES | FAQs | AND MORE…

A curious olive ridley turtle approaches in Baja California, Mexico. © JORGE CERVERA HAUSER | 2013; FRONT COVER: A loggerhead turtle swims over seagrass (*Posidonia oceanica*) in the Mediterranean Sea. © KOSTAS PAPAFITSOROS

Editor's Note

It's about WAY more than just turtles ...

If you're like me, you've probably walked into the room and heard, "Hey, it's the turtle guy (or girl)!" more times than you can recall. When I worked on my first turtle beach in Georgia (U.S.A.), "Turtle Boy" was my actual job title. Like it or not, that moniker has stuck with me for decades. I'm not complaining, because it provides me with a perfect opening to start a dialogue about my favorite topic. The conversations usually begin with a litany of queries: "How old do turtles get?" "Do they migrate?" "Where do the baby turtles go?" "Are turtles endangered?"—and other frequently asked questions that many in our community encounter daily. As a handy tool to prepare us for such questions, this volume of *SWOT Report* introduces a new section called "FAQs about Sea Turtles" (p. 36), in which we ask experts some of the common questions that are often not so easy to answer.

When the questions we are asked go beyond the curious mysteries and basic natural history traits of sea turtles, they sometimes touch on more profound issues such as: "Does it really matter if we have sea turtles on our planet? After all, the dinosaurs went extinct, and here we are"; or "Now that the status of many sea turtles appears to be improving, isn't your job done?"; or "Aren't there more important species to worry about?" Such questions give us the amazing opportunity to explain why our work as sea turtle girls and guys is so globally important.

Sea turtles are integral components of healthy oceans. They fill countless ecological niches, some of which no other creatures occupy. Healthy oceans mean a healthy planet and healthy humans too. So, when I am asked if sea turtles are worthy of conservation attention, I remind people that as long as we breathe air, drink water, eat food, and enjoy a livable climate—services provided by healthy oceans in which healthy populations of turtles thrive—then, yes, they do matter.

Our jobs as turtle folk are not insignificant but rather are among the most noble of endeavors in the 21st century—when human survival on Earth hangs in the balance. Our cooperation as a global sea turtle community, through SWOT and other conveners, is absolutely fundamental to achieving the synergy needed to meet the irrefutable requirement to save the oceans. In the words of another "sea turtle guy,"

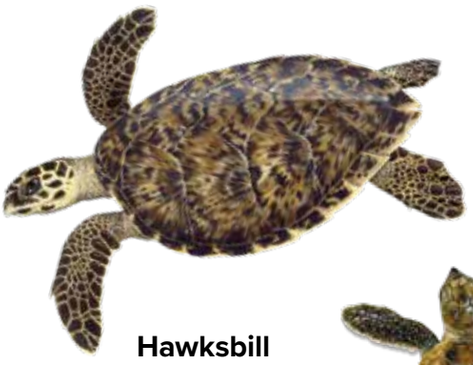
> *"The sea, the great unifier, is man's only hope. Now, as never before, the old phrase has a literal meaning: we are all in the same boat."*
>
> — Jacques Cousteau

Roderic B. Mast
Turtle Boy

AT LEFT: A female leatherback turtle in a freshwater river behind Grande Riviere Beach on Trinidad's north coast. After nesting, the seemingly disoriented turtle entered the river instead of returning to sea. © MICHAEL PATRICK O'NEILL

meet the turtles

The seven sea turtle species that grace our oceans belong to a unique evolutionary lineage that dates back at least 110 million years. Sea turtles fall into two main subgroups: (a) the unique family *Dermochelyidae*, which consists of a single species, the leatherback, and (b) the family *Cheloniidae*, which comprises the six species of hard-shelled sea turtles.



Hawksbill
(*Eretmochelys imbricata*)
IUCN Red List status:
Critically Endangered

Flatback (*Natator depressus*)
IUCN Red List status: Data Deficient

Kemp's ridley
(*Lepidochelys kempii*)
IUCN Red List status:
Critically Endangered

Green (*Chelonia mydas*)
IUCN Red List status: Endangered

Loggerhead (*Caretta caretta*)
IUCN Red List status: Vulnerable

Leatherback
(*Dermochelys coriacea*)
IUCN Red List status:
Vulnerable

Olive ridley
(*Lepidochelys olivacea*)
IUCN Red List status:
Vulnerable

Visit **www.SeaTurtleStatus.org** to learn more about all seven sea turtle species!

SWOT report
The State of the World's Sea Turtles

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table of contents

3 Editor's Note: It's About WAY More than Just Turtles ...
4 Meet the Turtles

research and status

6 Masirah's Sea Turtles: History, Trends, Action, and Hope
8 Eye of the Turtle
10 Florida's Red Tides and Their Impacts on Sea Turtles
12 Atlantic Loggerheads: Why Isn't the Best Understood Sea Turtle Recovering?
18 Map: Loggerhead Turtle Satellite Telemetry Data in the Atlantic Ocean

special feature

20 Sea Turtles of the Mediterranean Sea
26 Feature Maps: Biogeography of Sea Turtles in the Mediterranean Sea

policy and economics

30 The Continuing Tale of Circle Hooks in Brazil
34 Status Update: Modern Threats Taking a Toll on Northwest Atlantic Leatherbacks

outreach and action

36 FAQs About Sea Turtles
40 Stranding Networks Administer the Three R's in the American Atlantic
42 Finding the Keys to Safe Transport of Debilitated Turtles
44 A Caribbean Eden Recovers from Hurricane Irma

the SWOT team

46 SWOT Team Update: Examples of How the SWOT Database Has Been Used for Research and Conservation
48 Acting Globally: SWOT Small Grants 2018
50 SWOT Data Citations
56 Authors and Affiliations
57 Acknowledgments

Find Mr. Leatherback! How many times can you spot Mr. Leatherback's distinctive silhouette in this issue of *SWOT Report*? Check the SWOT website at **www.SeaTurtleStatus.org** for the correct answer!

Masirah's Sea Turtles

HISTORY, TRENDS, ACTION, AND HOPE

By ANDREW WILLSON, CRAIG TURLEY, MAÏA SARROUF WILLSON, SUAAD AL HARTHI, ASMA AL BULUSHI, MAYEUL DALLEAU, JÉRÔME BOURJEA, THURAYA AL SARIRI, and ROBERT BALDWIN

A TALE OF DISCOVERY AND DECLINE

Flanking the central coast of the Sultanate of Oman, less than 20 kilometers (12.4 miles) offshore, the dry, rugged desert island of Masirah hosts one of the most important loggerhead turtle rookeries in the world. In 1977, the scent of a major turtle discovery in Arabia had reached the nose of the renowned Dr. Archie Carr. Soon after, a joint initiative of the International Union for Conservation of Nature and World Wildlife Fund was launched, and Dr. James Perran Ross began a pioneering project there.

Spending much of the next three years embedded with the local community on Masirah, Ross helped to shape a team of young fishermen into turtle rangers. The rangers were responsible for enforcing new antipoaching regulations and assisting Oman's Marine Science and Fisheries Centre with an ambitious turtle research program. Foot patrol track counts, night surveys, and exhaustive tagging efforts provided the data for a landmark 1979 report about the ecology of the four sea turtle species nesting on the island. The prize of this report was the estimation that a minimum of 30,000 loggerheads nest on the island each year, "representing the largest known aggregation of this species in the world," according to Ross.

By May 2008, Masirah's turtle rangers, under the management of Oman's Ministry of Environment and Climate Affairs (MECA), had regrouped with help from turtle scientists supported by the Environment Society of Oman, the U.S. Fish and Wildlife Service, and local experts at Five Oceans Environmental Services (5OES). A new research strategy was designed to use both the prior 30 years of data and a new survey protocol to investigate long-term population trends of nesting loggerheads. By 2015, sufficient evidence had been amassed to declare Masirah's loggerheads (called the Northwest Indian Ocean subpopulation) critically endangered on the IUCN Red List (see *SWOT Repor*t, vol. XII, "The Population Status of Loggerhead Populations Worldwide"). This unexpected assessment of decline and heightened risk of extinction had been suspected some years earlier, but the official declaration motivated a cascade of cross-discipline questions about precisely how and when it had happened and, more important, what could be done in response.

OUT AT SEA, OUT OF MIND?

Telemetry studies initiated in 2006 by the Masirah Turtle Conservation Project and MECA drew the first lines of loggerhead movements beyond the beach and showed the internesting habitat close to shore and migratory movements predominantly to the south into the Gulf of Aden. Soon after, results from new nesting beach surveys began to ring alarm bells in the local community. Counts were not reaching historical levels, and rangers began to ask why. If the causes of the decline were from human impacts, were those threats occurring on the beaches, at sea from industrial fisheries, or—even unintentionally—as a result of the local artisanal fisheries?

ALL ABOARD

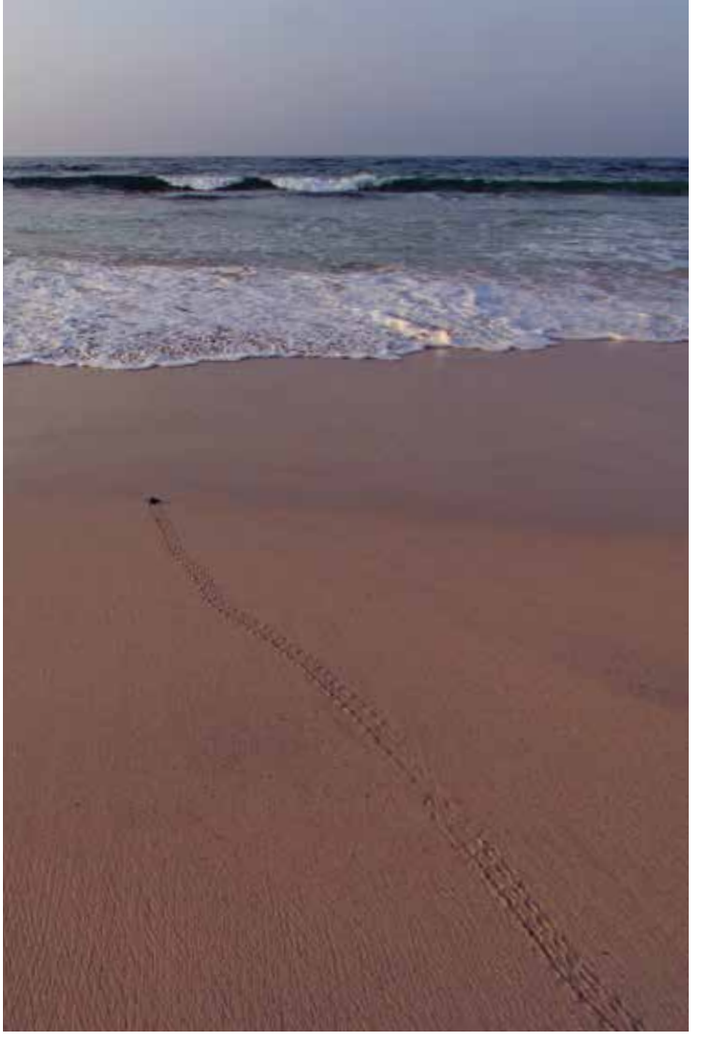
One of the first proactive responses to such questions was the launch of a community engagement project in 2010 to characterize Masirah's fisheries and to better understand and quantify the possible impacts of bycatch. In a study led by the Environment Society of Oman (ESO), by 2013 more than 15 percent of Masirah's 600-vessel fleet had contributed to interview-based surveys. Preliminary results indicated that an estimated 3,000–9,000 turtles were being captured in net fisheries each year, approximately 2,000 of which were thought to be loggerheads. Such a high level of bycatch was sufficient to prompt the next phase: a remote fisheries observer program backed by a full-time coordinator to gather data, engage with fishers, and explore techniques for bycatch reduction. Still in progress today, this work combines the results of tracking vessels and capturing automated images of vessel activities. Using spatial analysis of turtle movements from telemetry data, the project plots co-occurrence of fishing effort with turtle movements to monitor and reduce levels of bycatch.

SURPRISE FROM THE SOUTH

In the meantime, a much broader picture of loggerhead ecology was emerging far to the south. A regional turtle connectivity project instigated by the French research institute IFREMER and the Reunion Island–based organization Kelonia used satellite transmitters to track subadult loggerheads captured in the European long-line fleet that is operating in the Southern Indian Ocean. Dozens of tracked turtles headed toward the shores of Oman, with genetic sequencing confirming that the youngsters were from the Masirah rookery (see *SWOT Report*, vol. VII, pp. 10–11). Not only had this team documented new insights into movements of the species across the Indian Ocean basin, but also they had documented interactions with high seas fisheries and had discovered high levels of plastic ingestion by Omani loggerheads found close to Reunion Island. The conservation situation was becoming even more complex.

BACK TO THE BEACH

The nesting rookery itself has not been left behind in efforts to understand the broader conservation situation. With the hiring of full-time field researchers on Masirah, the capacity to investigate conservation concerns on the island vastly increased. That expansion included the addition of almost year-round surveys to monitor nesting activity of loggerheads and three other turtle species, as well as island-wide stranding and beach use surveys to monitor anthropogenic disturbances such as egg poaching and the seasonal distribution of fisheries.



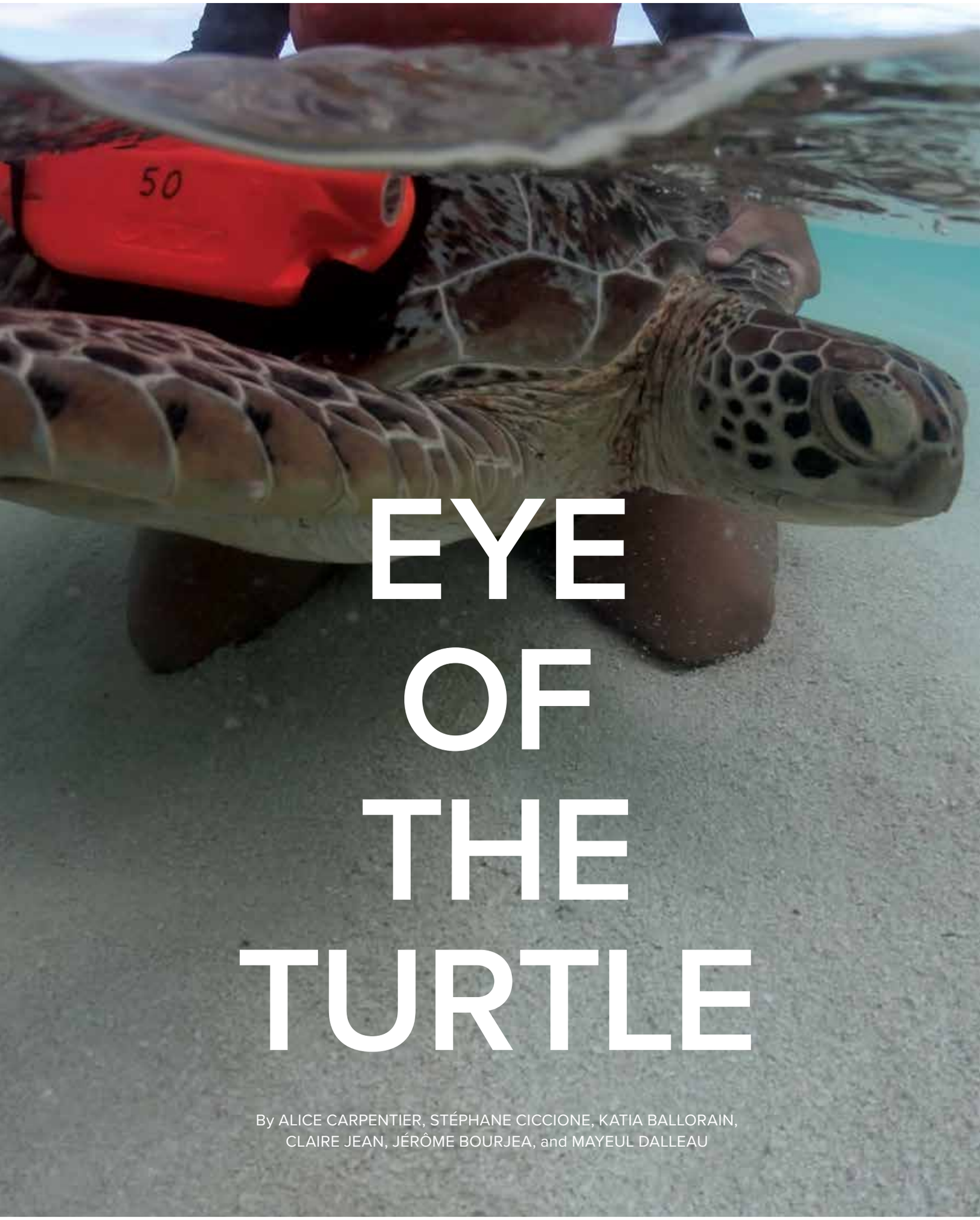
A loggerhead hatchling crawls toward the sea in Oman. © JÉRÔME BOURJEA; AT LEFT: A loggerhead nests on Masirah Island, Oman. © JÉRÔME BOURJEA

BEHAVIOR CHANGES

Working with Masirah communities starting in 2008, ESO and government stakeholders initiated projects to complement the ongoing research activities. Projects to raise awareness included school festivals, a sea turtle–inspired football league, bycatch workshops for fishermen, and workshops with the local Omani Women's Association for the development of eco-crafts. In 2014, 50 permanent signs were installed on the turtle nesting beaches to guide visitors' conduct; in 2018, organizers plan to launch a media event, with videos highlighting the community's efforts to conserve sea turtles.

In 2017, ESO and stakeholders mobilized a cleanup after the wreck of a cargo vessel left plastic strewn along the nesting beaches. The event became the catalyst for further cleanup operations, resulting in the clearance of an astonishing 38 tons of discarded fishing nets along 34 kilometers (21 miles) of nesting beach. Responding to the source of the problem, ESO has recently launched a new campaign that encourages local fishermen to adopt more sustainable fisheries practices, including responsible storage and disposal of fishing nets as well as continued dedicated net cleanups. The study represents a groundbreaking framework for changing behavior while using community-based social marketing as a tool. And a new campaign has begun to implement low-cost, high-impact solutions among beachside residents to target reduced light use, to shield lights, and to install turtle-friendly lighting along 2 kilometers (1.2 miles) of prime nesting habitat.

Extensive collaboration among more than a dozen local, national, and global organizations has allowed this potentially tragic story to evolve into one of hope for Masirah's sea turtles. ■



EYE OF THE TURTLE

By ALICE CARPENTIER, STÉPHANE CICCIONE, KATIA BALLORAIN, CLAIRE JEAN, JÉRÔME BOURJEA, and MAYEUL DALLEAU

Thanks to the latest advances in underwater cameras, researchers can now study sea turtle behaviors, habitat use, and fine-scale movements using an array of new technologies.

In the Southwest Indian Ocean, the use of animal-borne cameras on sea turtles started in 2015, with a total of 29 devices deployed on juvenile green and hawksbill sea turtles at four different study sites in French overseas islands: the Glorieuses Archipelago, Juan de Nova, Mayotte, and Reunion. To recover the cameras and avoid the loss of valuable and reusable equipment, researchers also successfully tested and deployed automatic releases and VHF radio tracking devices. Since 2017, researchers have also used 360-degree cameras anchored to the sea bed as a complement to the turtle-borne cameras in key sea turtle resting and feeding habitats in Reunion and Glorieuses. The anchored cameras decrease the potential data biases that may arise from the presence of cameras attached to the turtles. Thus far, the ongoing studies have yielded more than 115 hours of video footage using 360-degree cameras (with an average of 6.5 hours per deployment) and 142 hours of turtle-borne camera footage (with an average of 15.5 hours per animal).

Results so far have provided valuable insights into sea turtle behavioral ecology, diets, and habitat preferences, and those results have captured rarely reported activities, such as green turtles scrubbing and burying themselves on the sandy seafloor, unexpected social interactions between sea turtles, and predator interactions. In addition, anchored 360-degree cameras provided researchers with the unique opportunity to individually identify dozens of turtles using photo identification (PID) methods without having to capture the animals.

Another important benefit of using turtle-borne cameras has been the generation of footage for conservation outreach and awareness efforts. Several video sequences were combined into a powerful short film called "Eye of the Turtle," which was shown at numerous special events in support of sea turtle and ocean conservation and is now freely available for online viewing. On Reunion Island, footage gathered using 360-degree cameras is being incorporated into a three-dimensional documentary in which the audience becomes actively engaged through the use of virtual reality headsets, thus creating a "wow" effect and an immersive experience of the life of a sea turtle.

With further technological advances—such as improved camera functionality, data storage, battery capacity, and miniaturization—researchers will be able to collect video footage across different species, life stages, and habitats. By increasing the understanding of sea turtle habitat use, of foraging, and of behavioral ecology, researchers can help conserve these endangered populations. ■

THIS PAGE: An underwater camera captured this "turtle's eye view" in the southwest Indian Ocean. © AGENCE FRANÇAISE POUR LA BIODIVERSITÉ / CEDTM; AT LEFT: Researchers prepare to release a green turtle fitted with an underwater camera. © LAURE MONTCHAMP / AGENCE FRANÇAISE POUR LA BIODIVERSITÉ

Florida's Red Tides
AND THEIR IMPACTS ON SEA TURTLES

By JUSTIN R. PERRAULT, ALLEN M. FOLEY, LEANNE J. FLEWELLING, and CHARLES A. MANIRE

Harmful algal blooms (HABs) have occurred on Florida's west coast for centuries, with the first documented report of the HAB known as a red tide in 1844. Although many different organisms can cause HABs, the red tide that commonly affects the Gulf Coast of Florida is caused by a single-celled dinoflagellate known as *Karenia brevis* (formerly *Gymnodinium breve* and *Ptychodiscus brevis*), which can turn waters reddish-brown when its concentrations are elevated. Those algae are naturally occurring and likely originate in midshelf waters. However, when winds, currents, salinity, and temperatures are ideal for algal transport and growth, the cells can be concentrated and proliferate into what are known as blooms. Although natural biogeochemical cycles contribute to the presence of HABs, it is possible that anthropogenic influences, including industrial and agricultural runoff (e.g., fertilizers and phosphate mining wastes), and increased ocean temperatures are resulting in an amplification of the frequency, duration, and range of harmful algal blooms.

Red tide blooms are problems because they harm both terrestrial and marine organisms through their production of lipid-soluble neurotoxins, known as brevetoxins, which result in the following: neurotoxic shellfish poisoning and respiratory effects in humans; massive fish kills; and mortality of marine mammals, sea birds, and sea turtles. Air-breathing organisms, including sea turtles, are exposed to brevetoxins through two primary mechanisms. The first route of exposure occurs from inhalation of the aerosolized toxins. When *K. brevis* cells burst as a result of wave action or cell death, the toxins are released from the intracellular contents and become associated with organic particles that can be aerosolized. As marine turtles come to the surface to breathe, they can inhale those toxins.

It is unlikely that inhalation of aerosolized brevetoxins alone causes mortality, however. The more worrisome route of brevetoxin exposure comes from ingestion of contaminated prey. Loggerhead and Kemp's ridley sea turtles forage on mollusks and crustaceans, which can accumulate the lipophilic toxins and subsequently pass them up the food chain. Even largely herbivorous green turtles can become exposed by consumption of the numerous epibiota that grow on seagrasses. Exposure from contaminated prey can occur months after a red tide bloom has dissipated, indicating that the toxins are persistent in both the environment and the tissues of organisms.

Once exposed, brevetoxins act upon numerous organ systems within the bodies of sea turtles. Primarily, brevetoxins are neurotoxins that affect the central nervous system. After being ingested, brevetoxins bind to voltage-gated sodium channels and inhibit their inactivation, resulting in loss of muscle coordination. This loss, in turn, alters the afflicted turtle's ability to swim and breathe and—with more prolonged exposure—may lead to coma.

Other physiological changes associated with sea turtles include immunomodulation, alterations in gene expression, oxidative stress, and inflammation. Studies have also provided evidence of maternal transfer of the biotoxins through the egg yolk to developing sea turtle embryos. Additionally, plasma brevetoxin concentrations in green sea turtles correlated with fibropapilloma (FP) tumor loads, suggesting that they might serve as FP tumor promoters (similar to other biotoxins). However, this speculation requires further evaluation.

In the past, the treatment of sea turtles exposed to brevetoxins has typically been slow acting and only mildly successful, yet some sea turtles can recover relatively rapidly after toxin exposure. Current rehabilitation techniques include (a) removal of sea turtles from potential sources of brevetoxins, (b) oral administration of activated charcoal, (c) administration of electrolyte fluids, and (d)dehydration therapy. In the past decade, physicians and veterinarians have begun to use intravenous lipid emulsion (ILE) in the treatment of various acute intoxications caused by lipid soluble agents.

Theoretically, brevetoxins should bind to lipids present in the ILE and subsequently be eliminated in the feces. Recent studies using brevetoxin-exposed red-eared sliders as a model for sea turtles have shown ILE to be highly effective at rapidly eliminating symptoms—within 2 hours, with complete elimination in 24 hours —and at removing brevetoxins from the bloodstream with no adverse effects from the treatment. Total clearance time of brevetoxins with currently available treatments, such as dehydration therapy, can take up to 80 days.

Florida is currently experiencing one of the worst red tide blooms in more than a decade ... more than 500 sea turtles have been stranded.

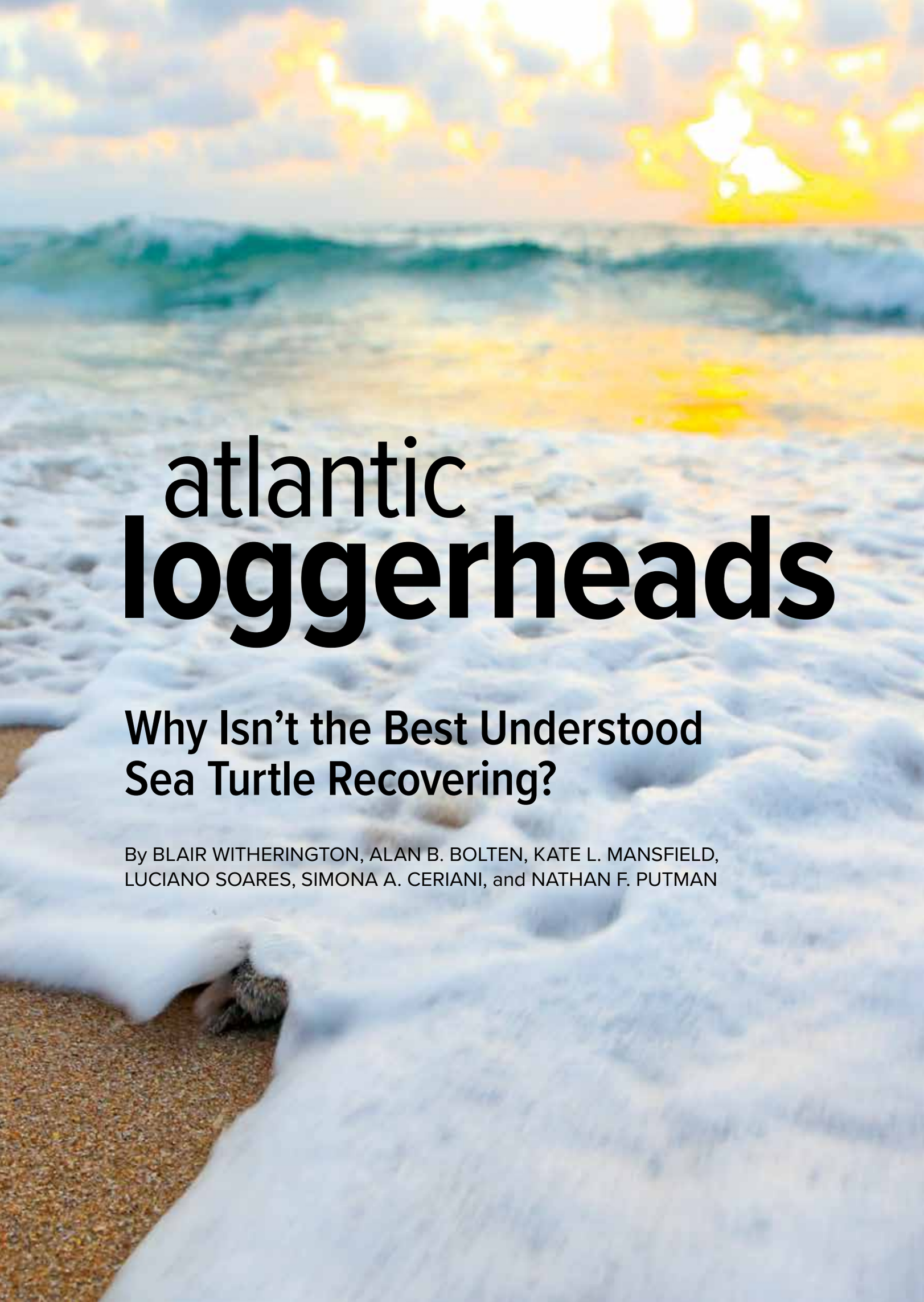
The development of ILE therapy in sea turtles is timely, as Florida is currently experiencing one of the worst red tide blooms in over a decade. Currently, more than 500 sea turtles have been stranded as a result of the red tide, a record for the state. Loggerheads and Kemp's ridleys account for about 90 percent of the strandings (45 percent for each species), and green turtles account for about 10 percent. The current bloom began in the Gulf of Mexico near Florida's west coast in October 2017, shortly after Hurricane Irma made landfall in Florida.

Although hurricane season is the time of year when Florida's red tides commonly occur, nutrient-rich runoff from Irma may have contributed to the persistence of the bloom, which continues to the present day (December 2018). Not only is this particular bloom persistent, but also it has been transported to regions less often affected by red tide, with *K. brevis* cell counts in Florida's panhandle and on Florida's east coast reaching more than 1 million cells per liter. However, very few sea turtles have been stranded in those areas as a result of the current red tide. Florida's east coast had not experienced red tide in nearly 10 years. However, when the blooms become extensive on Florida's west coast, they can become entrained in Florida's Loop Current, subsequently delivering the cells to the east coast through the Gulf Stream. One notable red tide in 2018 traveled as far north as North Carolina.

Currently, there are no completely effective and acceptable mechanisms to control K. brevis blooms. One of the major dilemmas lies with controlling a red tide that can span thousands of square kilometers. Ineffective and potentially harmful control mechanisms that have been used include the application of herbicides such as copper sulfate. One promising strategy lies within the ozone molecule, which, when added to seawater, destroys both the *K. brevis* cells and their associated toxins.

Strategies such as this may prove beneficial on a local scale but are unlikely to be effective at larger scales. A cure for the extensive blooms may never be found, and we must continue to advance the way we treat the symptoms. We also need to determine if the increases in red tides simply reflect the increased interest and advances in *K. brevis* cell and toxin detection, or whether those naturally occurring algae are capitalizing on anthropogenic effluent and climate change. As of now, this topic is hotly debated, but scientists will continue to look for an answer because the blooms persist and have detrimental effects on marine life. ■

AT LEFT: Workers prepare to pick up a dead loggerhead turtle in Sanibel, Florida, U.S.A., in August 2018. © GREG LOVETT / *PALM BEACH POST*



atlantic loggerheads

Why Isn't the Best Understood Sea Turtle Recovering?

By BLAIR WITHERINGTON, ALAN B. BOLTEN, KATE L. MANSFIELD, LUCIANO SOARES, SIMONA A. CERIANI, and NATHAN F. PUTMAN

The Atlantic Ocean has served as a laboratory for pioneering work to save sea turtles. It is where Professor Archie Carr—and many whom he inspired—first addressed some profound mysteries that had stymied the conservation of such enigmatic marine animals. Loggerhead sea turtles became an exemplar of this work, revealing critical concepts such as the oceanic dispersal, the nature of the "lost years," the migratory connections, and the relative importance of different life stages to population growth. These puzzle pieces have guided strategic sea turtle conservation for decades.

In addition to being a cradle for sea turtle conservation science, the Atlantic also happens to contain the largest population of loggerhead sea turtles on Earth (consequences of recent misfortune, rather than achievement, see pp. 6–7). If the adage "Where much is granted, much is expected" applies, this statement makes the stewards of the Atlantic disproportionately responsible for our future with sea turtles. So how are we doing? Is our understanding of Atlantic loggerheads benefiting them? Well, let's just say, it's never too late to show responsibility.

Humans have had an extensive presence in the Atlantic Ocean and its coastlines. Since before recorded history, native people on both shores drew upon resources from Atlantic coastal waters. And then, just 10 or so loggerhead generations ago, Europeans began ocean crossings that broadly spread both human appetites and the industrial capacity to satisfy them. Especially in the past century, people have consumed from the Atlantic and changed for the worse the waters where loggerheads live.

Loggerheads aren't picky, which has led some to suggest that the sea turtles might be resilient to all this human presence and might comfortably persist with us in the Sea of Atlas. They are globally distributed marine animals that forage widely. Their nesting range is almost as broad and includes islands, barrier strands, and continental beaches. Loggerheads are also generalists in where they live and what they eat—from estuaries, coastal shallows, and oceanic waters, with associated habitats spanning seagrass pastures, hard bottom, coral reefs, and the open sea. Their diet is satisfied by prey that vary over many phyla, from jellies to heavily armored crabs, clams, and large marine snails.

Perhaps because of their liberal and accommodating conduct, loggerheads and their kin have a track record of persistence. Their direct forebears have endured for more than 100 million years, with generalist species like the loggerhead surviving the cataclysmic events that snuffed out the dinosaurs. They prevailed through multiple ice ages and warming trends that shuffled habitats and drove sea-level changes of more than 200 meters. So we might imagine that loggerheads, with a capacity to fill such varied niches and to survive global tumult, would be able to avoid adverse effects from a single, albeit tough, competitor. But we'd be wrong.

Conventional wisdom accepts that the majority of the world's sea turtle populations are depleted owing to human actions. Many of these actions involve direct harvesting of eggs and turtles. But aren't we past that era? Shouldn't loggerheads be on the rebound? The recent IUCN Red List assessment (2013), drawing from decades of extensive monitoring on nesting beaches all over the world, concluded that the species is still vulnerable. But the assessment is complex (see *SWOT Report*, vol. XII, pp. 30–33). Ten loggerhead subpopulations make up the global species, with three in the Atlantic (excluding the Mediterranean). Of those three, the Northeastern Atlantic subpopulation is considered endangered because of its small size and restricted distribution, whereas the two Western Atlantic subpopulations (north and south) are listed as being of least concern. In this context, least concern does not mean recovered; they remain depleted but are holding their own for now. Why aren't these Atlantic populations recovering?

Overall, we've shown considerable conservation progress within the range of Atlantic loggerheads—we value them, seek to understand them, and attempt to manage our detrimental actions. Loggerheads in the Atlantic enjoy life on and off the shores of wealthy nations that show high conservation awareness. The Bahamas, Brazil, European countries, Mexico, the United States, and others are testament to this concern in their rule of law at sea—all of those nations have banned direct harvest of sea turtles.

We've also studied and monitored Atlantic loggerheads for decades, leading to those populations serving as the discovery point for comprehending sea turtle life histories, population biology, and ecology. If we draw on an index of numbers of nests made on Atlantic beaches, then we know much about how many adult loggerheads there are. The trend is disappointing—not dire, but certainly no recovery. Why? Perhaps we're impatient. The eggs we protected from poaching in the 1980s produced turtles that are only now coming home to nest. But the greatest toll we've taken on loggerhead populations has come from effects on life stages that are the most valuable to the population—older juveniles and adults with the highest probability of breeding. After only a couple of decades of protecting these animals in the water, we should now be seeing effects on recovery. Why don't we? Ostensibly, an answer lies not in our success toward ceasing the harm being done to them on purpose but in our inability to address the harm that occurs by accident.

A juvenile loggerhead drifts among jellyfish in the North Atlantic Ocean off Pico Island, Azores. © MICHAEL PATRICK O'NEILL; PREVIOUS SPREAD: Newly hatched loggerheads enter the Atlantic Ocean on the coast of Florida, U.S.A. © BENJHICKS.COM

CONNECTIONS—LIFE HISTORY, ECOLOGY, AND HAZARDOUS INTERSECTIONS

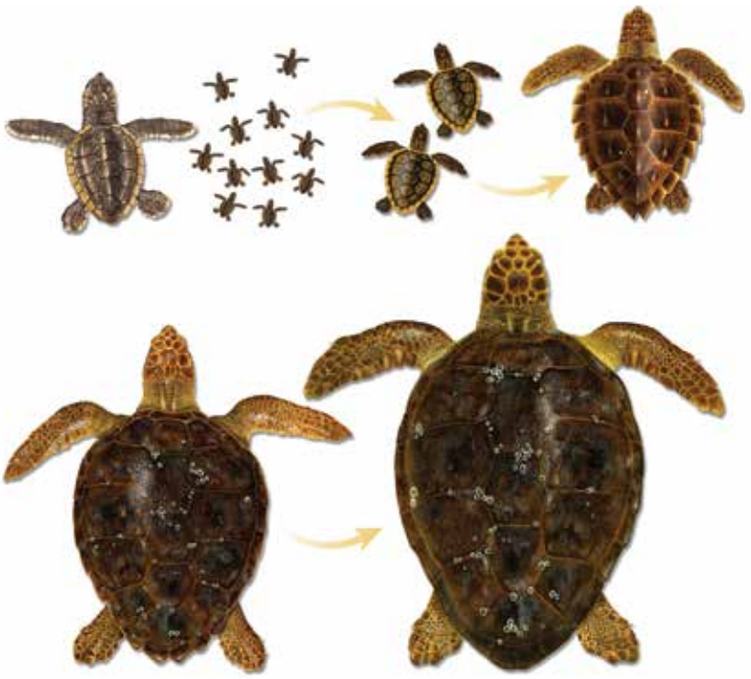
The loggerhead conservation puzzle finds clues in their connections to other organisms, ecological systems, human enterprise, and geopolitical states. Like all sea turtles, loggerheads are connected to the beaches where they lay their eggs. More so than with other sea turtles, loggerhead nesting covers many latitudes, with nests recorded as far north as New Jersey, on the U.S. coast, and as far south as the southern state of Paraná, Brazil. That range spans more than 3,700 nautical miles north to south. The southeastern coast of Florida is the center of nesting abundance, but considerable nesting also occurs in the remaining southeastern United States, on Mexico's Yucatan Peninsula, across Sergipe and northern Bahia states in Brazil, and in the Cabo Verde archipelago off western Africa.

Almost everywhere throughout the loggerhead's Atlantic nesting range, eggs are protected from poaching. But threats to nests and emerging hatchlings are common. Sources of mortality that are most severe stem from the incidental effects of coastal development. Human population centers close to beaches bring heavy-handed defense against erosion (sand pumping and seawalls), which leads to nesting habitat loss. However, the most injurious effects from development come from artificial lighting, which draws nocturnally emerging hatchlings away from the sea and causes high mortality on many beaches.

Hatchlings that survive the beach make a frenzied swim into the offshore Atlantic. This two-day sprint limits exposure to intense coastal fish predation and ends with little loggerheads settling in to the numerous surface features produced by converging ocean currents. The convergence zones collect the pelagic algae Sargassum, along with a host of small, slow-moving invertebrates that provide food for young sea turtles. Sargassum drift habitat is unique to the Atlantic, forming a massive oceanic habitat, with patches large enough to be viewed from space.

The currents that carry this drifting material manage to transport small loggerheads much more widely than they could disperse under their own swimming power. In the North Atlantic, the Gulf Stream and connected currents at the western edge of a clockwise, ocean-spanning North Atlantic Gyre carry neonate loggerheads across higher latitudes and into the eastern Atlantic. Hatchlings from Brazilian beaches may be transported even more widely, being either swept into the North Atlantic or circulated deeper into the South Atlantic and eastward toward Africa.

Until recently, a loggerhead's life in the open sea was almost completely unknown. How do they find their way? Answers came from Ken Lohmann and students at the University of North Carolina, who demonstrated that hatchlings use GPS-like cues from Earth's



Common appearances of life stages of loggerhead sea turtles in the Atlantic. Shown upper left to upper right are hatchlings, surface pelagic neonates, and oceanic juvenile, and from lower left to lower right are neritic juvenile and adult female.
© ILLUSTRATIONS BY DAWN WITHERINGTON

magnetic field to derive their location from the bi-coordinate grid of magnetic field strength and the angle of that field relative to the Earth's surface. From Atlantic loggerheads we now know that the relatedness of female loggerheads on their nesting beaches can be explained by the similarity of magnetic field values where the turtles nest. So it seems, at least in part, that magnetic fields guide loggerheads home. In the Atlantic, there is also considerable support for the hypothesis that young loggerheads use their magnetic sense to swim toward favorable open-sea habitat. And in the case of southeastern U.S. loggerheads, this directed swimming increases the odds of reaching their next life-history milestone—continuing to mature in the foraging habitats in the eastern Atlantic and Sargasso Sea.

To graduate to larger oceanic juveniles, neonate loggerheads must survive threats inherent to being small. Fish predation is believed to be high in this stage, but for eons, loggerhead reproduction (having lots of young) and behavior (rapid dispersal past risky coastal waters) have minimized this mortality. However, recent threats are developing that are too abrupt for accommodation. In a single loggerhead generation (roughly 45 years), an extraordinarily pernicious, human-generated ingestion hazard has spread into every crevice of the Atlantic—plastic litter. And it is in those crevices where little loggerheads find their food. We don't know the lethal magnitude of this incidental human threat, but we do know it is pervasive. Nearly all of the neonate loggerheads swept dead onto Atlantic beaches during severe storms had ingested shards of degraded plastics, with compromised nutrition and gut blockage being a likely cause of death.

One of the greatest mysteries of a loggerhead's life at sea was how long they spent there. We first came to understand from Atlantic loggerheads that their enigmatic "lost year" in the open sea was more like a lost decade. In 1982, Helen Martins (University of the Azores) began tagging platter-size loggerheads found near the Azores archipelago in the eastern Atlantic. She forwarded the turtles' size data to Archie Carr, who used the information to lay out the case for a connection between loggerheads nesting in the western Atlantic and those swimming in eastern-Atlantic Azorean waters.

In what has now been a 35-year collaboration, the Archie Carr Center for Sea Turtle Research, the University of Florida (principally, Alan Bolten and Karen Bjorndal), and the University of the Azores have made advances in understanding loggerhead conservation challenges. Revelations include how fast loggerheads grow and compensate for periods of low growth, their extent of migratory movements, their ecological connections, and their odds of survival. This work also revealed important new findings on threats from plastic pollution, nutrient dilution, and—most important— bycatch in oceanic longline fisheries. The latter hazard is compounded by the decade that loggerheads endure as oceanic juveniles. Bycatch mortality is an onerous consequence of biology intersecting with economic enterprise; it occurs in both the northwestern and southwestern Atlantic loggerhead populations, whose open-ocean life stage makes up a third of the animal's maturation.

Following many years of growth in the open sea, most loggerheads return to the vicinity of their natal coast, a profound habitat shift accompanied by changes in behavior and diet. The turtle's mouth has grown along with its body size, making it capable of crunching a wide variety of shelled sea-bottom invertebrates. This shift is not always permanent. Some Atlantic loggerheads settle permanently into coastal waters, others move between coastal and offshore waters, and some remain largely oceanic while moving into shallow seas only during breeding migrations to their nesting beaches. Yet as most loggerheads grow closer to a mature size, they become more likely to occupy waters where they dive to the bottom for their food.

Coastal loggerheads are faithful to specific foraging grounds, but their fidelity is punctuated by seasonal migrations. Water temperature changes drive juveniles and adults into warming northern waters in the spring and south again in the fall as waters cool. Many North Atlantic coastal loggerheads move north and south of Cape Hatteras during such seasonal migrations, as they spend the winter over deep water along the western edge of the warm Gulf Stream current. Those turtles follow three-dimensional thermoclines within their habitats, remaining mostly at the surface during colder months, when ocean temperatures are more stratified, and feeding on the bottom once those deeper waters mix in the spring and summer.

Again, an unfortunate proximity of biology and human enterprise burdens larger loggerheads with exposure to a variety of coastal hazards. Perilous fisheries include trawling for shrimp and finfish, dredge fishing for scallops, and gill netting for finfish. Those fisheries are regulated throughout much of the loggerhead's Atlantic range, and fishers have made efforts to modify their gear and methods, yet incidental drowning in fishing gear remains a critical source of loggerhead mortality. Boat traffic in general constitutes another severe coastal threat to loggerheads, with boat strikes being the most common identifiable cause of death for sea turtles stranded on U.S. Atlantic shores.

Loggerheads that survive to adulthood are exposed to most of the same threats felt by younger coastal turtles. One additional array of threats experienced by adults may result from their breeding migrations. In the North Atlantic, breeding movements may be similar to coastal north-and-south travel seen seasonally in younger

loggerheads. But some breeding migrations are more extensive, like the common route females take between Chesapeake Bay foraging grounds and Florida nesting beaches, and the route between the northern Gulf of Mexico and eastern Florida. These periodic coastal movements multiply the risk of lethal interactions with an array of coastal hazards.

Despite what we think we know about how loggerheads breed, some profound mysteries remain. One of those is the presumed threat from hybridization. Although there are sporadic reports of loggerheads worldwide hybridizing with other sea turtle species, only in the southwestern Atlantic do such observations occur at an alarming frequency (see *SWOT Report*, vol. XI, p. 19). In the northeastern Brazilian rookeries of Bahia and Sergipe, hybridization between loggerheads and hawksbills, and between loggerheads and olive ridleys, occur at rates of more than 20 percent. This hybridization is not sex-specific. Both male and female loggerheads mate with other species, and both male and female adult hybrids have been identified. Remarkably, the hybrids do not seem to be at a reproductive disadvantage relative to their parental species in regard to hatchling production, and hybrid hatchlings have similar viability to nonhybrids. The cause and consequences of this blurring of sea turtle species are unknown.

PREDICTIONS

Atlantic loggerheads exemplify the challenges and opportunities characterizing life for sea turtles in a prospering world. Much of our activity in pursuing that prosperity has unintentional consequences for loggerheads. Yet the achievement of economic success over much of the loggerhead's Atlantic range, as well as the political systems governing that success, allow the people who accidentally harm loggerheads the luxury of purposefully conserving them.

A juvenile loggerhead fitted with a satellite transmitter is about to be released. Only recently has technology made it possible to satellite-tag such small turtles.
© KATE L. MANSFIELD

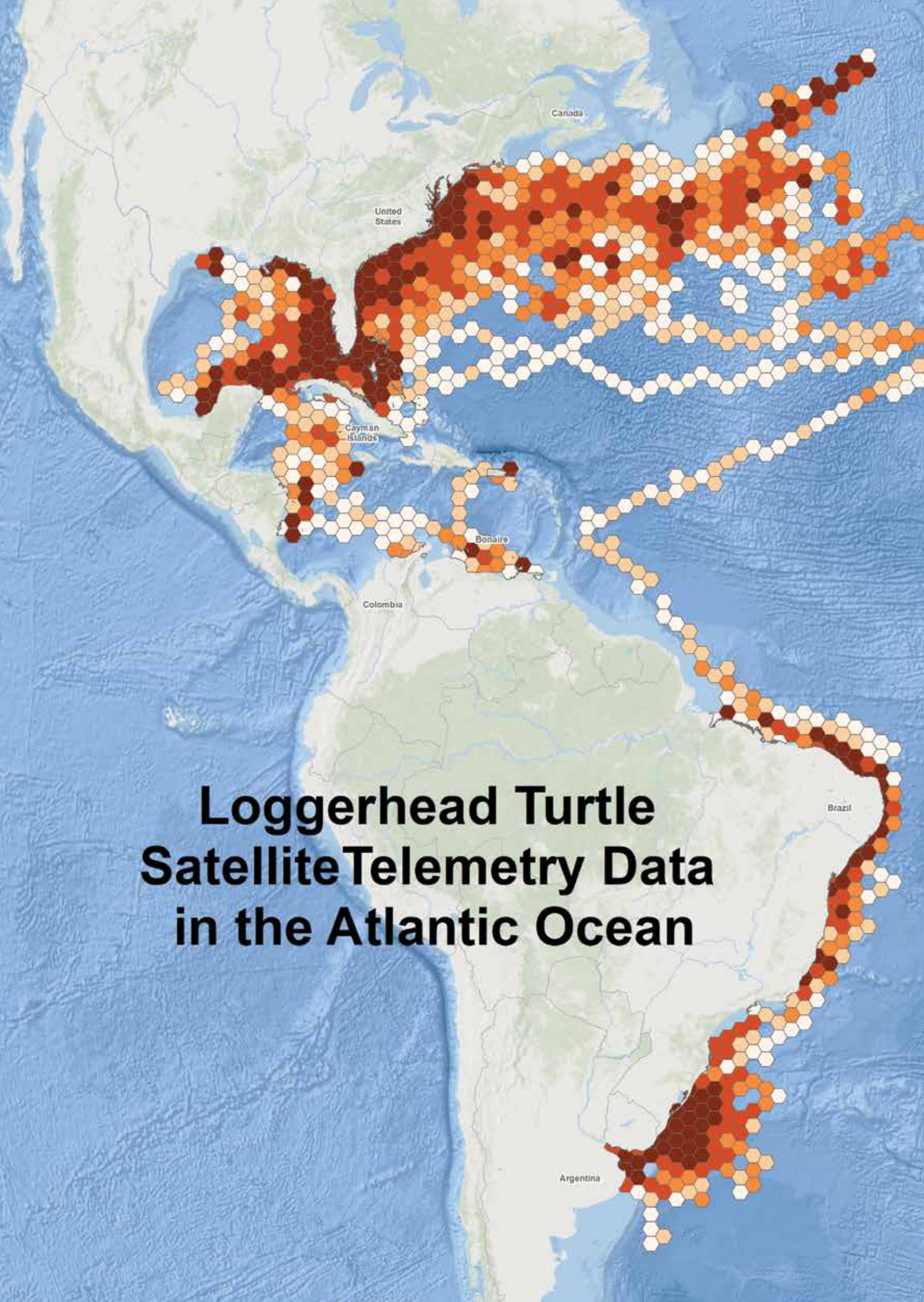
One common thread weaving through the story of loggerheads in the Atlantic is that their lives span their ocean. Each knot in a loggerhead's life-history thread, which is tied in waters of dozens of different countries or in waters belonging to all, lengthens the strand. But each knot can also break. No single country or entity will save our Atlantic loggerheads.

The international imperative for conserving sea turtles is most obvious when considering ubiquitous global threats. Climate change comes to mind, of course. But what are the implications for loggerheads? In short, climate change is expected to bring about widespread, abrupt, persistent changes in how marine ecosystems function (called ecological regime shifts). Those shifts will lead to altered growth rates, delays in graduation from life stages, and reduced population growth. Evidence for this cascade of effects comes from work on Atlantic sea turtles led by Karen Bjorndal. Her work revealed that somatic growth rates of loggerheads and two other sea turtle species throughout the region began to decline in the late 1990s as the result of an ecological regime shift. The decline continues to the present. Whether this environmental change is natural or anthropogenic matters not to our loggerheads. The result is the same—turtles endure risks for longer periods, delay their breeding, and contribute less to potential population growth. Do conservationists throw up their hands? No, they recognize the exigency and work harder.

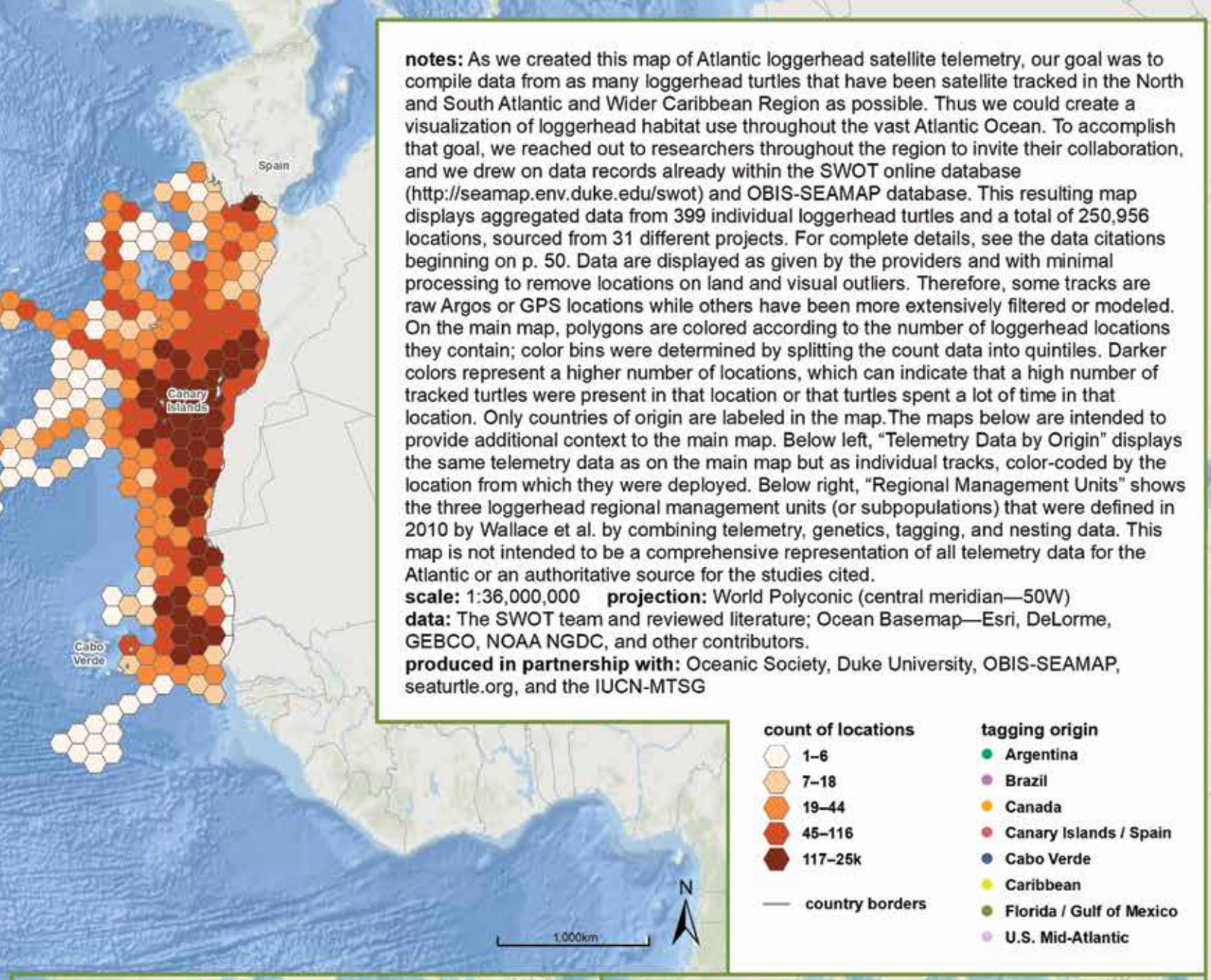
Another daunting but crucial area of conservation work for loggerheads is management of global fisheries. Unlike climate-change solutions, resolving threats to fisheries requires sea turtles to play an inspirational role. Already, loggerheads and other sea turtles in the Atlantic are the impetus for global thought, local action, and global action. In the western Atlantic, the Inter-American Convention (IAC) for the Protection and Conservation of Sea Turtles, signed by 15 countries in the Americas and Caribbean, has provided a legal framework for protection as an intergovernmental treaty since 2001. And conservation diplomacy continues.

Recently, a South Atlantic Network was established, within which sea turtle biologists and conservationists in West Africa and South America exchange information and ideas. The latest development from this network is a loggerhead threats analysis conducted by colleagues in Argentina, Brazil, and Uruguay and will soon include West Africa. The work would build on a similar analysis developed by the Northwest Atlantic Loggerhead Turtle Recovery Team. Threat analyses like these will show where conservation action can be directed to provide the greatest benefit to loggerhead populations.

There is justifiable hope. Yes, Atlantic loggerheads suffer within the challenging "tragedy of the commons." The turtles are indeed a shared resource affected by individual users who act in their own self-interest and collectively behave contrary to the common good—in this case, by depleting the oceans' loggerheads. However, there are solutions to avoid the tragic outcome of such circumstances. They are the underlying goals of conservationists—cooperation and rule of law. To get there, to save our loggerheads, we'll need measurable progress on all fronts in the Atlantic region. Some will work toward advancing the conservation science. Others will work within the social sciences to understand required sociopolitical relationships. But we will also need guidance on the art of communication, of winning friends, and of generating influence. We are on our way. Go team! ■



Loggerhead Turtle Satellite Telemetry Data in the Atlantic Ocean



notes: As we created this map of Atlantic loggerhead satellite telemetry, our goal was to compile data from as many loggerhead turtles that have been satellite tracked in the North and South Atlantic and Wider Caribbean Region as possible. Thus we could create a visualization of loggerhead habitat use throughout the vast Atlantic Ocean. To accomplish that goal, we reached out to researchers throughout the region to invite their collaboration, and we drew on data records already within the SWOT online database (http://seamap.env.duke.edu/swot) and OBIS-SEAMAP database. This resulting map displays aggregated data from 399 individual loggerhead turtles and a total of 250,956 locations, sourced from 31 different projects. For complete details, see the data citations beginning on p. 50. Data are displayed as given by the providers and with minimal processing to remove locations on land and visual outliers. Therefore, some tracks are raw Argos or GPS locations while others have been more extensively filtered or modeled. On the main map, polygons are colored according to the number of loggerhead locations they contain; color bins were determined by splitting the count data into quintiles. Darker colors represent a higher number of locations, which can indicate that a high number of tracked turtles were present in that location or that turtles spent a lot of time in that location. Only countries of origin are labeled in the map.The maps below are intended to provide additional context to the main map. Below left, "Telemetry Data by Origin" displays the same telemetry data as on the main map but as individual tracks, color-coded by the location from which they were deployed. Below right, "Regional Management Units" shows the three loggerhead regional management units (or subpopulations) that were defined in 2010 by Wallace et al. by combining telemetry, genetics, tagging, and nesting data. This map is not intended to be a comprehensive representation of all telemetry data for the Atlantic or an authoritative source for the studies cited.

scale: 1:36,000,000 **projection:** World Polyconic (central meridian—50W)

data: The SWOT team and reviewed literature; Ocean Basemap—Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors.

produced in partnership with: Oceanic Society, Duke University, OBIS-SEAMAP, seaturtle.org, and the IUCN-MTSG

count of locations

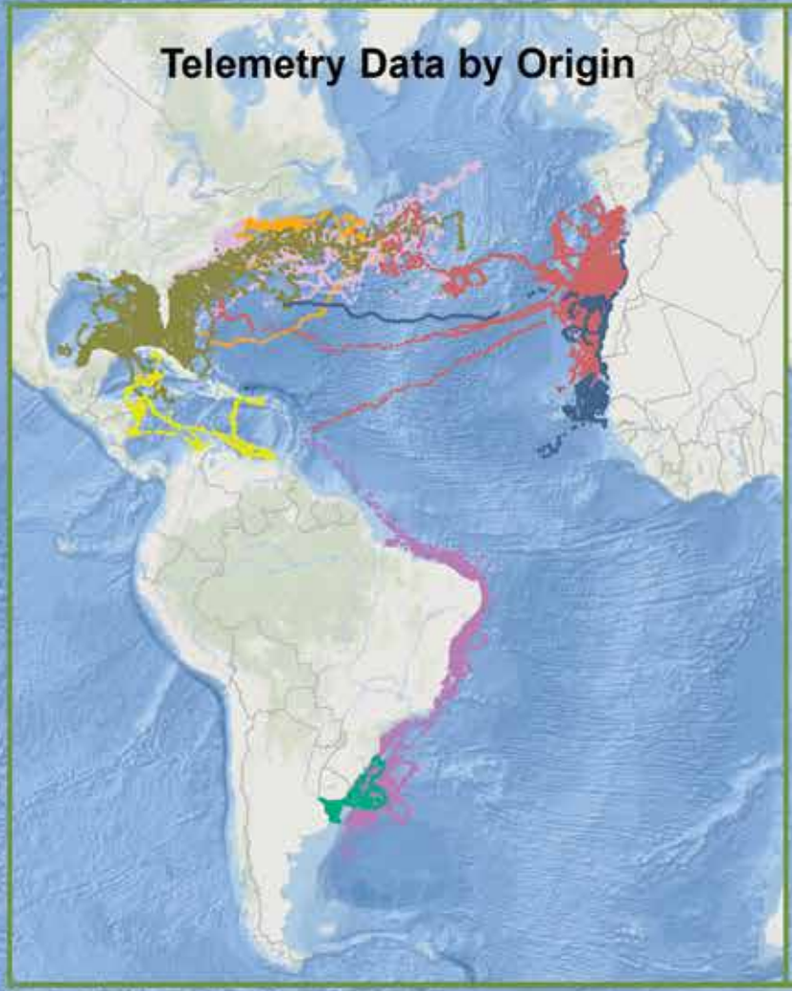
- 1–6
- 7–18
- 19–44
- 45–116
- 117–25k

country borders

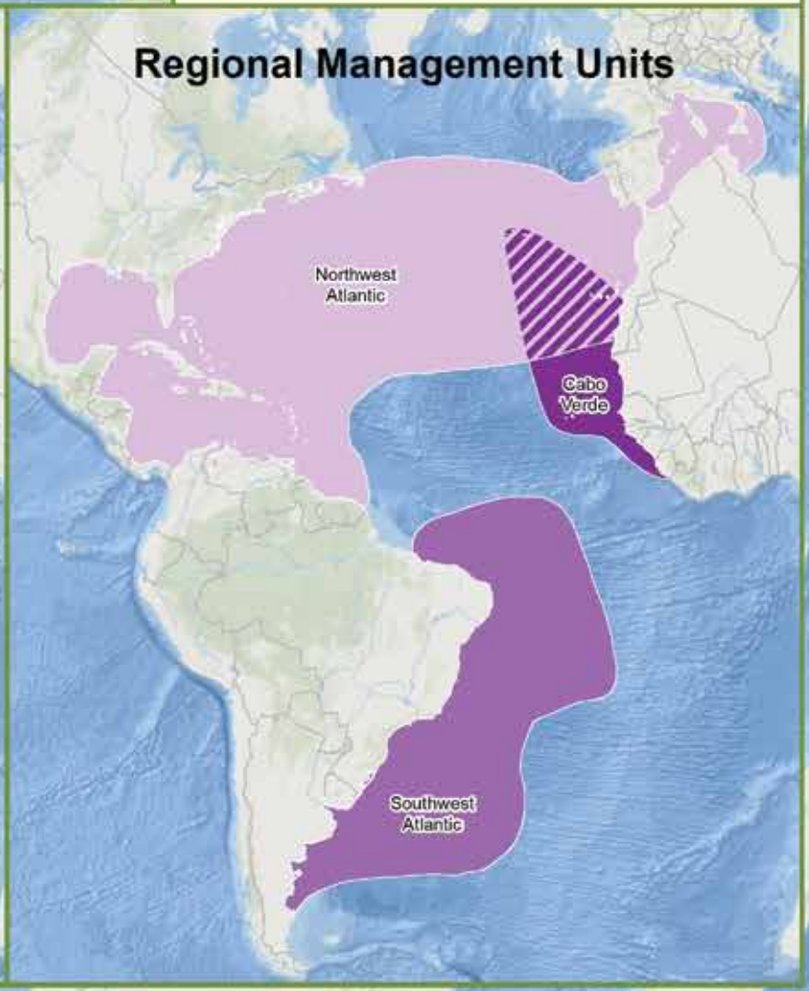
tagging origin

- Argentina
- Brazil
- Canada
- Canary Islands / Spain
- Cabo Verde
- Caribbean
- Florida / Gulf of Mexico
- U.S. Mid-Atlantic

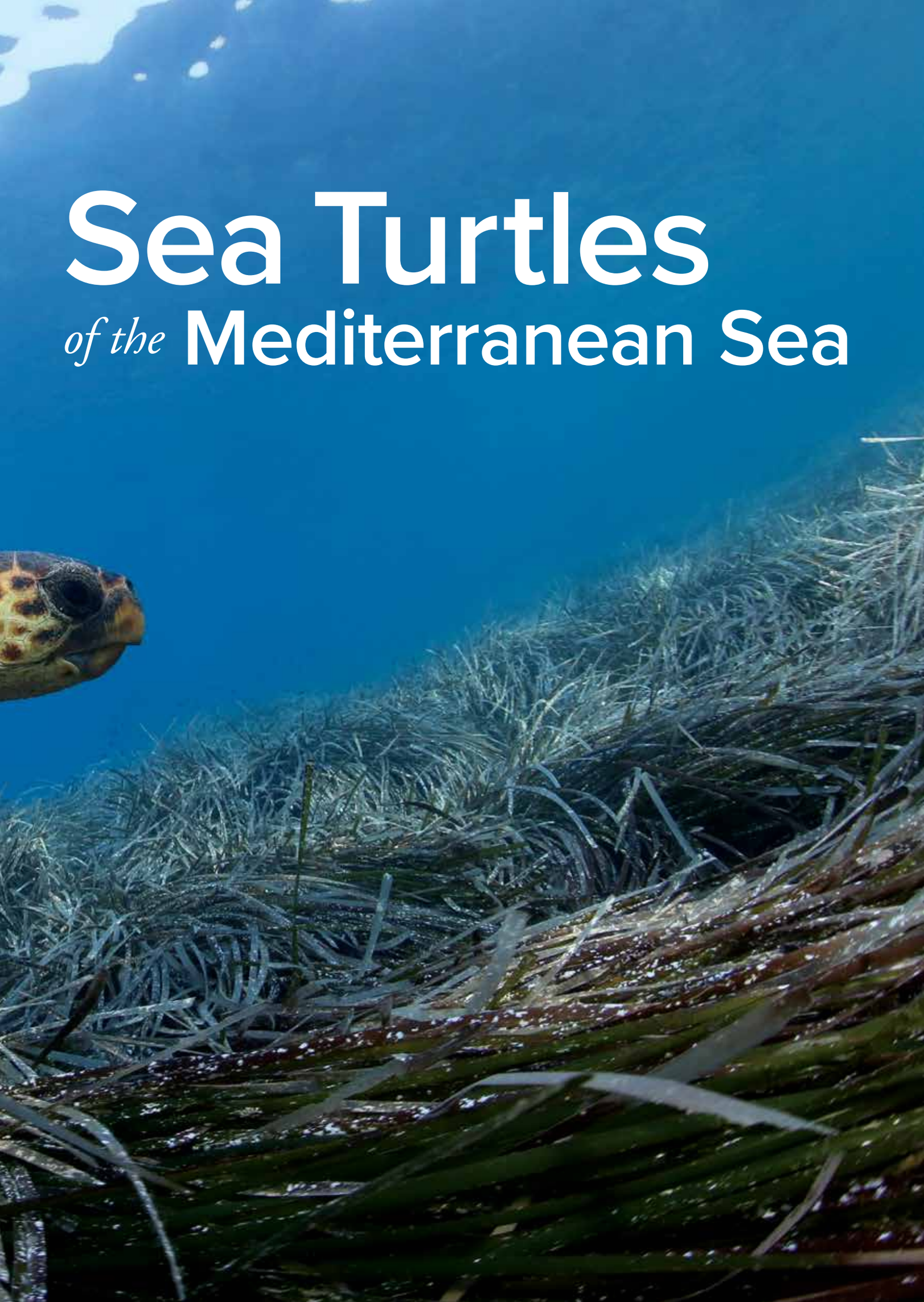
Telemetry Data by Origin



Regional Management Units



Sea Turtles
of the Mediterranean Sea



By SANDRA HOCHSCHEID, MUSTAPHA AKSISSOU, THOMAS ARAPIS, MOULOUD BENABDI, LIZA BOURA, ANNETTE BRODERICK, LUIS CARDONA, CARLOS CARRERAS, FRANÇOISE CLARO, ANDREAS DEMETROPOULOS, WAYNE J. FULLER, IMED JRIBI, YAKUP KASKA, YANIV LEVY, FULVIO MAFFUCCI, DIMITRIS MARGARITOULIS, CARMEN MIFSUD, ALIKI PANAGOPOULOU, JACQUES SACCHI, JESÚS TOMÁS, OĞUZ TÜRKOZAN, and ALAN REES

A SEA OF BOUNTY AND DANGER

The Mediterranean Sea is a bountiful yet dangerous place for sea turtles. In an area bounded by Europe on its northern shores, Asia to the east, and Africa to the south, sea turtles share their relatively small home (2.5 million square kilometers, or about 1 million square miles) with more than 150 million people who live along the coasts of 20 countries and two island nations. On top of that, the Mediterranean basin is by far the largest global tourism destination, attracting almost a third of the world's international tourists every year. Characterized by beautiful natural and cultural heritage sites and by rich biodiversity, the Mediterranean is also a troubled and overexploited sea, where sea turtles have a hard time coping with high fishing pressure, gas and oil development, major cross-continental maritime traffic, beachfront and other habitat impacts, and widespread marine pollution.

A turtle's journey around the Mediterranean, following the main counterclockwise surface currents, would begin at the inflow from the Atlantic that passes through the 14-kilometer-wide (less than 9 miles) Strait of Gibraltar, then along the coast of North Africa starting in Morocco, passing between Tunisia and Malta, and moving into the eastern basin. By now our hypothetical turtle would have gotten used to the high salinity (over 38 practical salinity units) caused by an imbalance between water gain through river inflow and loss through high evaporation. He would continue past the endless beaches of Libya and go by Egypt, where the Suez Canal allows Lessepsian fauna and flora migrants to enter from the Red Sea.

Now he'd turn north, traveling through the Levant from Israel to Syria, passing zones of human conflict where turtle conservationists must watch out for more than just turtle nests on the beaches. Continuing westward, he'd pass between Cyprus and Turkey to continue along the southern coasts of Crete (Greece). Crossing over the sea's deepest recorded point of 5,267 meters (3.3 miles) in the Ionian Sea, he would then take a trip to Croatia in the far north of the cold Adriatic Sea and would circumnavigate the Italian peninsula to complete his tour in Spain, having traveled some 11,700 kilometers (7,270 miles).

TURTLE RESIDENTS AND VISITORS

Two of the world's seven species of sea turtles breed in the Mediterranean, and their nesting distribution is the result of several preglacial and postglacial colonization events. Two sea turtle regional management units (RMUs), or subpopulations, are present (see map, pp. 28–29). The Mediterranean loggerhead RMU is considered of least concern, though the species (*Caretta caretta*) is vulnerable globally, and the Mediterranean green RMU is as yet unranked, with the species (*Chelonia mydas*) considered endangered globally. Mediterranean loggerheads are the smallest specimens of this species in the world, and their nesting areas range from the Western Mediterranean to the Levantine coast in the east, with most of the estimated 8,000 clutches laid annually occurring in the Eastern Mediterranean, especially in Greece (see *SWOT Report*, vol. X, pp. 24–25). Green turtle nesting is confined to the easternmost part of the Eastern Mediterranean, mostly in Cyprus and Turkey, where more than 2,200 clutches are laid each year. Juvenile loggerheads forage throughout the Western Mediterranean in deep oceanic and shallow continental shelf regions. In the Eastern Mediterranean, adults tend to frequent the shallow continental shelf of the northern Adriatic and the Tunisian shelf, while juveniles remain more oceanic. Adult green turtles forage in Turkey, on the coasts of the Levant, and on North African shores (to Libya's western border). Some juvenile foraging has been reported in the Eastern Mediterranean, off the Peloponnesian coast of Greece, and possibly also in the southern Adriatic.

Nonbreeding turtles from the Atlantic often enter the Mediterranean as well. They are mainly loggerheads from both sides of the Atlantic, which coexist with their indigenous conspecifics on oceanic foraging grounds. Generally, the Atlantic loggerheads enter the Mediterranean as small juveniles and are unable to depart until they have grown much larger and can confront the strong inward current at the Strait of Gibraltar, though new evidence has revealed that some Atlantic loggerheads are now breeding and nesting within the Western Mediterranean (see box, p. 25).

Visitors from the Atlantic also include green turtles that frequent the Western Mediterranean. Since indigenous greens are found only in the Eastern Mediterranean, the Atlantic greens do not share foraging grounds with the local greens. Leatherbacks have also been recorded throughout the basin and as far east as Egypt, Israel, and Syria. Though Mediterranean leatherbacks are generally large juveniles and adults of both sexes, no nesting by this species has ever been confirmed. The presence of both Kemp's and olive ridleys in the Mediterranean is confirmed but rare, with only a handful of records of juvenile Kemp's ridleys in France, Italy, Malta, and southern Spain and a single record of an olive ridley from Spain. There are several records of hawksbills in the Mediterranean.

A loggerhead turtle swims near seaside homes on the coast of Greece. With more than 150 million coastal residents and one of the world's highest levels of tourism, the Mediterranean Sea is an environment profoundly shaped by people. © KOSTAS PAPAFITSOROS; PREVIOUS SPREAD: A loggerhead turtle swims above endemic seagrass (*Posidonia oceanica*) in the Mediterranean Sea. © KOSTAS PAPAFITSOROS

MAJOR TURTLE REGIONS

SOUTHERN SHORES (Morocco to Egypt, Including Malta)

The 500 km (311 mi) coastline of Morocco is primarily a foraging habitat for loggerheads; leatherbacks also are regularly observed—and on rare occasions, greens. Most of the knowledge about sea turtles in this zone comes from strandings and animals incidentally captured by fishers. Fisheries interactions are unquestionably the most common threat to Morocco's turtles. However, until 2007, juvenile loggerheads were also found in markets, not necessarily for consumption but rather for the use of their carapaces and other products.

The 1,622 km (1,007 mi) Algerian coastline is dominated by rocky shores and sandy beaches, and here too sea turtles have been reported since the 1800s as stranding and being caught accidentally by fishers. They are typically loggerheads (70 percent) and some leatherbacks (30 percent). To date, no nesting has been confirmed, but rising temperatures may make nesting possible in Algeria; thus, authorities began to monitor beach temperatures in 2017 to evaluate potential nesting areas.

Three sea turtle species are observed in the waters adjacent to Tunisia's 1,148 km (713 mi) coastline; greens are rare, leatherbacks are regularly observed, and loggerheads are the most common. The wide continental shelf in southern Tunisia, including the Gulf of Gabès, is one of the most important foraging areas for sea turtles in the whole Mediterranean. The number of accidental captures by trawlers, longlines, and gill nets suggests a high turtle density in that region. Tunisia has an active sea turtle stranding network and a rescue center based in Monastir. Loggerhead turtles also nest regularly in Tunisia, especially on Kuriat Island, which receives about 25 nests each year.

The small (315 sq km, or 122 sq mi) island nation of Malta lies southeast of the Sicily Channel, connecting the Mediterranean's western and eastern basins. Turtles are frequently found in Maltese waters, with five species being recorded; however, subadult and juvenile loggerheads are the most commonly seen. Malta has three marine NATURA 2000 sites (part of the European Union's NATURA 2000 network of protected areas) for protection of loggerhead turtles, and since 2001, a rescue center has rehabilitated many of the accidentally caught and stranded turtles, especially those with ingested fishing lines. Malta has also seen some sporadic turtle nesting, although sandy beaches are rare, only 2.5 percent of all beaches.

A green turtle returns to sea after nesting on the island of Cyprus. © LAWRENCE SAMPSON

At 1,770 km (1,000 mi), Libya's coastline is the longest of any African country bordering the Mediterranean, and long sandy beaches are its predominant feature. It also has the oldest nesting colony for loggerhead turtles in the entire basin. The Libyan Sea Turtle Program, supported by the Regional Activity Centre for Specially Protected Areas (RAC/SPA), which is part of the United Nations Environment Programme's Mediterranean Action Plan (UNEP-MAP), has been monitoring loggerhead turtles for many years, even during periods of political turmoil. However, the total numbers of nesting females still remain unknown. Postnesting loggerheads also seem to frequent the Tunisian shelf. No green turtle has been found nesting in the country, but Libyan waters provide ample foraging and overwintering habitats in the Gulfs of Bomba and Sirte for green turtles that nest in Levantine countries.

Egypt's 1,050 km (652 mi) of Mediterranean coast host potentially important loggerhead and green turtle foraging grounds and migratory corridors. The presence of leatherbacks has also been verified through stranding and bycatch data. Of special interest is Bardawil lagoon, an important foraging and possible overwintering site, which requires further in-water investigation and conservation action, especially with regard to fisheries interactions.

Loggerhead and green turtle nesting in Egypt are low when compared with other Mediterranean sites, though minor diffuse nesting is scattered along the western Egyptian coastline. The main nesting area is a 22 km (14 mi) sandy beach on the North Sinai Peninsula (average nests/year: 67 for loggerheads and 7 for greens). Ongoing surveys by Egyptian authorities with assistance from RAC/SPA are expected to provide updated information in relation to nesting along the western coastline (between Port Said and El Salum). In addition to widespread regional threats like habitat degradation, pollution, and bycatch, illegal trade is particularly acute. Trade in turtle products has been reported since the beginning of the 20th century, and consumption is a tradition that has been documented since at least the 1970s and up through the present, predominantly in Alexandria and Port Said.

LEVANTINE COAST (Israel to Turkey, Including Cyprus)

Israel's 200 km (124 mi) Mediterranean coastline is largely suitable for loggerhead and green turtle nesting, although light pollution is a problem, and the continental shelf's moderate slope provides foraging grounds for both species. Since 1993, Israel's Nature and Parks Authority has surveyed beaches during nesting season; nests are

relocated to protected hatcheries, a practice that has increased nest numbers over time. In 1999, a turtle rescue center was founded that today tends to about 100 animals yearly, with 70 percent being returned to the wild. A turtle head-start program that was begun in 2002 is now a captive breeding facility as well. The facility's volunteers serve the public through lectures, media publications, school programs, and other turtle conservation work, and their research addresses aspects of turtle biology, genetics, movement ecology, husbandry, veterinary care, and endocrinology.

Lebanon's 200 km (124 mi) coast has only a few sandy beaches suitable for sea turtle nesting. Extensive urban development, sand mining, and litter reduce the available turtle habitat even further. Loggerhead and green turtle nests are found in small numbers in southern Lebanon, an area affected by military operations that is also home to the Tyre Coast Nature Reserve, which is dedicated to the protection of sea turtles.

Loggerhead turtle nesting was first recorded in 1991 on Syria's 193 km (120 mi) coast by the Mediterranean Association to Save the Sea Turtles (MEDASSET), and a survey in 2004 confirmed that low-level loggerhead nesting occurred at several locations in the country. The survey also declared Syria among the top 10 nesting areas for Mediterranean green turtles, specifically one 12.5 km (8 mi) beach south of Latakia city. Local researchers have monitored turtle nesting there and at other places, though internal turmoil has prevented the acquisition of consistent data. Syria's coastal waters are home to juvenile green turtles year-round and are part of a migratory corridor for turtles nesting in Cyprus and other areas to the west.

Green and loggerhead turtles nest on the beaches of Cyprus (an island with an area of 9,250 sq km, or 3,571 sq mi). In 2018, well over 1,300 green and 2,200 loggerhead clutches were laid islandwide, making this a noteworthy nesting site for both species. Because of significant long-term conservation efforts, including caging of nests and beach protection, nesting populations appear to be stable or rising, although loss of nesting habitat and predation by dogs and foxes is an ongoing problem.

Large numbers of both species also forage around the shores of Cyprus, with juvenile and subadult green and adult loggerhead turtles being the most common. More than 1,000 turtles are estimated to be accidentally caught by small-scale fisheries each year, with a mortality rate in excess of 50 percent. Ongoing projects are under way to further understand and mitigate this effect. Through long-term monitoring of individual females nesting in Cyprus, researchers have learned a great deal about their life history and behavior. Most notably, females of both species can breed for at least 24 years—maybe longer—according to 27 years of observations. Furthermore, research has demonstrated that females show site fidelity to their winter foraging grounds and that the coast of Cyprus is an important migratory corridor for turtles from both Cyprus and Turkey.

In the north of the Levant, Turkey has a total of 21 nesting beaches along its 1,577 km (980 mi) of Mediterranean coastline. Its western beaches are mainly used by loggerhead turtles, which nest in the highest densities on Amamur, Belek, and Dalyan beaches and represent 65 percent of the country's nesting activity. With annual numbers of loggerhead turtle nests as high as 6,000, Turkish beaches make a very important contribution of around one-third of the total loggerhead nests in the Mediterranean basin. Green turtles nest mainly on Turkey's eastern beaches, including Akyatan, Alata, Davultepe, Kazanlı, Samandag, and Sugözü, which represent 88 percent of the country's nesting and as many

CLIMATE CHANGE INDUCES A LOGGERHEAD RANGE EXTENSION

At the beginning of the 21st century, loggerhead nesting in the Western Mediterranean was extremely rare. On the few occasions that a nest was recorded, hatching success and the proportion of female offspring were generally low, probably owing to the relatively cold temperatures. In the past two decades, loggerhead nesting events have steadily increased, and in 2018, the northernmost loggerhead turtle nest ever was recorded in France, well above latitude 43° north, which produced 63 hatchlings. Nest locations are scattered, but researchers have identified one area in southern Italy where nesting has occurred regularly since 2012. Not only have the number of nests increased, but also it is predicted that nests are producing more female hatchlings, which is possible only when the environmental temperature is sufficiently warm. Dozens of loggerhead nests are now reported each year in the Western Mediterranean, and the actual nesting intensity is probably even higher, since many nests are likely to go undetected.

Not surprisingly, there appears to be a correlation between this trend and warming sea surface temperatures in southern Italy over the past century. Climate change is widening the temporal window of suitable thermal conditions that can be opportunistically used for nesting by adult loggerheads foraging in the Western Mediterranean. Genetic analysis of the nesting events suggests that the sporadic nests are not remnants of a past population but the result of long-distance dispersal events from both Mediterranean and Atlantic nesting beaches. Although it is exciting to witness a significant range extension like this, such a change implies that measures must be urgently imposed so that these animals have suitable habitat for their changing needs. Conservation programs to mitigate the effect of anthropogenic activities, coupled with extensive monitoring of potential suitable habitats, will be crucial to stabilize this new nesting population in the Western Mediterranean.

as 4,000 nests per year, or nearly two-thirds of the total green turtle nests in the Mediterranean.

The Turkish coast also hosts important feeding grounds for different age classes of both species. Monitoring of 15 of those beaches is carried out by universities, nongovernmental organizations, and government authorities. Turkey also has a turtle rescue center and three first aid stations along the Aegean and Mediterranean shores. Scientific studies in Turkey include sea turtle genetics, temperature-based sex determination, stable isotope analyses, pollution and plastic ingestion, and fisheries bycatch monitoring.

NORTHERN SHORES (Greece, the Adriatic, and West to Spain)

Systematic nest counts that have been conducted since 1984 by the Sea Turtle Protection Society of Greece (ARCHELON) and its contingent of international volunteers have shown that Greece hosts the largest number of loggerhead nests in the Mediterranean (more than 6,000 in 2018). Top nesting sites include Kyparissia Bay in the Peloponnese and Laganas Bay in Zakynthos. Both sites have been protected since 1999, the former by presidential decree and the latter by the establishment of the National Marine Park of Zakynthos.

Other important nesting beaches in the Peloponnese and on Crete are included in the European Union's NATURA 2000 network of protected areas. Over the years, the total number of nests has remained more or less stable. However, a notable steep increase at Kyparissia Bay, which now exhibits higher nest numbers than Laganas Bay, is a result of long-term nest protection against mammal predators. This increase is offset by severe declines in Rethymno and Chania on Crete, which can be attributed to rising anthropogenic pressures. ARCHELON continues in-water work in Amvrakikos Bay, a notable foraging area for loggerhead turtles, with more than 1,000 juvenile and adult loggerheads—mostly male—now tagged and measured. ARCHELON has also operated a Sea Turtle Rescue Centre in Glyfada since 1994, which rehabilitates injured turtles that are found along the 16,000 km (9,942 mi) Greek shoreline through their Stranding Network.

Entering the Adriatic Sea, loggerheads, greens, and leatherbacks migrate past or reside along Albania's 362 km (225 mi) coastline. Although there has been evidence of sporadic nesting for some years, the first actual nest was officially confirmed in 2018. Albania's Drini Bay is potentially an important habitat for overwintering and foraging—and possibly as a developmental habitat for both adult and subadult loggerheads (mostly originating from Greece) and occasionally by greens as well. A systematic study of Albania's turtle population structure in 2008–2010 showed the presence of a large number of male turtles and a very substantial proportion of subadult animals. Tagging and satellite tracking revealed site fidelity both intra-annually and interannually. Apart from the usual hazards found throughout the Mediterranean, illegal fishing techniques, such as the use of dynamite, pose serious threats to Albania's turtles and other marine life.

North along the Adriatic coast from Albania, Montenegro has 294 km (183 mi) of coastline, and Bosnia and Herzegovina has 20 km (12.4 mi). Croatia has the longest eastern Adriatic coastline, at 526 km (327 mi), though that number becomes 7,368 km (4,578 mi) when including the coastlines of the country's many islands. Finally, Slovenia has 47 km (29 mi) of coastline. Those countries are similar in that sea turtles do not nest on their beaches, but tens of thousands of turtles, mostly loggerheads, are found year-round in their nearby waters. Genetic research has shown that most of these animals originated in Greece, and satellite and flipper tagging have further confirmed that many loggerheads nesting in Greece migrate to the Adriatic for foraging and overwintering.

Italy, including its many islands, has a coastline of about 7,600 km (4,722 mi) on the Adriatic, Ionian, and Tyrrhenian seas, and it is effectively the dividing line between the western and eastern basins of the Mediterranean. Turtles of all species that roam the Mediterranean Sea inevitably cross Italian waters at some point, whether for foraging or simply moving from one place to another, though the most common species in Italy is the loggerhead in all life stages. There are good neritic foraging habitats off the Tyrrhenian and Adriatic shores; however, those zones are also heavily fished, resulting in bycatch mortality and high stranding rates. High numbers of human-induced strandings have led to a proliferation of more than 20 sea turtle rescue centers, making Italy the country with the highest number of such facilities in the region. Italy has regular nesting along the southern Ionian coast and on nearby pelagic islands, and loggerhead nesting has recently increased on Italy's western beaches.

The French Mediterranean waters, including Corsica, are frequented mainly by loggerhead turtles and occasional leatherbacks. Leaving the pelagic waters of the Liguro-Provençal current, loggerhead juveniles arrive in the spring for feeding in the Gulf of Lions, but they may remain, as it is also believed to be an overwintering area. Recently the fourth loggerhead nest since 2002 was observed on the Languedoc coast, giving France the northernmost nesting site of this species worldwide. Loggerheads are frequently caught unintentionally by fishermen, and many also wash ashore dead. Annually, these strandings account for 50–110 animals, as recorded by the French observer network, Réseau Tortues Marines de Méditerranée Française (RTMMF) and French rescue centers.

Notwithstanding the tiny peninsula of Gibraltar (UK) with its 4 km (2.5 mi) coastline that witnesses the comings and goings of sea turtles between the Atlantic and Mediterranean through the Strait of Gibraltar, Spain is the final country of this counterclockwise tour around the Mediterranean. Spain reports five sea turtle species in the waters adjacent its 1,670 km (1,037 mi) of coast, yet only loggerheads occur in large numbers. Most of those are juveniles from nesting beaches in the northwest Atlantic, the Mediterranean, and Cape Verde. The loggerheads of Mediterranean origin are predominantly found off eastern Spain in shallow seas; conversely, loggerheads of northwest Atlantic origin are mostly found off the Balearic Islands and are more oceanic. Loggerheads from Cape Verde represent less than 4 percent of the total number of loggerheads in Spanish seas.

Bottom trawling and drifting longline fisheries are the main threats for turtles off mainland Spain and the Balearic Islands. Until 2001, evidence of loggerhead turtle nesting was scarce, but Spain has recorded about 42 nests over the past two decades, and genetic analyses indicate an ongoing and exciting process of colonization from distant nesting beaches (see box, p. 25).

CONSERVATION

Sea turtle conservation started on Cyprus's nesting beaches in the early 1970s, then in Greece and Turkey in the 1980s, and in Israel by the 1990s. Surprisingly, important turtle nesting rookeries were still being discovered into the 2000s. For countries that host the majority of the Mediterranean's sea turtle nesting, such as Cyprus, Greece, and Turkey, nest protection has been the principal conservation focus, led by local communities, nonprofit groups, and volunteers. Where turtle nesting is less common, as in Italy, sea turtle rescue and rehabilitation centers are more prevalent and serve as the frontlines of actions to help sea turtles.

The 1980s saw the inauguration of important national and international grassroots turtle conservation organizations in the Mediterranean, including ARCHELON and MEDASSET, in addition to projects supported by the World Wide Fund for Nature (WWF) and others. Meanwhile, on a governmental policy scale, the Parties to the Barcelona Convention for the Protection of the Marine Environment and the Coastal Regions of the Mediterranean, a treaty that began in 1975 as "the Convention for Protection of the Mediterranean Sea against Pollution," was amended by the Genoa Declaration in September 1985 to include the protection of Mediterranean marine turtles among their priority targets for the period 1985–1995. And in 1989, all the Mediterranean countries adopted an Action Plan for the Conservation of Marine Turtles within the Mediterranean Action Plan (MAP) framework.

In 1990, the Council of Europe (Bern Convention) released one of the first important reports on Mediterranean marine turtles, which described the conservation status and geographical distribution of all species and recommended cost-effective research and realistic conservation measures. Finally, UNEP's RAC/SPA has been working for more than three decades on marine turtles.

CONCLUSION

The Mediterranean is an exciting place for sea turtle research, with prospects of range expansion and new colonization, and with long-term conservation projects that have achieved stable or even positive population trends. Yet researchers and conservationists still have a long way to go before turtles in the Mediterranean can be called safe. Indeed, many major threats, particularly fisheries bycatch and climate change, still urgently need solutions. To that end, a solid network of conservationists, researchers, and stakeholders must continue to focus their energies on the actions needed to ensure that Mediterranean sea turtles survive and thrive into the future. Fortunately, the community dedicated to the Mediterranean sea turtle, despite its disparity of cultures and languages, is a consolidated and collaborative movement of individuals, institutions, and governments committed to this worthy goal. ■

FEATURE MAPS:
BIOGEOGRAPHY OF SEA TURTLES IN THE MEDITERRANEAN SEA

The maps on pp. 28–29 display available nesting and satellite telemetry data for sea turtles in the Mediterranean Sea, as well as modeled foraging areas for loggerhead turtles (p. 28, bottom left). The data include 216 nesting sites and 316 satellite tags, compiled through a literature review and contributed directly to SWOT by dozens of data contributors throughout the Mediterranean region. For metadata and information regarding data sources and contributors, see the data citations beginning on p. 50.

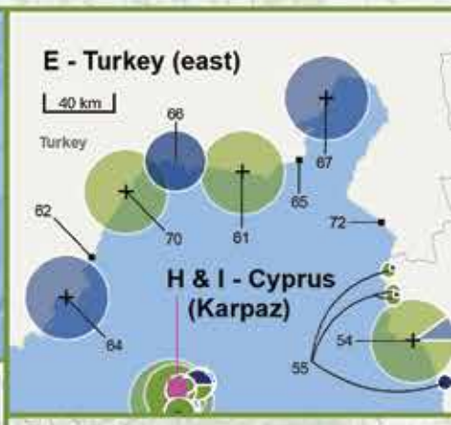
Nesting sites are represented by dots that are colored and scaled according to the species present and their relative nesting abundance in the most recent year from which data are available. If multiple species are present at a particular nesting site, the dot for that site is scaled according to the total nesting abundance for both species combined, and the proportion of nesting by each species is indicated by the proportion of each species' respective color within the dot. For the purposes of uniformity, all types of nesting counts (e.g., number of nesting females, number of crawls) were converted to number of clutches as needed. Conversion factors were as follows: for *Caretta caretta*, a ratio of 2 nests to each nesting female and 0.68 nests for every crawl; for *Chelonia mydas*, a ratio of 3 nests to each nesting female and 0.64 nests for every crawl.

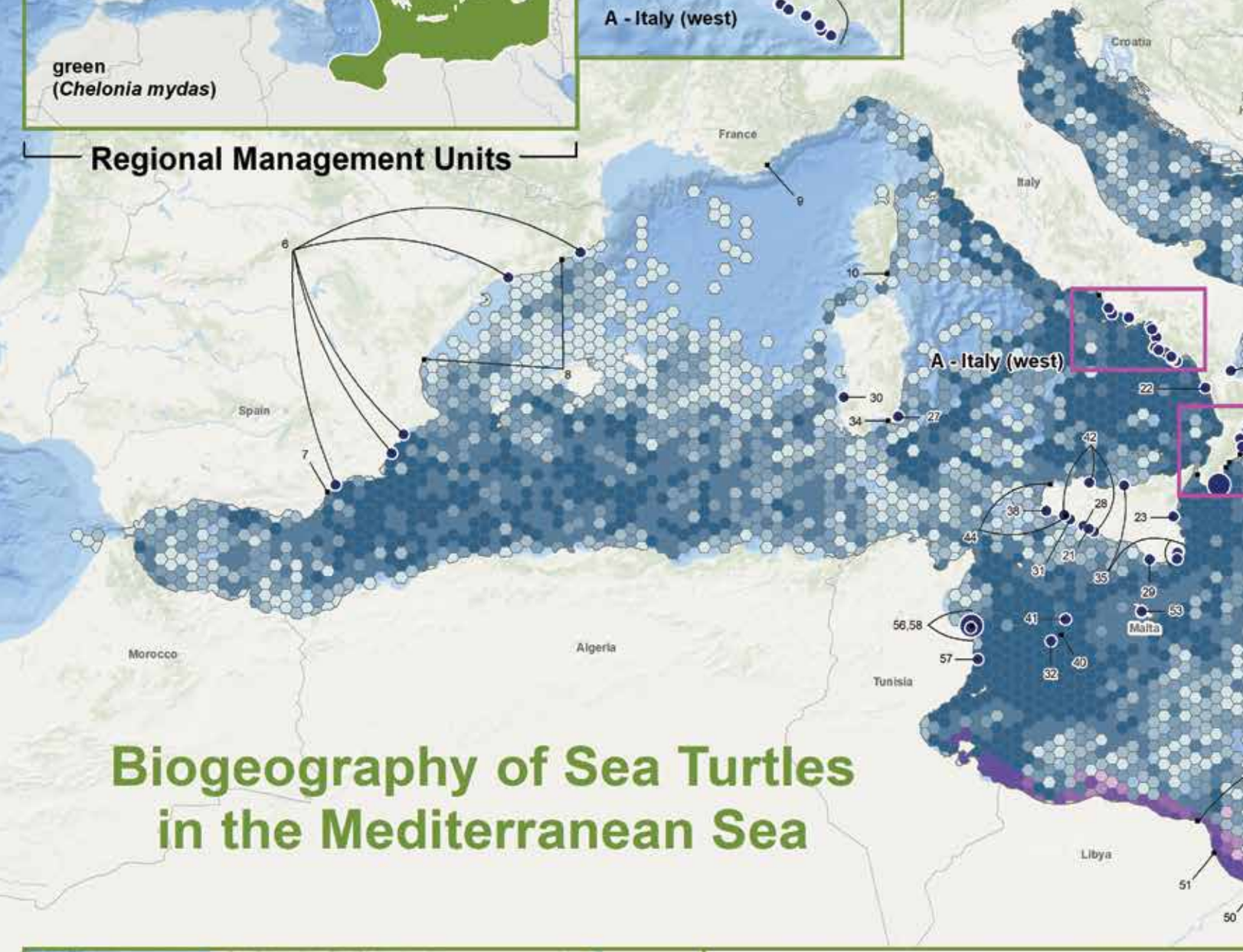
Satellite telemetry data are represented as polygons that are colored according to the number of locations and the composition of species they contain. Darker colors represent a higher number of locations, which can indicate that a high number of tracked turtles were present in that location or that turtles spent a lot of time in that location. Telemetry data are displayed as given by the providers, with minimal processing to remove locations on land and visual outliers. As such, some tracks are raw Argos or GPS locations, whereas others have been more extensively filtered or modeled.

The maps on the upper left of p. 28, "Regional Management Units," show the two Regional Management Units (or subpopulations) that primarily reside within the Mediterranean Sea. They were defined by Wallace et al. in 2010 by combining telemetry, genetics, tagging, and nesting data. Newer data have shown a wider range for green turtles into the southwestern Mediterranean that is not captured in the boundary of that Regional Management Unit.

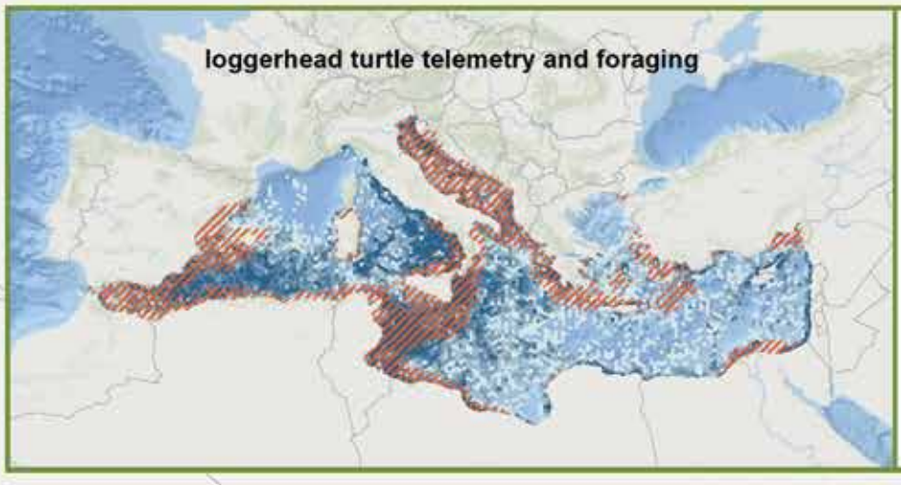
We are grateful to all of the data contributors and projects that participated in this effort—please see the complete data citations beginning on p. 50 for details.

Regional Management Units



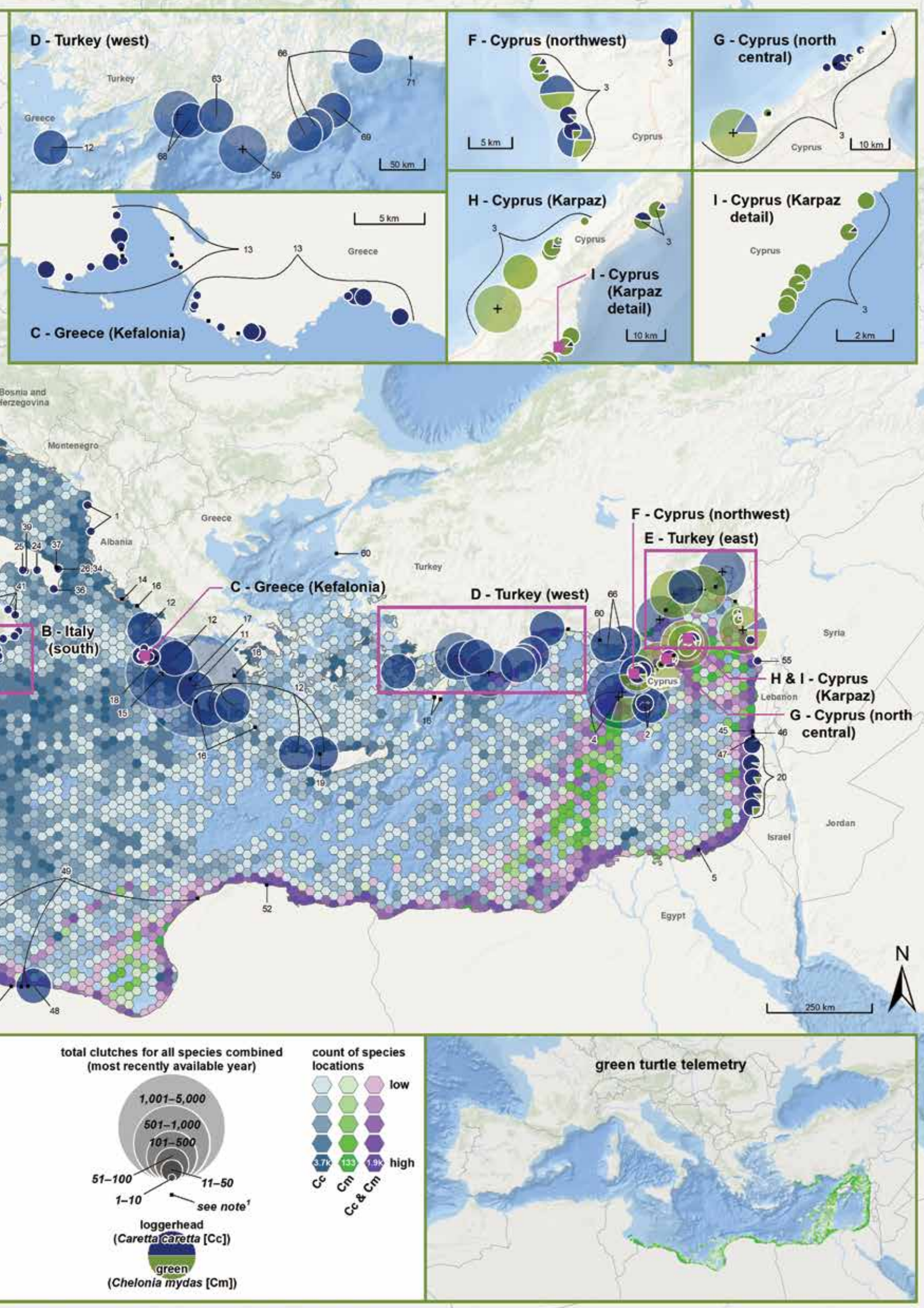


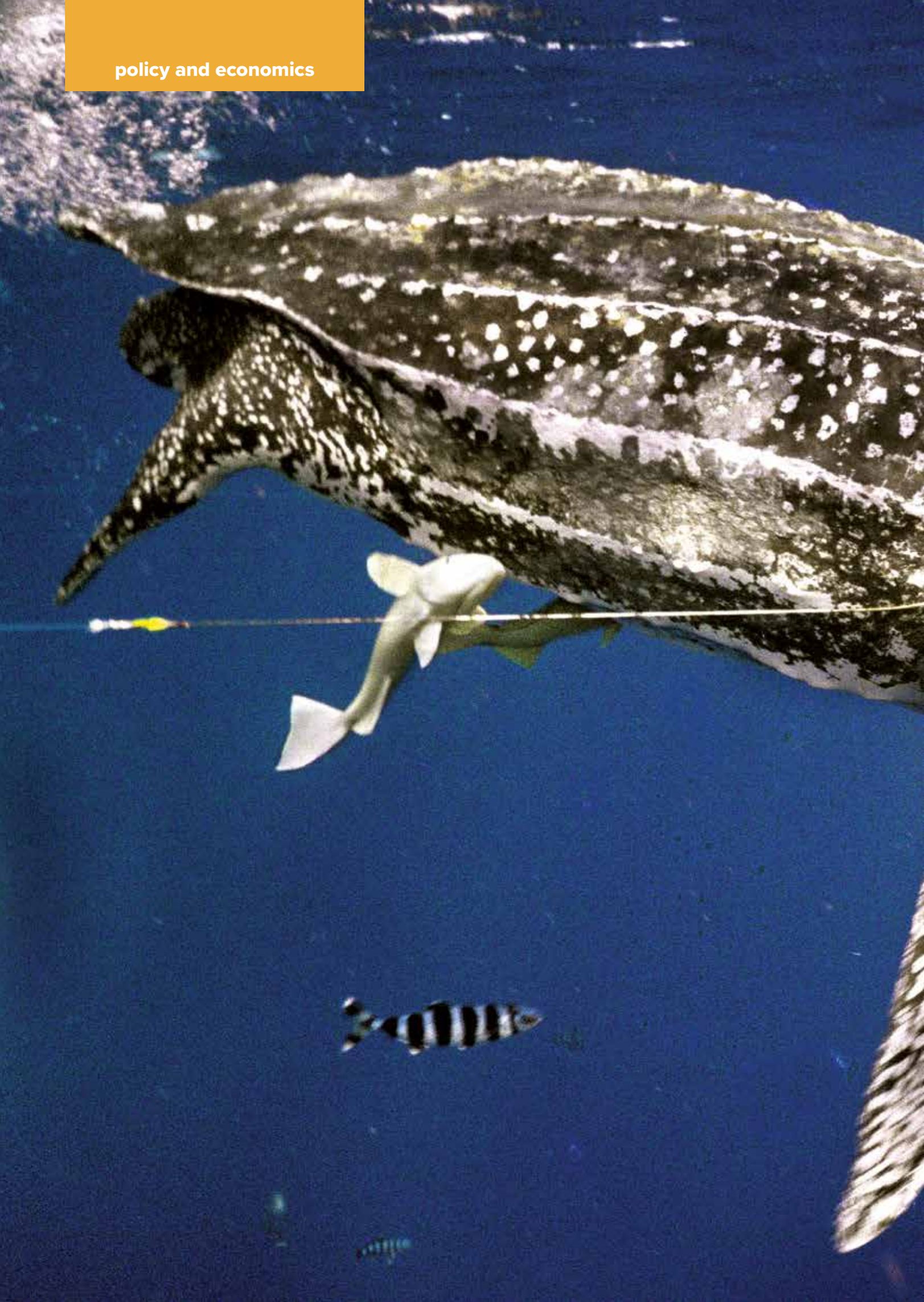
Biogeography of Sea Turtles in the Mediterranean Sea



scale: 1:10,000,000
projection: Europe Albers Equal Area Conic
data: The SWOT team and reviewed literature (see end of report for citations); Ocean Basemap—Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors; boundary data—Esri Maps and Data for ArcGIS 2016.
notes: 1. Data are older than 10 years, data are unquantified, or count was given as zero (sites with confirmed nesting in the past but no nesting in the most recent year for which data are available are given as a count of zero); 2. loggerhead foraging areas are based on modeled relationships between satellite telemetry locations and environmental covariates (see Mazor et al. 2016 for details); species that comprise less than 5% of the clutches at nesting sites are not displayed on the map but are reflected in the citations.
produced in partnership with: Oceanic Society, OBIS-SEAMAP, and the IUCN-MTSG.

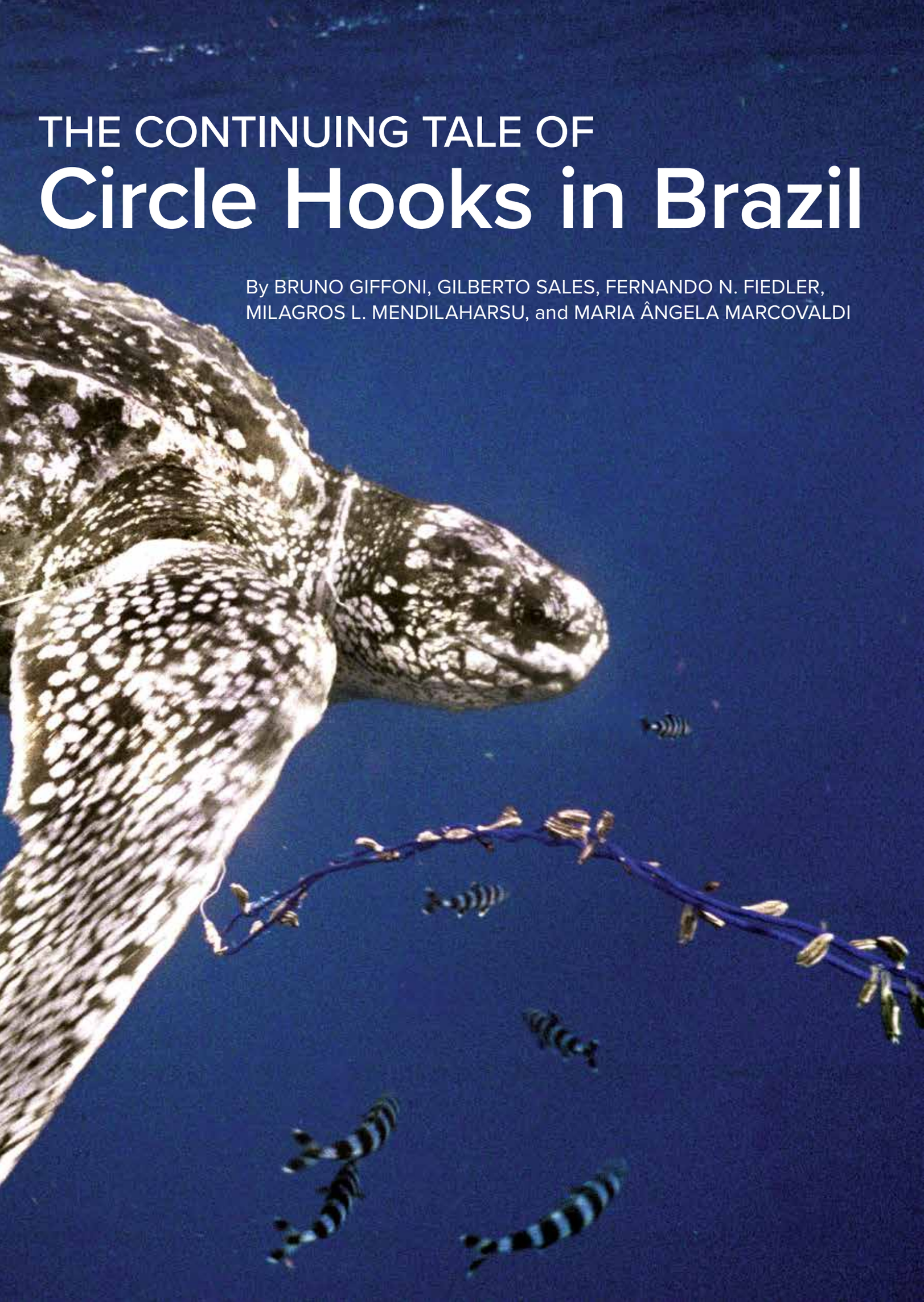
country borders modeled foraging areas[2]


D - Turkey (west)
Turkey
Greece
50 km
F - Cyprus (northwest)
Cyprus
5 km
G - Cyprus (north central)
Cyprus
10 km
C - Greece (Kefalonia)
Greece
5 km
H - Cyprus (Karpaz)
Cyprus
I - Cyprus (Karpaz detail)
10 km
I - Cyprus (Karpaz detail)
Cyprus
2 km
Bosnia and Herzegovina
Montenegro
Albania
Greece
Turkey
Syria
Lebanon
Cyprus
Israel
Jordan
Egypt
B - Italy (south)
C - Greece (Kefalonia)
D - Turkey (west)
E - Turkey (east)
F - Cyprus (northwest)
H & I - Cyprus (Karpaz)
G - Cyprus (north central)
250 km
N
total clutches for all species combined (most recently available year)
1,001–5,000
501–1,000
101–500
51–100
11–50
1–10
see note[1]
loggerhead (Caretta caretta [Cc])
green (Chelonia mydas [Cm])
count of species locations
low
high
3.7K
133
1.9K
Cc
Cm
Cc & Cm
green turtle telemetry



THE CONTINUING TALE OF
Circle Hooks in Brazil

By BRUNO GIFFONI, GILBERTO SALES, FERNANDO N. FIEDLER, MILAGROS L. MENDILAHARSU, and MARIA ÂNGELA MARCOVALDI



Incidental capture of sea turtles in pelagic and coastal fisheries (also called bycatch) is arguably the greatest threat to sea turtles worldwide. Yet, until recently, there was practically no information regarding sea turtle interactions with longline fisheries in the southwestern Atlantic Ocean. The first studies about this topic were made public by Uruguayan researchers in 1998, the same year that Brazilian researchers presented a report about the incidental capture of loggerhead turtles by longline vessels in Brazil. At the time, Brazilian nongovernmental organizations (NGOs) and government agencies were at loggerheads (pun intended) about the magnitude of sea turtle capture by longline vessels. Although the government insisted that incidental capture was very low, Brazilian NGOs such as Projeto TAMAR asserted the opposite. However, very few formal studies supported either assertion.

Thus, in 2001, Projeto TAMAR undertook a national-scale program to assess bycatch levels in Brazil's national fisheries. After TAMAR's increased monitoring of the longline fleet, it became clear that longlining indeed posed a major threat to sea turtles in the southwest Atlantic Ocean; something had to be done. One of the more promising (though still imperfect) solutions to the bycatch problem was the circle hook, which can significantly reduce sea turtle bycatch when compared to the traditional J-shaped hook (see *SWOT Repor*t, vol. I, p. 24). Projeto TAMAR's bycatch assessment planted a seed, and what began as a study of the effectiveness of circle hooks grew into a national effort to ban the use of J-hooks on longlining vessels.

Understanding the need to promote a discussion about circle hooks among different stakeholders (e.g., scientists, conservationists, fishers, fisheries, managers, policymakers, and the general public) and the need to build a common set of goals among those stakeholders, Projeto TAMAR mobilized resources to develop and launch communication strategies. TAMAR began weekly informal talks with longline captains and crews anchored on Itajaí/Navegantes, one of the most important fishing harbor complexes in Brazil. TAMAR also developed and donated circle hooks and bycatch mitigation toolkits, which included dehooking tools, line cutters, and dipnets.

TAMAR held training workshops, conducted lectures, and led countless meetings with fishing associations and fishers, and it even produced informational videos about the effect of longline fisheries on sea turtles and about using circle hooks. The campaign was widespread and was covered by newspapers and on TV.

With public attention on the benefits of circle hooks, TAMAR elevated the discussion to the level of decisionmakers so they could make their voices heard in Brazil's national governmental forums for tuna fisheries management. Next, Brazil's case was presented to the International Commission for the Conservation of Atlantic Tuna (ICCAT).

A hard-fought victory came in 2017 when the Brazilian government published Act 74/2017, which forbids the use of J-hooks on all licensed longline vessels that target swordfish and tuna. The act mandates the use of circle hooks and requires that vessels be equipped with onboard bycatch mitigation tools. The new legislation was cause for celebration. After 15 years of shaking hands with fishers, raising public awareness, and working with policymakers, Projeto TAMAR had helped enact real policy that will certainly reduce sea turtle mortality on longlining vessels in the southwest Atlantic. What's more, alliances were built along the way with decisionmakers and within the fishing industry, without whose voluntary participation the victory would have been impossible.

The regulations came into effect in 2018, thereby presenting a new set of challenges. With a projected spike in demand for circle hooks and mitigation tools, how can a market shortage of such items be avoided? How can regulators ensure that the new laws are being enforced? To confront the challenges, Projeto TAMAR has already contacted manufacturers and importers to inform them about a potential spike in demand, and TAMAR continues to spread the word about the benefits of using circle hooks (and the illegality of J-hooks) among fishers and the general public in fishing communities.

To add another layer of complexity to the southwest Atlantic's circle hook saga, the scientific community has never fully endorsed the advantages of circle hooks, mainly because those hooks have been shown to increase the bycatch of sharks. In Brazil, sharks—especially blue sharks (*Prionace glauca*)—are, sadly, a target species for the pelagic longline fishery. Further work about legal measures and ameliorative gear types is needed as part of efforts to protect not only sea turtles but also sharks and marine ecosystems as a whole from the devastating effects of longline fishing.

Although the passage of the J-hook ban is a hard-won success, the shark bycatch issue reminds us that there are no perfect solutions in conservation. In the end, success will depend on the same principles that have driven Projeto TAMAR's efforts thus far: (a) finding common objectives among diverse stakeholders and (b) mobilizing institutions through a solid and active network. ■

THIS PAGE: Circle hooks of different sizes: 18/0 (left), 16/0 (middle), and 14/0 (right). © PROJETO TAMAR; PREVIOUS SPREAD: This leatherback turtle was hooked by longline fishing gear targeting swordfish off the coast of Brazil. The blue rope attached to its flipper is from an earlier interaction with longline fishing gear targeting mahi-mahi. All gear was removed and the turtle was released in good condition. © PROJETO TAMAR; AT RIGHT: A fisherman releases a loggerhead turtle that was caught on its flipper by a J-hook in Brazil. © PROJETO TAMAR

Status Update

MODERN THREATS TAKING A TOLL ON NORTHWEST ATLANTIC LEATHERBACKS

By NORTHWEST ATLANTIC LEATHERBACK WORKING GROUP

Thanks to the decades of effort by dedicated beach monitors around the world, we know more about the status of sea turtle populations than ever before. We know where populations are in rough shape after being depleted by decades of unsustainable capture (accidental or otherwise), where habitat alterations have occurred, and where other threats from humans exist. And we know where populations with positive trends are offering beacons of hope. Until recently, the Northwest Atlantic (NWA) leatherback, which nests throughout the Wider Caribbean region and spans the entire North Atlantic Ocean, even peeking into the Mediterranean, was one such beacon.

Previous assessments of NWA leatherback status found that this regional management unit (RMU), or subpopulation, was abundant, with a stable and even increasing trend. For example, the current IUCN Red List assessment (published in 2013) for this subpopulation concluded that the long-term trend in annual nest abundance was generally increasing through 2010, which meant that NWA leatherbacks qualified for the unfortunately named listing of least concern (see *SWOT Report*, vol. 11, pp. 28–31). Despite this official status on the IUCN Red List, the 2013 assessors of this subpopulation highlighted the importance of continued conservation efforts to prevent collapses such as those previously documented for leatherback subpopulations in the Pacific.

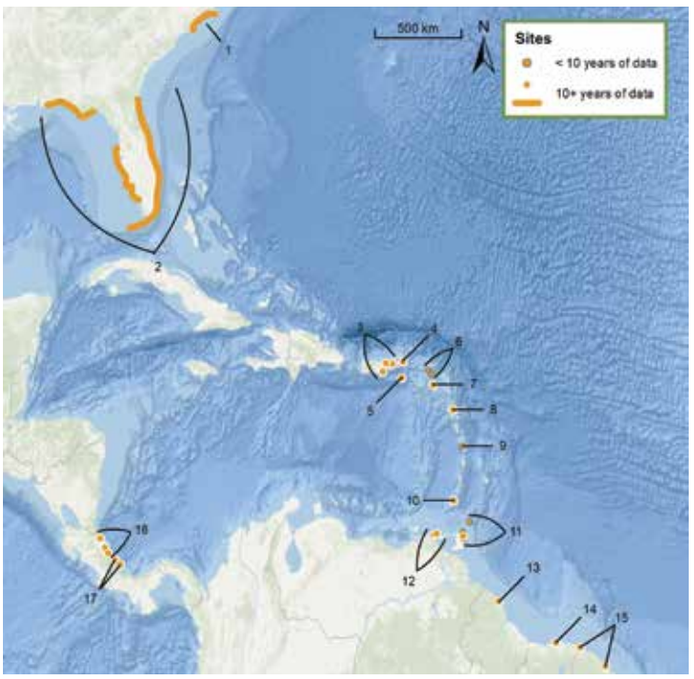
In recent years, community-based monitoring efforts throughout the NWA region were noting with concern that annual counts of leatherback nests and nesting females appeared to be in decline. Such concerns became a discussion that culminated in data holders from across the Wider Caribbean convening a NWA Leatherback Working Group at the 2018 annual meeting of the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), to assemble and contribute existing nesting data to a regionwide trend analysis for NWA leatherbacks.

The results of this work has flipped the existing knowledge about the status of this population on its head. Trend analyses of leatherback nesting data from 17 countries and territories since 1990 revealed significant declines across most nesting sites, among all genetic stocks, and at the regionwide scale, this population has declined more than 4 percent per year since 1990. The negative trends were apparent at large and small rookeries over the long term (1990–2017) and in recent years (2008–2017).

What happened to change the status so dramatically? Although specific causes and their effects are not completely clear, one possibility is that bycatch—particularly near key nesting beaches and in important foraging habitats in national and international waters—has finally taken a toll that is now visible on nesting beaches. But because the declines are widespread across rookeries throughout the region, there are likely multiple factors at work.

For example, the working group also flagged the effects of habitat loss due to natural beach erosion that has significantly diminished available leatherback nesting habitat, particularly in the Guianas. It is also possible that longer remigration intervals caused by changes in environmental conditions on foraging grounds might have made resources less available, less predictable, or both. Those types of hypotheses await further investigation.

Although the causes are uncertain, one thing is for sure, and it is a common issue for so many sea turtle programs worldwide: trends based solely on observed nesting activity hinder our ability to really know what's happening in a population. In fact, they usually don't reveal that something is wrong until *after* the effects on the population have already occurred. Going forward, the working group (like many sea turtle researchers in other places) will be emphasizing the importance of combining information from different areas and life stages for a more holistic understanding of population-scale trends.

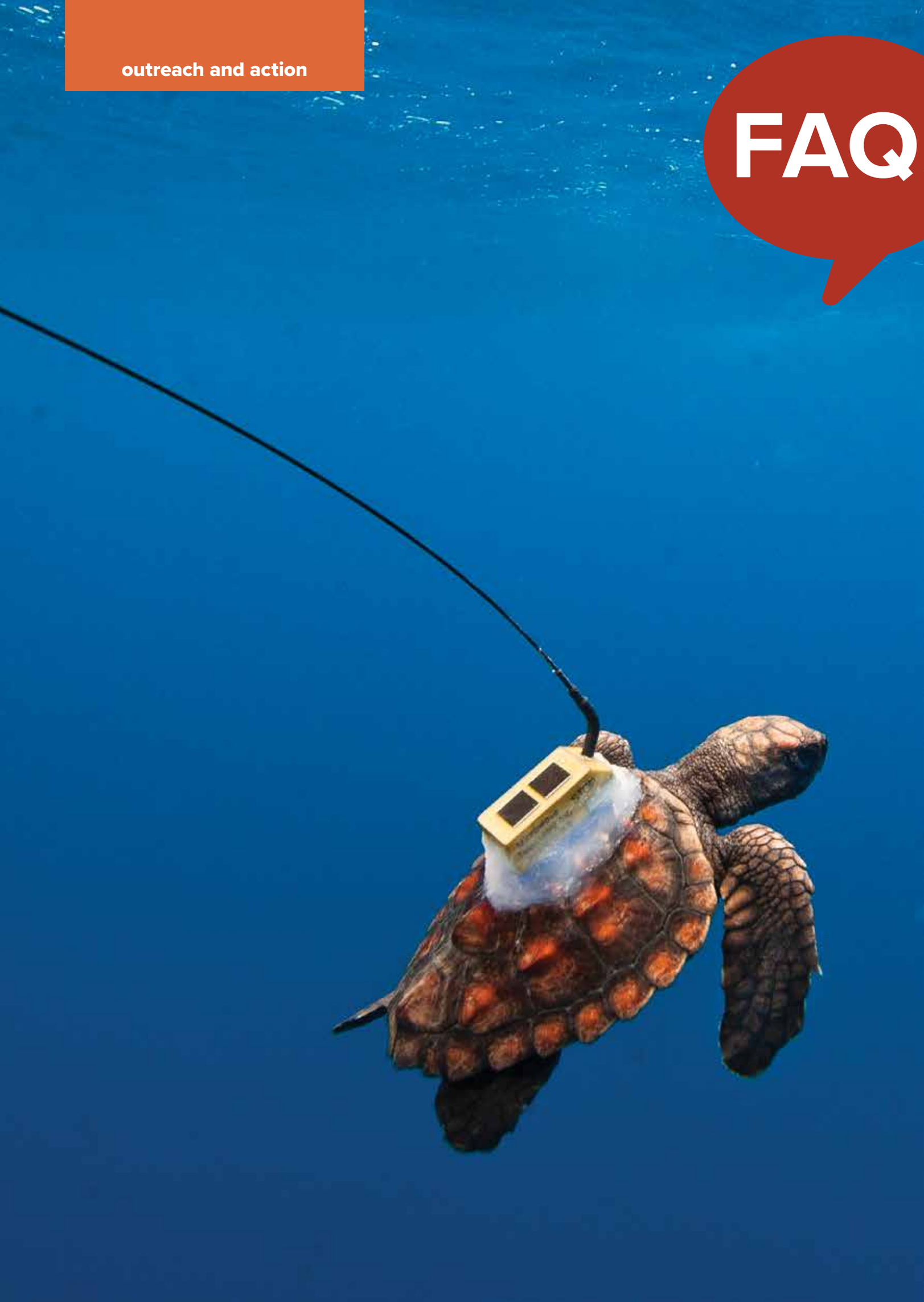


Northwest Atlantic Leatherback Assessment Sites: Assessment locations are (1) North Carolina, U.S.A. (highlighted coastline); (2) Florida, U.S.A. (highlighted coastline); (3) Culebra, Maunabo, and Luqillo-Fajardo, Puerto Rico, U.S.A.; (4) Tortola, BVI; (5) St. Croix, USVI; (6) St. Martin and St. Bathélemy; (7) St. Kitts and Nevis; (8) Guadeloupe; (9) Martinque; (10) Grenada; (11) Matura, Fishing Pond, Grand Riviere, and Tobago; Trinidad and Tobago; (12) Cipara and Querepare, Venezuela; (13) Guyana; (14) Suriname; (15) Awala-Yalimapo and Cayenne, French Guiana; (16) Pacuare, Mondonguillo, Estacion Las Torgugas, Tortuguero, Cahuita, and Gandoca, Costa Rica; (17) Chiriqui and Soropta, Panama. AT LEFT: A leatherback turtle, pursued by remoras, swims offshore of Juno Beach, Florida, U.S.A. © MICHAEL PATRICK O'NEILL

So what happens now? The cautionary tale of Pacific leatherbacks—which have been depleted to alarmingly low numbers as a result of similar factors—has taught us that time is of the essence to mount an effective, sustained response to turn the population trajectory around. The NWA leatherback working group is starting efforts to identify the highest priority actions and locations to work with managers and fishing communities to reduce leatherback bycatch. In upcoming meetings, bycatch data will be shared and techniques to reduce bycatch will be discussed. Moreover, an updated IUCN Red List assessment is being prepared to reflect these trends and to make the decline as widely known as possible.

Despite the bad news about the current status of the NWA leatherback population, this exercise has shown us the importance of collaboration in sea turtle conservation. By sharing data, insights, and experiences, we are able to address shared conservation challenges, together. ■

FAQ



s About Sea Turtles

With their specialized biology and their unique behaviors, sea turtles tend to provoke a lot of questions. Spend an hour with someone who is watching a turtle nest for the first time, and inevitably the questions will come: How old do they get? Where will she go after she leaves the beach? Where did she mate? When will she come back? How long until the babies become adults? And so on.

When it comes to turtles, however, the answers to such seemingly simple questions can be surprisingly elusive. Those of us who work with turtles have therefore grown accustomed to answering with phrases such as "We don't really know, but ..." or "Our best guess is that ...." Although the lack of concise answers to basic questions about sea turtle biology can be frustrating, that lack is precisely what makes sea turtles so interesting to study. After 60 years of science, sea turtles are still mysterious in many ways.

Increasingly, however, advancements in technology and the results of long-term studies are giving scientists the information they need to answer with increasing certainty some age-old questions about turtles. Some mysteries are being solved, and yet others are still answerable only with our best guess. With such continuing mysteries in mind, we thought it would be fun to invite three experts to weigh in with current perspectives about three of the most frequently asked questions concerning sea turtles, and here is what they had to say.

? How Many Eggs Does It Take to Make an Adult Turtle?

By PILAR SANTIDRIÁN-TOMILLO

Shortly after arriving at our project in Pacific Costa Rica, volunteers go on beach patrol and excitedly anticipate their first encounter with a nesting leatherback turtle. Walking along the beach in the middle of the night or watching a turtle lay eggs in the beam of a red light will make anybody wonder about sea turtle biology. Not surprisingly, many excellent questions arise. A common one we hear is "How many eggs make an adult turtle?" The answer to this apparently simple question is actually very complex and requires many assumptions. In fact, there is not one magical number that serves as the correct answer.

A female of any species in a stable population (and this is the first assumption) produces enough offspring to replace herself and her male partner. Because we know very little about male turtles and because natural sex ratios are complex (they are normally female biased as hatchlings but are possibly more evenly balanced among reproductive animals), we make a second assumption that there are 1:1 sex ratios (i.e., a female needs to reproduce herself and one male in her lifetime). We could make the problem more complicated, because sea turtles exhibit both polyandry and polygyny, but to answer this question succinctly, we'll keep it simple.

Next, we also need to know how many eggs a female will lay, on average, during her lifetime to be able to replace herself and a male. This question implies knowing how many eggs she lays per clutch, how many clutches she has per season, how frequently she reproduces, and how long her reproductive lifespan lasts. The last piece is especially difficult, because most projects haven't been around for long enough to exceed the reproductive lifespan of a long-lived sea turtle, but some projects have observed that turtles can reproduce over a period of 20–30 years.

So, let's say that an average female leatherback in Pacific Costa Rica lays 66 eggs per clutch, lays 6 clutches per season, reproduces every 3.7 years, and has a reproductive life of 20 years. Such a female will lay 2,141 eggs in her lifetime to replace two adults (herself and her partner), which yields an estimate of about 1,000 eggs to make one adult turtle.

To arrive at our estimate, we have made a rough, but educated, guess. It is based on the best available information from a single population of a single species. Although it is by no means accurate, nevertheless, it gives us an idea of the effort that it takes to keep sea turtle populations stable. From this calculation, we can see that turtles must make a huge investment in reproduction because many eggs, hatchlings, and juveniles die before reaching maturity. The investment needed to keep the population stable varies among species, across populations, and with changes in survival of the different age classes within the same population. Moreover, populations are not stable; they are dynamic and change over time. The best way to approach this question, therefore, is to look at the unique characteristics of each nesting population and to make the calculations using population-specific numbers.

In the end, finding an exact number to this elusive question may be less valuable than the thinking that is stimulated by simply asking it.

AT LEFT: Researchers fitted juvenile loggerheads with small satellite tags in Brazil to study their movements. © PROJETO TAMAR

How Old Is That Sea Turtle?

By LARISA AVENS

Maybe folklore and popular culture have imbued turtles with the aspect of the eternal, or maybe sea turtles seem improbably and impossibly large (and presumably old) compared to most of their terrestrial and freshwater counterparts. Whatever the reason, one of the most common questions that sea turtle researchers and conservationists hear from the public is "How old is that turtle?"

From the moment they hatch and leave the beach to disperse in the marine environment, sea turtles make it very difficult for us to calculate how old they are. Their long migrations and their multiple habitat shifts often span entire ocean basins and thus impede our ability to follow wild individuals throughout their lives so we can directly monitor their age and growth.

Captive turtles have shown remarkable growth potential, but hard-won mark-recapture data for wild turtles have typically demonstrated slower overall growth rates. And because there is so much variability in growth rates across species, populations, and even individuals, it is impossible to accurately predict age on the basis of size alone. Moreover, unlike some turtle species, sea turtles do not retain lifelong records of annual growth increments in the scutes of the carapace or plastron.

In light of those challenges to directly quantify sea turtle age by size or appearance, researchers have explored a number of indirect approaches for studying growth and aging among live turtles. Unfortunately, attempts to relate rates of change in molecular or chemical "clocks" to age in wild sea turtles have been hampered by limited information about individual histories, such as influences of heredity, thermal environments, and stressors.

Another indirect approach to studying growth and aging is to examine growth increments in the bones of dead animals (similar to using tree rings to estimate a tree's age), a practice known as *skeletochronology*. Given the large numbers of sea turtle strandings that occur worldwide, this method makes it possible to collect age and growth data relatively rapidly, as long as a number of considerations are recognized and addressed. These considerations include (a) finding the most optimal bone and processing method to measure skeletal growth marks, (b) verifying whether the marks are deposited annually to allow age estimation, and (c) defining the relationship between bone and body growth to permit somatic growth rate calculations from bone growth mark spacing.

Because early growth marks at the center of the bone are often absorbed in larger juvenile and adult sea turtles, it is also necessary to collect samples from all life stages so we can develop predictive models that account for any early marks that were lost. Finally, because this method is limited to studying stranded turtles whose cause of death is typically unknown, sample sizes must be large enough to ensure that the data are truly representative of the study population (i.e., finding the signal in the noise).

Over the past few decades, advances have been made in meeting such requirements, primarily for hard-shelled sea turtle species. Recent skeletochronological studies have generated size-at-age relationships and somatic growth rates for individuals and populations over periods spanning decades. Those studies provide valuable information regarding long-term, large-scale patterns in age and growth. One of the most important insights recently highlighted through correspondence among mark-recapture, captive-rearing, and skeletochronology data is that a spectrum of sizes at any given age is possible, depending on interactions among a suite of individual-specific influences and experiences. As a result, the ages and sizes at which wild sea turtles transition between life stages and mature will vary extensively.

Admittedly, this approach is not very helpful for answering the question of how old any particular live turtle might be. That being said, using the same standardized skeletochronological approach for wild loggerheads and Kemp's ridleys in the western North Atlantic has provided a valuable opportunity for comparison between species. The time to maturation for loggerheads—as well as their reproductive longevity—appears to be two to three times longer than that for Kemp's ridleys, thereby highlighting species-specific life history strategies and potentially providing a framework for evaluating relative influences of anthropogenic threats and management approaches.

Characterization of sea turtle age and growth using diverse approaches is ongoing, and additional comparisons among populations and species will be forthcoming. In addition, by our combining skeletochronology with recent advancements in stable isotope and trace element analyses, we can now integrate age, growth, foraging ecology, and habitat use data, which further increases our understanding. As new technologies are developed, refined, and applied, we will continue to make progress on solving the mystery of how old that turtle really is.

Where Do the Baby Turtles Go?

By KATE L. MANSFIELD

Given the terrestrial nature of humans, coastal beaches are where we are most likely to encounter sea turtles, their tracks in the sand, or nests they leave behind. It is incredibly labor-intensive, logistically difficult, and expensive to follow or survey turtles, especially little ones, in the middle of the open ocean. As a result, most of what we know about sea turtle biology derives from work conducted on beaches. Very little is known about sea turtles from the time little hatchlings depart their nesting beaches and enter offshore, oceanic waters, until they return to shallower coastal waters years later as larger "teenage" turtles.

In fact, so little was historically known about this period in sea turtles' lives that it has been dubbed the "lost years." Nonetheless, the

time that sea turtles spend on land equates to but a blink of an eye when compared to their long lives spent at sea. Understanding sea turtle behavior at all their life stages is critical for ensuring the conservation and survival of those threatened and endangered species.

So, where do the baby turtles go after they leave the beach? How do they get there? How do they interact with their environment? Are they passively drifting with ocean currents or actively orienting and swimming to developmental habitats? Where and when are human activities more likely to affect their survival and their health? How long do they spend in oceanic waters before returning to coastal habitats as larger juveniles?

Historically, much of what we once knew about the sea turtle lost years was based on opportunistic sightings offshore or within boating distance of islands or the coast, or knowledge was derived (a) from lab-based studies of young turtles' sensory capabilities, behavior, and orientation or (b) from short-term tracking studies (spanning a period of hours) of baby turtles from their nesting habitats. But little by little, technology is enabling us to answer some of the great questions about sea turtle biology.

Beginning in the late 2000s, satellite tags became small enough to enable researchers to track little three- to nine-month-old loggerheads in the western North Atlantic. Small, 9-gram, solar-powered bird tags (modified for a marine environment) were attached to the young turtles' shells with a combination of manicure acrylic, neoprene from old wetsuits, toupee glue, and aquarium silicone. The turtles were then released off their natal beaches in southeast Florida, providing the first long-term data about the movements and dispersal of young, oceanic-stage turtles.

The turtles' tracks, combined with ocean modeling, confirmed that the young turtles were indeed living offshore, remaining mostly at the surface, and traveling within the large ocean currents that make up the North Atlantic Subtropical Gyre (NASG). But, unexpectedly, many of those turtles left the major ocean currents that make up the NASG and traveled to the Sargasso Sea, an area in the interior of the North Atlantic named for the Sargassum that collects in the region.

This travel makes sense; if small turtles are living on a mat of algae, they can easily find food, blend in with the brown algae to hide from predators, and hang out in a nice warm habitat. They bask at the sea surface while conserving energy by floating with the Sargassum—their "mobile home." For little cold-blooded animals, having this thermal benefit in a safe, food-rich habitat where they can grow and thrive is likely key to their early survival.

Yet not all tracked turtles entered the Sargasso Sea; some turtles remained in the currents as expected, heading to the Azores in under 200–300 days from offshore of their south Florida natal beaches. The Sargasso Sea is emerging as an important developmental habitat for North Atlantic loggerheads and other species of sea turtle. The currents that make up the NASG may act as an enormous playpen for the young turtles, thus keeping them within the confines of the North Atlantic Ocean and the Sargasso Sea.

Follow-up studies in the Gulf of Mexico and the South Atlantic using passive oceanographic drifters—a fancy term for floating buckets with GPS satellite tags on them—demonstrated that young loggerheads are not always passive drifters being pushed around by ocean currents as was historically assumed. In fact, young (3- to 12-month-old) satellite-tracked loggerheads were observed to actively

A loggerhead hatchling begins its journey to sea. So little has been known about the early part of sea turtles' lives that this period is often called the "lost years."
© KATE L. MANSFIELD

orient and actively swim in very different directions and with more velocities than the passively drifting buckets. Some loggerheads tagged in the Gulf of Mexico off of the coast of Louisiana, U.S.A., left the Gulf, traveled into the western North Atlantic, and connected with the NASG currents, whereby after less than a month and a half they were off the Grand Banks near Nova Scotia, Canada.

The South Atlantic has a similar gyre system to the north, called the South Atlantic Subtropical Gyre (SASG). Unlike in the Gulf Stream in the North Atlantic, the currents making up the SASG seasonally shift in their location off the coast of Brazil, which is home to the South Atlantic's main loggerhead nesting beaches. Hence, turtles emerging from nests early in the South Atlantic hatching season will experience different currents (and modes of dispersal transport) than will turtles that hatch later in the season.

Young, oceanic-stage turtles that were satellite tracked early in the hatching season traveled to the south, whereas late-season tracked turtles traveled to the north, crossed the Equator, and entered the North Atlantic and Caribbean waters. Similar to loggerheads tracked from the Gulf of Mexico, Brazilian loggerheads connected with other regions and water bodies. However, none of the turtles tracked in the South Atlantic entered the center of the Gyre (like the turtles observed in the North Atlantic that traveled to the Sargasso Sea).

This is an exciting time. Newer, smaller tags are becoming available, allowing us to satellite-track younger turtles for longer distances. As more turtles are tagged in more regions and more oceans, we are finding that we can't assume that baby turtles in different oceans are behaving in the same way. Where do the baby turtles go? The answer depends on where in the world the question is asked. What we do know is (a) that little sea turtles are surface-dwelling oceanic creatures that actively orient and actively swim and (b) that we have a long way to go until we fully understand the sea turtle lost years. ■

Stranding Networks

ADMINISTER THE THREE R'S IN THE AMERICAN ATLANTIC

By MARK SWINGLE, BILL DEERR, JENNIFER DITTMAR, MEGHAN KOPERSKI, CHARLES A. MANIRE, WILLOW MELAMET, CONNIE MERIGO, MAXINE MONTELLO, CAROL PRICE, SARAH ROSE, KATE SAMPSON, AMBER WHITE, and KATHY ZAGZEBSKI

Aligned along the edge of the western North Atlantic Ocean is the U.S. Atlantic seaboard, a heavily populated region of coastal cities, maritime ports, military bases, and tourist beach destinations that covers more than 25,000 miles of coastline and spans 14 U.S. states from Florida to Maine. It is inevitable that sea turtles and human activities will intersect in the coastal waters and beaches of this highly trafficked zone. This story is about the region's ongoing programs that **R**escue, **R**ehabilitate, and **R**elease (the three Rs) thousands of sea turtles annually and about the network of dedicated organizations and passionate professionals, volunteers, and public supporters who make it all happen.

U.S. recovery plans for all five sea turtle species found in the region encourage strong stranding and salvage networks that are overseen by the U.S. National Oceanic and Atmospheric Administration (NOAA) and the U.S. Fish and Wildlife Service. Those networks are made up primarily of nongovernmental organizations that voluntarily engage in the three Rs as first responders to emergencies and unusual events involving sea turtle mass mortalities, injuries, and illness. They are responsible for systematic data collection on stranded animals, and they ensure that all distressed animals are transferred to professional centers for treatment and rehabilitation for eventual release to the wild.

Some of those organizations have cared for animals and have been at the forefront of sea turtle husbandry and medical care for more than 30 years. Many are public aquariums accredited by the Association of Zoos and Aquariums, including the New England Aquarium, National Aquarium in Baltimore, Virginia Aquarium & Marine Science Center, three North Carolina Aquariums, South Carolina Aquarium, and SeaWorld Orlando. Most of those have a small number of sea turtles on public display as conservation ambassadors, in addition to committing substantial resources to the recovery of wild populations.

Other network organizations are focused more exclusively on marine animal rehabilitation, such as the Loggerhead Marinelife Center in Florida, Georgia Sea Turtle Center, Karen Beasley Sea Turtle Rescue and Rehabilitation Center (North Carolina), Sea Turtle Recovery (New Jersey), Riverhead Foundation for Marine Research and Preservation (New York), and National Marine Life Center (Massachusetts). All of those groups have conservation of sea turtles and their natural habitats firmly embedded in their missions.

In the past 10 years, along the U.S. Atlantic coast nearly 10,000 sea turtles in need of attention from natural or human impacts have been rescued. Cold stunning (hypothermia) is the single most common cause, followed by entanglement in active and discarded fishing gear, hookings, boat strikes, ingestion of marine debris, harmful algal blooms, and disease. Cold-stunning events alone can bring more than 600 sea turtles into rehabilitation facilities in a single season, mostly juvenile Kemp's ridleys (see *SWOT Report*, vol. XI, pp. 42–43). Over the past decade, more than 40 leatherbacks were disentangled from fishing gear.

Despite the serious illnesses and injuries associated with stranded sea turtles and despite rehabilitation periods that can range from several days to multiple years, on average more than 70 percent are

A juvenile green turtle is measured prior to release in Florida, U.S.A. After swallowing a fishhook, the turtle underwent surgery and recovery at Loggerhead Marinelife Center in Juno Beach. © LOGGERHEAD MARINELIFE CENTER, TAKEN UNDER FLORIDA MARINE TURTLE PERMIT MTP-18-086

successfully released and reintegrated into their natural populations. In addition, the rehabilitation process provides significant opportunities for study, leading to advances in medical care and increasing knowledge of sea turtle biology and life history. The expertise of U.S. eastern seaboard experts has even been called upon outside the region—for instance, when the BP Deepwater Horizon oil spill in the Gulf of Mexico mobilized Atlantic regional expertise in support of rehabilitation efforts for hundreds of affected sea turtles (see *SWOT Report*, vol. VI, pp. 16–21).

In the big picture, rehabilitated sea turtles have only a limited potential for direct conservation effects. Although the animal welfare benefits are significant, the total numbers of rehabilitated animals are relatively small compared to the size of sea turtle populations. Yet in another critical arena, the sea turtle recovery actions are having a major effect—in the court of public opinion. Another area of agreement among all recovery plans is the need for public education and community engagement. Most threats to sea turtles, such as fisheries bycatch, vessel strikes, oil pollution, and ingestion of marine debris, can be reduced through human behavior changes, and those changes begin with an informed and engaged public that supports sea turtle protection and stewardship of ocean ecosystems. Rehabilitation programs have proved to be unmatched for galvanizing public attention and support. People have a natural desire to be a part of programs to help sea turtles in their own backyard, and this reaction, in turn, opens doors to developing better public support for broader and more comprehensive conservation actions.

In one example that brings this story of the three Rs full circle, the Association of Zoos and Aquariums has developed a program called Saving Animals From Extinction (SAFE). Led by a number of aquariums involved in sea turtle rehabilitation, the SAFE Sea Turtles Program is just getting under way. SAFE brings together a collective of organizations to tackle some of the world's most critical sea turtle conservation needs. Sea turtles' natural environments have never been more severely affected by humans than they are today. Regional rehabilitation efforts have been very successful in generating a foundation of public support. The next step will be to build on that success, to come together, and to focus our collective efforts on sea turtle conservation where it is needed most. The conservation engine that has been stoked for decades by sea turtle rescue, rehabilitation, and release is ready to roll. ■

FINDING THE KEYS TO Safe Transport of Debilitated Turtles

By ROGER D. PSZONOWSKY, NIKIA RICE, and DAVID G. CHENEY JR.

Dead, dying, and debilitated sea turtles wash ashore along the 300 miles of ocean and lagoon shoreline of Brevard County, Florida, U.S.A., about 160 times a year, with 47 percent of the affected animals requiring transport to a rescue or rehabilitation facility that may be hours away. Such journeys are logistically complex and carry a number of risks for both the turtles and their rescuers. Founded in 1984, the Sea Turtle Preservation Society (STPS) has 25 permitted volunteers who regularly transport stranded turtles in Brevard County. Drawing on the experiences of this team and on advice from Drs. Craig Pelton and Charles Manire, who are qualified sea turtle veterinarians, STPS developed a set of best practices for transporting disabled turtles while mitigating some of the risks.

The effort began by meeting with veterinarians and rehabilitation staff members at a number of facilities and by interviewing experts at the Florida Fish and Wildlife Conservation Commission (FWC) to gather background information about the most important equipment, tools, and techniques to use for safe transportation of injured turtles. Because most of STPS's first responders are local volunteers who may see only a few strandings per year and for whom specialized equipment is unaffordable or impractical, STPS's best practices guidelines focus on the use of cost-effective tools that are readily available to the public.

BEST PRACTICES FOR SAFE TURTLE TRANSPORT

Rehabilitation facilities have professional medical staff members and specialized equipment to care for turtles once they are on site. Thus, the greatest challenge is often ensuring that the turtles get from the stranding site to the facilities without creating more problems. Transporting the turtles can mean confronting a gauntlet of back-breaking lifting, loading, and long drives over difficult terrain in open air or hot vehicles—all factors that can stress and cause internal injuries to a turtle if not performed properly.

Moving a weak or injured turtle weighing as much as 200 pounds from the ocean or shore and into a vehicle can harm both the turtle *and* the person trying to help; if done incorrectly, simply lifting the animal can result in distress and potentially serious injuries. In some cases, veterinarians have noted that injuries to turtles that occurred during rescue and that transport may have contributed to the animal's death.

STPS created a visual aid program to educate volunteers about the most common situations that one may encounter. In the video, a trainer explains the best techniques for moving turtles, for making them comfortable, and for securing them during transport. Emphasis is placed on the importance of proper lifting, the use of appropriate containers and padding, and the monitoring of the animal's core temperature during transport.

First, it is best to avoid lifting turtles. Instead, one should find a means to float the turtle or to gently slide it onto a board for support. This method is particularly important with emaciated turtles, which make up about 20–25 percent of the animals that end up in rehabilitation centers. Marginal support, such as that provided by a flat surface beneath the animal, is very important. One should always avoid lifting a turtle by the carapace alone because the plastron bones (the hyoplastron or xiphiplastron) can actually puncture the heart and other organs if improper pressures are applied. It is further recommended to keep the animal flat and to prevent the turtle from moving during transport.

Second, maintaining the core body temperature of a rescued turtle is important. Medical staff members prefer that temperature remain relatively constant. If the turtle has been in the sun for an extended time, cooling it slowly may be required during transport. Similarly, if the animal is cold, warming it must be extremely gradual to avoid shock. Transporters are trained in the proper techniques for maintaining core temperatures by using towels and water. When questions or problems arise, the transporters know how to contact FWC, and they remain in contact with the designated treatment facility during transport to give the facility reliable estimated times of arrival and updates on the turtle's condition.

STPS TURTLE TRANSPORT TEAM

Not unlike an ambulance crew that deals with human patients, STPS built a special transport team from among its nearly 300 members who actively participate in rescue, education, and data collection. Those team members possess the permits required to ensure compliance with federal and state laws related to the handling and transport of protected species under the U.S. Federal Endangered Species Act and Florida's Marine Turtle Protection Act.

When a live turtle is reported on the STPS hotline, a text message goes out to the transport team with information, including location, size, injuries, and contact information about the turtle, as well as the specific treatment facility that will take the turtle. The transporter will assist the stranding team in moving the turtle off the beach; loading it into a secure container with padding; and using wet or dry towels to help cool, warm, or maintain the turtle's core body temperature. The transporter will also maintain contact with the hotline and treatment facility during transport.

When a call comes to save a turtle, volunteers' adrenaline starts pumping. They must rush to the scene, assess the situation, inform FWC, and often enlist the support of willing bystanders because moving a large turtle off the beach and out of the hot sun often requires the assistance of nearby people who must be educated on the spot about proper handling techniques.

Members of the STPS transport team must meet the following criteria:

- Be licensed and capable of driving an STPS van and truck, or have a personal vehicle with a covered cargo area.
- Have access to a climate-controlled area.
- Have a hands-free mobile phone.
- Have several sizes of containers with padding available.
- Have a supply of clean towels and gloves for handling turtles.
- Have a water container for keeping animals damp and cool.
- Have a digital thermometer.
- Be able to monitor a turtle's vital signs during transport.
- Have knowledge of rehabilitation facility locations and contacts.
- Have copies of all required permits.

A POWERFUL AMPLIFIER FOR CONSERVATION

Following those simple guidelines has improved the success of STPS's sea turtle rescue program with little additional cost. Although most concerns in the sea turtle conservation community revolve around addressing population and species-level threats, it is also important to help the individual victims of ingested plastic, climate change–induced cold snaps, and other threats that injure or kill turtles on our shores every year. When local residents and tourists know that a dedicated team of trained and committed turtle rescue professionals is just a phone call away, such knowledge can act as a powerful amplifier for the success of sea turtle conservation on all levels. ■

One of the keys to safely transporting a sea turtle is to lift the turtle on a flat surface rather than by the carapace alone, which can lead to injury. © CARLA MROZ

A Caribbean Eden
RECOVERS FROM HURRICANE IRMA

By WENDY MCFARLANE, MAXINE MONTELLO, MELISSA LACROCE, and NANCY TODD

Barbuda is a small island (162 sq km, or 62.5 sq mi) located in the Leeward Islands chain of the eastern Caribbean, 62 km (38.5 mi) from its sister island, Antigua. It is a flat, limestone-based island with a maximum elevation of only 42 meters (46 yards) and a population of 1,700 people in its one town of Codrington. So few are Barbuda's human residents, in fact, that the donkeys, goats, horses, dogs, and cats that roam the island likely outnumber the people. Although not globally known as a tourist destination, Barbuda boasts numerous pristine white and pink beaches, on which nest substantial populations of hawksbill, leatherback, and green sea turtles. Loggerheads, too, are known to periodically forage around the island's seagrass beds and offshore reefs, and a leatherback is occasionally spotted.

Research on Barbuda's turtles over the past eight years suggests that this is a very important nesting site in the eastern Caribbean. Four index beaches have been identified as areas of high nesting activity for hawksbills and greens, and their physical characteristics have been mapped and described. Currently, there is an initiative to create a sea turtle monitoring program on Barbuda that will help (a) to estimate nesting population sizes and trends and (b) to fully illustrate the importance of this tiny island for the production of future generations of Atlantic turtles. Barbudan culture has historically welcomed the harvest of both adult turtles and eggs, yet today there is little legislation to protect turtles and inadequate surveillance and enforcement by governing bodies. As such, much work remains to be done to ensure the protection of such vulnerable reptiles.

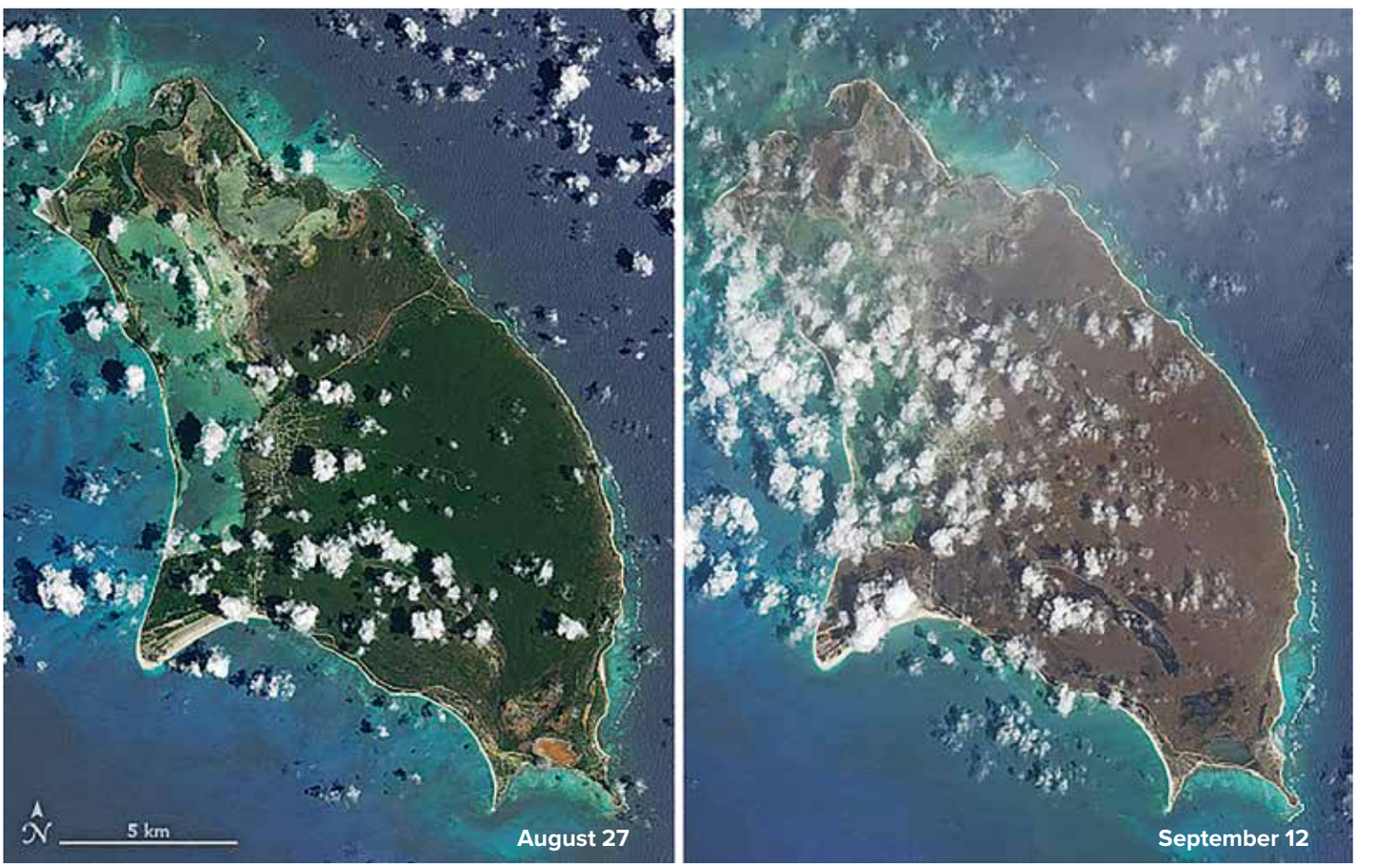
On September 6, 2017, the face of Barbuda changed forever with the arrival of Category 5 Hurricane Irma. The tiny island experienced Irma's first landfall and found itself at Mother Nature's mercy. Irma left a trail of destruction. Surprisingly, only one human death was recorded, but more than 90 percent of the island's buildings were damaged, livestock was killed, vegetation was uprooted, and the storm surge caused massive flooding. The entire population of Barbuda had to be evacuated to Antigua; it was the first time in 300 years of recorded history that there was not a single human soul on the island. The recovery effort has been slow, compounded by the evacuation of all the residents, scant financial resources, and legal conflicts relating to unsettled property rights. However, the rebuilding of schools and homes is taking place, and the restoration of Barbudan life is under way. A Go Fund Me campaign started by the Barbudan Ecological Research Group has raised nearly $14,000 to help some of the families that lost everything to Irma.

In the early days after the hurricane, National Park Service rangers disentangled a number of turtles that had washed up alive on debris-filled beaches. The 2017 sea turtle nesting season was negatively affected, as newly laid nests were most certainly washed into the sea. The hurricane also severely damaged some important turtle nesting beaches along Barbuda's western coast; in some cases, beaches were completely wiped out. The future for sea turtle nesting beaches on Barbuda is not entirely clear, but signs of hope are seen in the natural beach restoration that is occurring. Some beaches that were completely washed away are forming as coastal currents allow sand to build up, and turtles will surely find these suitable nesting sites. In fact, very soon after the hurricane, numerous turtles were nesting on Barbuda once again.

Sea turtle research in Barbuda has taken two forms: a survey of nesting distribution and a study of the determinants of nesting site choice, plus ongoing education and outreach efforts. Barbudan youth have been taken out into the field to learn data collection techniques, and a variety of programs in schools and summer camps allow students to learn the importance of endangered sea turtles and island biodiversity. Although a primary research goal is to assess beach conditions and turtle nesting post-Irma, it also is important to continue outreach programs about sea turtles and to better understand the resilience of species and ecosystems in the face of hurricanes and other climate-related impacts.

For now, the focus for Barbudans needs to be not only on recovering from the effects of Hurricane Irma but also on preparing for the next hurricane season. Readiness takes the form of rebuilding structures to withstand higher winds, but it also could include managing beach habitats that are important to sea turtles. This is an opportunity to redevelop resorts as ecotourism destinations and to plan around beach sites to ensure the preservation of ecological systems and habitats. Strategies that are being considered include reducing unnecessary light sources and planting vegetation to anchor sands in vulnerable areas along the western coastline of the island. At this point, education and outreach remain key factors in such changes. The hope is that through collaboration with this small population of islanders, good investment can safeguard the future of endangered turtles on Barbuda and throughout the Caribbean. ■

The authors wish to thank Mr. Ogden Burton and Codrington Lagoon National Park staff for their ongoing collaborative efforts on this study.



Satellite images reveal the significant impacts on Barbuda of Hurricane Irma, which made landfall on September 6, 2018. © NASA EARTH OBSERVATORY; AT LEFT: Barbuda boasts pristine beaches that are home to nesting hawksbill, leatherback, and green turtles. © WENDY MCFARLANE

SWOT Team Update

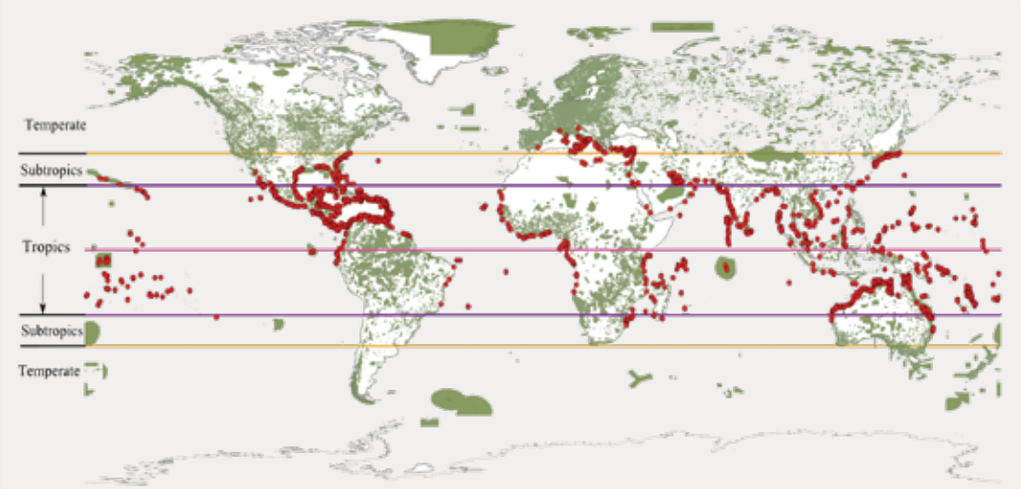
EXAMPLES OF HOW THE SWOT DATABASE HAS BEEN USED FOR RESEARCH AND CONSERVATION

The sea turtle data that are housed within the global SWOT database have been made publicly available by the original data contributors and by the SWOT Program both for educational purposes and for facilitation of an exchange among sea turtle researchers and conservationists. The data are protected by SWOT's terms of use, but anyone may request to use the data by following a simple request process.

Information from the SWOT database has been requested more than 100 times and is used in a variety of projects that aim to advance sea turtle research and conservation worldwide. Users have ranged from researchers conducting peer-reviewed scientific studies and using spatial planning applications, to students learning to make maps in university geographic information system (GIS) classes, to elementary schoolchildren learning about sea turtles. Next are some products that have benefited from SWOT's global sea turtle database. If you have ideas about how SWOT data could be put to use for sea turtle research and conservation, visit **https://www.seaturtlestatus.org/request-data/** today and let us know!

A Global Gap Analysis of Sea Turtle Protection Coverage (Mazaris et al. 2014)

The authors evaluated the extent to which the current global network of protected areas encompasses sea turtle nesting sites to identify gaps in sea turtle protection globally and regionally. The analysis used data on the global distribution of sea turtle nesting sites from the SWOT database.

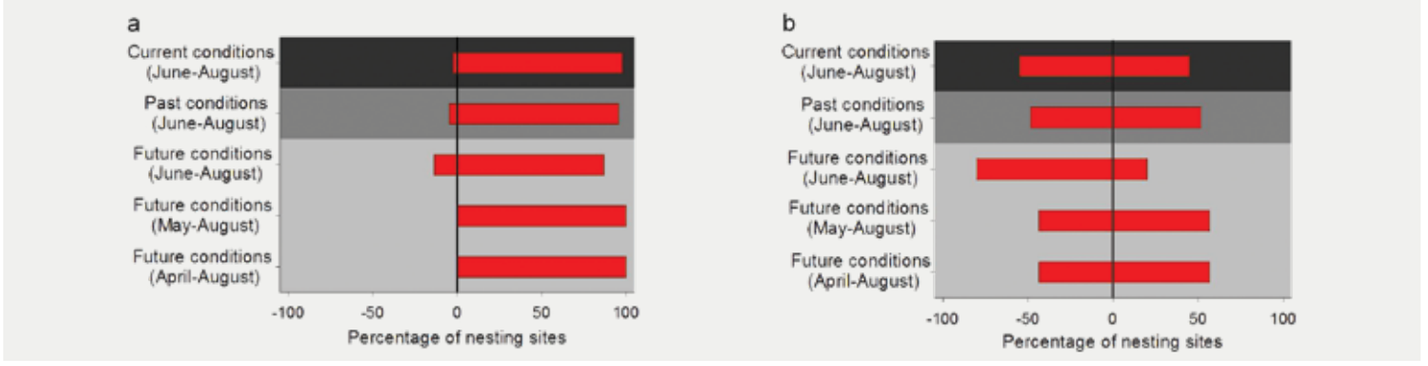


Citation: Mazaris, A. D., V. Almpanidou, B. P. Wallace, J. D. Pantis, and G. Schofield. 2014. A global gap analysis of sea turtle protection coverage. Biological Conservation 173: 17–23.

Using Climatic Suitability Thresholds to Identify Past, Present and Future Population Viability (Almpanidou et al. 2016)

The authors used climatic niche models to generate thresholds of climatic suitability for loggerhead turtles nesting in the Mediterranean and assessed the climatic suitability of loggerhead nesting sites in the past and future. The analysis used data on the location of loggerhead nesting sites in the Mediterranean from the SWOT database.

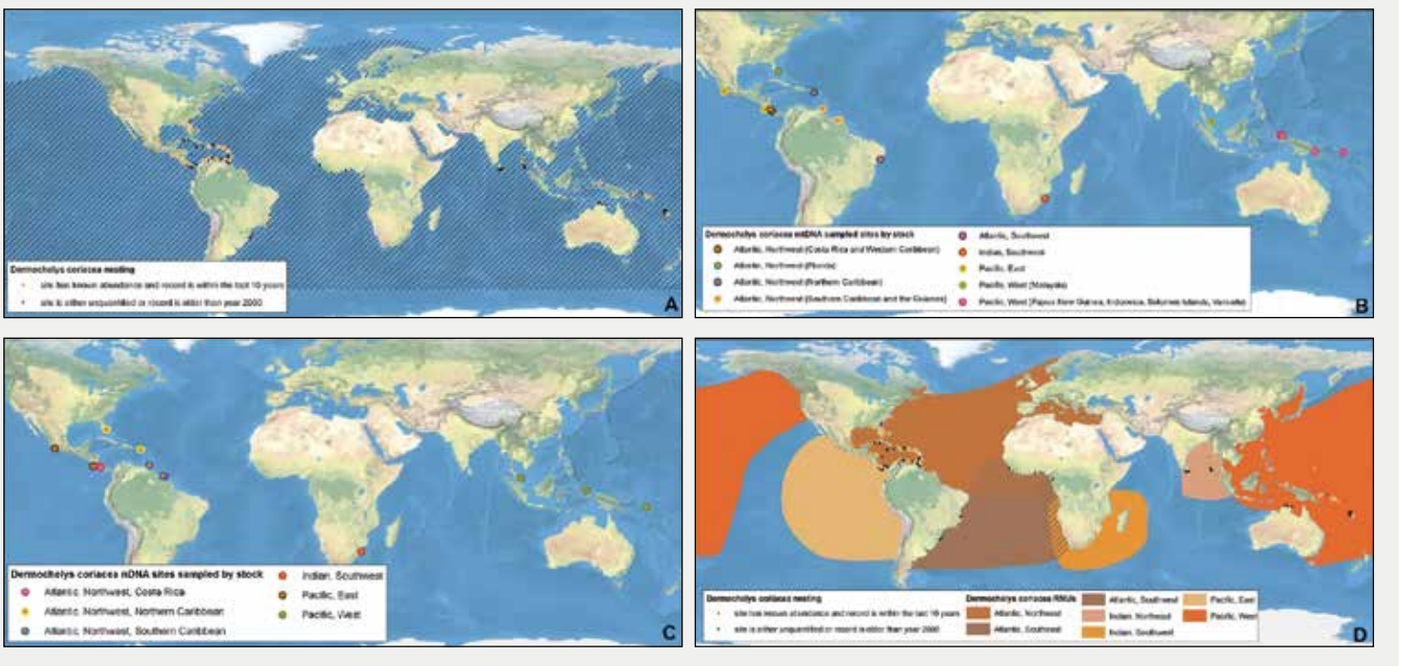
Citation: Almpanidou, V., G. Schofield, A. S. Kallimanis, O. Türkozan, G. C. Hays, and A. D. Mazaris. 2016. Using climatic suitability thresholds to identify past, present and future population viability. Ecological Indicators 71: 551–556.



Regional Management Units for Marine Turtles: A Novel Framework for Prioritizing Conservation and Research across Multiple Scales (Wallace et al. 2010)

This landmark publication by members of the IUCN-SSC Marine Turtle Specialist Group defined Regional Management Units (RMUs, i.e., subpopulations) of marine turtles worldwide for the first time. To delineate the RMUs, the authors collated all available information on marine turtle biogeography, including nesting sites, population abundances and trends, population genetics, and satellite telemetry. The SWOT database was used to help identify and georeference nesting sites globally for all species, a fundamental component of each RMU.

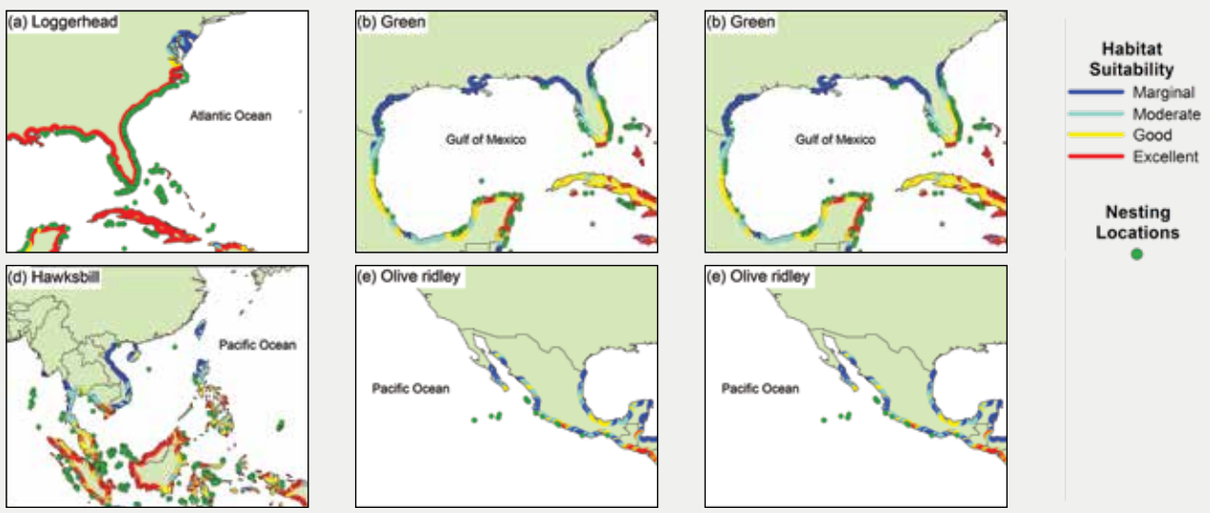
Citation: Wallace, B. P., et al. 2010. Regional Management Units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. PLoS ONE 5 (12): e15465.



Climate Influences the Global Distribution of Sea Turtle Nesting (Pike 2013)

Author David Pike predicted the spatial distributions of nesting habitat under current climatic conditions for seven sea turtle species worldwide in an effort to understand whether climate limits current sea turtle nesting distributions and shapes the ecological niche of the terrestrial life-history stage of these wide-ranging marine vertebrates. The analysis used data on nesting beach locations from SWOT and other sources, and the resulting data layer (a global index of habitat suitability) is available through the SWOT database online.

Citation: Pike, D. A. 2013. Climate influences the global distribution of sea turtle nesting. Global Ecology and Biogeography *22: 555–556.*



Acting Globally

SWOT Small Grants 2018

Since 2006, SWOT's small grants have helped field-based partners around the world to realize their research and conservation goals. To date, 79 grants have been awarded to 56 applicants in more than 40 countries and territories for work addressing three key themes: (a) networking and capacity building, (b) science, and (c) education and outreach. The following are brief updates from our 2018 grantees. Visit **www.SeaTurtleStatus.org** to apply for a 2019 SWOT small grant!

JOHOR, MALAYSIA

Harris Wei-Khang Heng

The Sibu-Tinggi Archipelago in Johor, Malaysia, hosts poorly known populations of foraging green and hawksbill sea turtles on the extensive seagrass meadows in its subtidal zones. Those unique habitats are also very important for dugongs. Harris Heng from the University of Malaya will use a 2018 SWOT grant to conduct surveys and spatial ecology studies that will require an unmanned aerial vehicle. SWOT support will help purchase equipment and cover travel costs to reach the remote archipelago. Results of the work will be used to encourage the expansion of conservation efforts beyond nesting beaches.

NORTH SULAWESI, INDONESIA

Manengkel Solidaritas

The village of Ranowang Dua in North Sulawesi consists of only four families totaling about 20 people, but the area is a very important nesting habitat for five sea turtle species. Turtle meat consumption is an essential part of traditional ceremonies and is the greatest threat to the animals. The nongovernmental organization Manengkel Solidaritas will use its 2018 SWOT grant to assist local villagers (a) in collecting data with the objective of better understanding turtle populations and (b) in fostering a behavioral change away from sea turtle consumption. Data will also be used by Manengkel Solidaritas to potentially verify loggerhead nesting in Indonesia.

LIBREVILLE, GABON

Aventures Sans Frontières

The sea turtle nesting beaches near Gabon's capital city, Libreville, are a popular recreation destination for the city's inhabitants. Visitors leave behind plastic waste that can become a hindrance to nesting females, and extensive coastal development creates pockets of wastewater that can be deadly to hatchlings. Aventures Sans Frontières will use a 2018 SWOT grant to raise awareness about sea turtles among coastal residents through programs within four local schools and with beachgoers and residents living near the most heavily trafficked beaches. The program will also implement beach cleanups and hatchling rescue and release efforts.

JURADÓ, COLOMBIA

Fundación Neotropical

The community of Juradó lies along the Pacific coast of Colombia near the border with Panama. The extremely biodiverse area contains sandy and rocky beaches, rainforests, mangroves, and marshes that are poorly studied as a result of 50 years of armed conflict. Juradó's leatherback and hawksbill turtle populations face many human-generated threats, including egg consumption and predation by feral dogs. Using a 2018 SWOT grant, Fundación Neotropical will launch a program to educate local community members and to engage them in sea turtle conservation efforts. Activities will include workshops, beach cleanups, beach monitoring, and mural paintings with local children.

PEARL CAYS, NICARAGUA

Cynthia J. Lagueux and Cathi L. Campbell

The Pearl Cays lie along the central coast of Caribbean Nicaragua and are an important developmental and nesting habitat for hawksbills. Fishers often capture turtles intentionally or as bycatch. This 2018 SWOT grant will be used to support a Fisher-to-Fisher program that will enable a local fisher, William McCoy, to conduct community outreach that will reduce the killing of sea turtles. This interaction with local fishers aids in raising awareness of the importance of sea turtles in maintaining healthy marine ecosystems. It also encourages fishers to donate captured turtles so that they may be tagged and released.

NEW YORK, USA

Riverhead Foundation for Marine Research and Preservation (RFMRP)

RFMRP is the primary response team for sea turtle rescue in New York, U.S.A., and it is the state's only facility permitted to rehabilitate animals. The team responds to the second highest amount of cold stuns affecting Kemp's ridleys, greens, and loggerheads in the U.S. Atlantic. A 2018 SWOT grant will be used to expand the lecture series and to implement a Citizen Science Response Program. Thirty-one citizen scientists have been recruited to patrol beaches daily during the cold stun season and to increase rescues, limit the time that animals are exposed to extreme conditions, and increase the chances for successful rehabilitation.

SWOT Data Citations

LOGGERHEAD TURTLE SATELLITE TELEMETRY IN THE ATLANTIC OCEAN

The following data records refer to satellite telemetry datasets from tags that were deployed on loggerhead turtles in the Atlantic Ocean and were combined to create the maps on pp. 18–19. They are organized by country of deployment. For information regarding data processing and filtering, see the note on the map on p. 19. These data were generously contributed to SWOT by the people and partners listed subsequently. Records that have a SWOT ID can be viewed in detail in the SWOT online database and mapping application at http://seamap.env.duke.edu/swot, which contains additional information about the projects and their methodologies.

To save space, we have used the following abbreviations in the data source fields below: (1) "STAT" refers to Coyne, M. S., and B. J. Godley. 2005. Satellite Tracking and Analysis Tool (STAT): An integrated system for archiving, analyzing, and mapping animal tracking data. *Marine Ecology Progress Series* 301: 1–7; (2) "SWOT Online Database" refers to Kot, C. Y., E. Fujioka, A. DiMatteo, B. P. Wallace, B. J. Hutchinson, J. Cleary, P. N. Halpin, and R. B. Mast. 2015. The State of the World's Sea Turtles Online Database: Data provided by the SWOT Team and hosted on OBIS-SEAMAP. Oceanic Society, IUCN Marine Turtle Specialist Group, and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu/swot; and (3) "OBIS-SEAMAP" refers to Halpin, P. N., A. J. Read, E. Fujioka, B. D. Best, B. Donnelly, L. J. Hazen, C. Kot, K. Urian, E. LaBrecque, A. DiMatteo, J. Cleary, C. Good, L. B. Crowder, and K. D. Hyrenbach. 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. *Oceanography* 22(2): 104–115. When listed, these sources indicate that the dataset was contributed online through STAT, SWOT, or OBIS-SEAMAP.

ARGENTINA

DATA RECORD 1

Metadata: 6 *Caretta caretta*; tags deployed in Argentina.
Source: González Carman, V., I. Bruno, S. Maxwell, K. Álvarez, D. Albareda, E. M. Acha, and C. Campagna. 2016. Habitat use, site fidelity and conservation opportunities for juvenile loggerhead sea turtles in the Río de la Plata, Argentina. *Marine Biology* 163: 1–13.
SWOT Contact: Carman González

BRAZIL

DATA RECORD 2

Metadata: 19 juvenile *Caretta caretta*; tags deployed at sea.
Source: Mansfield, K. L., M. L. Mendilaharsu, N. F. Putman, M. A. G. dei Marcovaldi, A. E. Sacco, G. Lopez, T. Pires, and Y. Swimmer. 2017. First satellite tracks of South Atlantic sea turtle "lost years": Trans-equatorial and seasonal implications for population connectivity. *Proceedings of the Royal Society B* 284: 20171730.
SWOT Contact: Kate Mansfield

DATA RECORD 3

Metadata: 10 nesting *Caretta caretta*.
Source: Marcovaldi, M. Â., G. G. Lopez, L. S. Soares, E. S. H. M. Lima, J. C. A. Thome, and A. P. Almeida. 2010. Satellite-tracking of female loggerhead turtles highlights fidelity behavior in northeastern Brazil. *Endangered Species Research* 12: 263–272.
SWOT Contact: Neca Marcovaldi

DATA RECORD 4

Metadata: 13 *Caretta caretta*; tags deployed in Brazil.
Source: Marcovaldi, M. Â. 2018. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
SWOT Contact: Neca Marcovaldi

DATA RECORD 5 | SWOT ID: 951

Project Title: Brazil Trawl-Caught Turtles
Project Partners: Fisheries Bycatch Research Group, Projeto Tartarugas no Mar
Metadata: 5 juvenile and 3 adult *Caretta caretta*; tags deployed in 2013 and 2014.
Sources: (1) Monteiro, D. 2018. Brazil Trawl-Caught Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/951) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Danielle Monteiro

DATA RECORD 6 | SWOT ID: 1148

Project Title: Neonates Tagged Off Brazil
Project Partners: Fisheries Bycatch Research Group, TAMAR, NOAA, UCF
Metadata: 4 juvenile *Caretta caretta*; tags deployed in 2013.
Sources: (1) Swimmer, Y. 2017. Neonates tagged off Brazil. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1148) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Yonat Swimmer

BONAIRE

DATA RECORD 7

Metadata: 5 female *Caretta caretta*; tags deployed on nesting turtles.
Sources: (1) Nava, M. I., and Sea Turtle Conservation Bonaire. 2019. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019). **(2)** Becking, L. E., M. J. A. Christianen, M. I. Nava, N. Miller, S. Willis, and R. P. van Dam. 2016. Post-breeding migration routes of marine turtles from Bonaire and Klein Bonaire, Caribbean Netherlands. *Endangered Species Research* 30: 117–124.
SWOT Contact: Mabel Nava

CABO VERDE

DATA RECORD 8 | SWOT ID: 346

Project Title: Cabo Verde (Proyecto Aegina): Males and Female
Project Partners: Instituto Canario de Ciencias Marinas (ICCM), Gobierno de Canarias; Instituto Nacional de Desenvolvimento das Pescas (INDP); Direcção Geral do Ambiente; Ministerio de Ambiente, Agricultura e Pescas of the Republic of Cabo Verde
Metadata: 3 adult *Caretta caretta*.
Sources: (1) Cruz, N. 2018. Cabo Verde (Proyecto Aegina): Males and female. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/346) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Nuria Cruz

DATA RECORD 9 | SWOT ID: 1442

Project Title: Cabo Verde: LIFE *Caretta caretta*
Project Partners: LIFE *Caretta caretta*
Metadata: 4 adult *Caretta caretta*; tags deployed in 1999.
Sources: (1) Cruz, N. 2018. Cabo Verde. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1442) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Nuria Cruz

CANADA

DATA RECORD 10

Metadata: 11 *Caretta caretta*; tags deployed at sea.
Source: James, M., and Sea Turtle Unit, Fisheries and Oceans Canada. 2019. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
SWOT Contact: Mike James

CANARY ISLANDS

DATA RECORD 11 | SWOT ID: 496

Project Title: Canary Islands: OAG
Project Partners: Observatorio Ambiental Granadilla; Sociedad de Estudio de Cetáceos en el Archipiélago Canario (SECAC); Centro de Gestión de Biodiversidad (BIOGES), Departamento de Biología, Universidad de Las Palmas de Gran Canaria; Centro de Recuperación de Fauna Silvestre, Cabildo Insular de Gran Canaria (CRFS)
Metadata: 18 juvenile and 1 subadult *Caretta caretta*; tags deployed between 2008 and 2010.
Sources: (1) Machado, A. 2017. Canary Islands: OAG. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/496) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Antonio Machado

DATA RECORD 12 | SWOT ID: 347

Project Title: Islas Canarias (Proyecto Aegina): Juvenile Loggerheads
Project Partners: Instituto Canario de Ciencias Marinas (ICCM), Gobierno de Canarias; Instituto Nacional de Desenvolvimento das Pescas (INDP); Direcção Geral do Ambiente, Ministerio de Ambiente, Agricultura e Pescas of the Republic of Cabo Verde
Metadata: 11 juvenile *Caretta caretta*; tags deployed in 2006.
Sources: (1) Cruz, N. 2018. Islas Canarias (Proyecto Aegina): Juvenile loggerheads. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/347) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Nuria Cruz

DATA RECORD 13 | SWOT ID: 1444

Project Title: Canary Islands: LIFE *Caretta caretta*
Project Partners: LIFE *Caretta caretta*
Metadata: 10 juvenile *Caretta caretta*; tags deployed between 1998 and 2000.
Sources: (1) Cruz, N. 2018. Canary Islands. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1444) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Nuria Cruz

DATA RECORD 14 | SWOT ID: 1801

Project Title: Juvenile Loggerheads: Canary Islands Reintroduction Program—ADS Biodiversidad
Project Partners: Asociación para el Desarrollo Sostenible y Conservación de la Biodiversidad (ADS Biodiversidad), Centre of Cabildo de Fuerteventura (Morro Jable)
Metadata: 5 juvenile *Caretta caretta*; individuals are 7–8 years old and have been reared in captivity; tags deployed at Cofete Beach.
Sources: (1) Cruz, N. 2018. Juvenile loggerheads: Canary Islands reintroduction program. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1801) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Nuria Cruz

CAYMAN ISLANDS

DATA RECORD 15 | SWOT ID: 349

Project Title: Cayman Islands 2003: Loggerhead & Green Turtles
Project Partners: Marine Turtle Research Group, Cayman Islands Department of Environment
Metadata: 1 adult *Caretta caretta*; tag deployed July 2003.
Sources: (1) Blumenthal, J. 2018. Cayman Islands 2003: Loggerhead & Green Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/349) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Janice Blumenthal

DATA RECORD 16 | SWOT ID: 350

Project Title: Cayman Islands 2004: Loggerhead & Green Turtles
Project Partners: Marine Turtle Research Group, Cayman Islands Department of Environment
Metadata: 2 adult *Caretta caretta*; tags deployed in 2005 and 2006.
Sources: (1) Blumenthal, J. 2018. Cayman Islands 2004: Loggerhead & Green Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/350) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Janice Blumenthal

COLOMBIA

DATA RECORD 17 | SWOT ID: 1292

Project Title: Caribbean Colombian Sea Turtle Satellite Tracking
Project Partners: Sea Turtles and Mammal Conservation Program, UTADEO—Colombian Caribbean, Universidad Jorge Tadeo Lozano (UTADEO); Mundo Marino Aquarium, Museo del Mar Foundation
Metadata: 1 neonate, 1 juvenile, and 1 adult *Caretta caretta*; tags deployed in 2016, 2017, and 2018, respectively.
Sources: (1) Sea Turtles and Marine Mammal Conservation Program (ProCTMM). 2018. Caribbean Colombian Sea Turtle Satellite Tracking. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1292) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: ProCTMM

SPAIN

DATA RECORD 18 | SWOT ID: 1146

Project Title: Spain Tags Merged
Project Partners: Fisheries Bycatch Research Group, NOAA, Kai Submon, UNCW
Metadata: 1 adult, 5 juvenile, and 20 subadult *Caretta caretta*; tags deployed between 2008 and 2012.
Data Sources: (1) Swimmer, Y. 2017. Spain tags merged. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1146) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Yonat Swimmer

DATA RECORD 19 | SWOT ID: 1401

Project Title: Conservación y Preservación de Tortugas Marinas
Project Partners: Fundación para la Conservación y Recuperación de Animales Marinos (CRAM), Universitat Politècnica de València
Metadata: 3 juvenile and 3 adult *Caretta caretta*; tags deployed in Tarragona, Spain, in 2016; dataset includes an adult male loggerhead that traveled across the Atlantic to waters east of Florida, U.S.A.
Data Sources: (1) Fundación para la Conservación y Recuperación de Animales Marinos (CRAM). 2019. Conservación y preservación de tortugas marinas. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1401) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.

UNITED STATES OF AMERICA

DATA RECORD 20

Metadata: 3 *Caretta caretta*.
Source: Godfrey, M. 2018. Rehabilitated sea turtles from Topsail Island, North Carolina. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
SWOT Contact: Matthew Godfrey and Karen Beasley

DATA RECORD 21 | SWOT ID: 996

Project Title: North Carolina Rehabilitated Sea Turtle Monitoring Project
Project Partners: Karen Beasley Sea Turtle Rescue and Rehabilitation Center, North Carolina State University
Metadata: 2 subadult *Caretta caretta*; tags deployed in 2009 and 2013 on rehabilitated individuals.
Sources: (1) Coyne, M. 2017. North Carolina Rehabilitated Sea Turtle Monitoring Project. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/996) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Michael Coyne

DATA RECORD 22
Metadata: 17 juvenile *Caretta caretta*; tags deployed at sea.
Source: Mansfield, K. L., J. Wyneken., W. Porter, and J. Luo. 2014. First satellite tracks of neonate sea turtles redefine the "lost years" oceanic niche. *Proceedings of the Royal Society B* 281 (1781): 20133039.
SWOT Contact: Kate Mansfield

DATA RECORD 23
Project Partners: College of William and Mary, Virginia Institute of Marine Science
Metadata: 21 juvenile and 10 adult *Caretta caretta*.
Sources: (1) Mansfield, K. L., V. S. Saba, J. Keinath, and J. A. Musick. 2009. Satellite telemetry reveals a dichotomy in migration strategies among juvenile loggerhead sea turtles in the northwest Atlantic. *Marine Biology* 156: 2555–2570. **(2)** Mansfield, K. L. 2006. Sources of mortality, movements and behavior of sea turtles in Virginia. Dissertation. College of William and Mary, Marine Science School, Virginia Institute of Marine Science, Gloucester Point, VA.
SWOT Contact: Kate Mansfield

DATA RECORD 24
Metadata: 127 *Caretta caretta*; tags deployed on nesting females.
Source: Tucker, T., and K. Mazzarella. 2018. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
SWOT Contact: Tony Tucker

DATA RECORD 25 | SWOT ID: 410
Project Title: Virginia Aquarium Stranding Response Program
Project Partners: Virginia Aquarium Stranding Response Program, Virginia Aquarium & Marine Science Center, Seaturtle.org
Metadata: 17 juvenile, 3 subadult, and 1 adult *Caretta caretta*; tags deployed between 2007 and 2016 on stranded turtles.
Sources: (1) Lockhart, G. 2018. Virginia Aquarium Stranding Response Program. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/410) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contacts: Gwen Lockhart and Susan Barco

DATA RECORD 26 | SWOT ID: 978
Project Title: Virginia Aquarium Sea Turtle Research
Project Partner: Virginia Aquarium & Marine Science Center Foundation
Metadata: 1 adult, 7 subadult, and 2 unknown-life-stage *Caretta caretta*; tags deployed on wild-caught or by-caught individuals in 2013 and 2015.
Sources: (1) Barco, S. 2018. Virginia Aquarium Sea Turtle Research. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/978) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Susan Barco

DATA RECORD 27 | SWOT ID: 1018
Project Title: Virginia Aquarium and U.S. Navy Sea Turtle Research Project
Project Partners: Virginia Aquarium Research and Conservation Department; U.S. Fleet Forces Command, Naval Facilities Engineering Command (NAVFAC) Atlantic
Metadata: 1 adult, 4 juvenile, and 11 unknown-life-stage *Caretta caretta*; tags deployed between 2013 and 2015.
Sources: (1) Lockhart, G. 2018. Virginia Aquarium and U.S. Navy Sea Turtle Research Project. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1018) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Gwen Lockhart

DATA RECORD 28 | SWOT ID: 655
Project Title: North Carolina Long-Term Sea Turtle Monitoring Project
Project Partners: Seaturtle.org, the North Carolina Wildlife Resources Commission, Duke University Marine Laboratory
Metadata: 8 adult *Caretta caretta*; tags deployed in 2010, 2012, and 2013.
Sources: (1) Coyne, M. 2017. North Carolina Long-Term Sea Turtle Monitoring Project. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/655) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Michael Coyne

DATA RECORD 29 | SWOT ID: 1342
Project Title: Florida Loggerhead Migrations
Project Partners: National Marine Fisheries Service Office of Protected Resources
Metadata: 38 adult *Caretta caretta*; tags deployed between 1998 and 2000.
Sources: (1) Schroeder, B. 2018. Florida Loggerhead Migrations. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1342) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Barbara Schroeder

DATA RECORD 30 | SWOT ID: 1490
Project Title: Juvenile Loggerhead Use of the Gulf Stream off Cape Hatteras, NC
Project Partners: North Carolina Renewable Ocean Energy Program, Protected Resources Branch of the National Oceanic and Atmospheric Administration Beaufort Laboratory, University of North Carolina Coastal Studies Institute, North Carolina Aquariums at Pine Knoll Shores and Roanoke Island, University of Central Florida
Metadata: 3 juvenile *Caretta caretta*; headstarted turtles were originally collected from North Carolina nests. Tagged turtles released in Sargassum mats in the Gulf Stream off the coast of North Carolina in May 2017.
Sources: (1) Dubbs, L. 2017. Juvenile loggerhead use of the Gulf Stream off Cape Hatteras, NC. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1490) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Lindsey Dubbs

MEDITERRANEAN

We are grateful to all who generously contributed their sea turtle data for inclusion in the maps on pages 28–29. For information about how the maps were created, please see page 26. We are especially grateful to Lucy Omeyer for her assistance in researching and compiling data from published and unpublished sources.

GUIDELINES OF DATA USE AND CITATION

The data that follow correspond directly to the maps on pages 28–29. In the case of nesting data, every data record is numbered to correspond with its respective point on the map. To use these data for research or publication, you must obtain permission from the data providers.

NESTING DATA CITATIONS

DEFINITIONS OF TERMS

Clutches: A count of the number of nests of eggs laid by females during the monitoring period. **Nesting females:** A count of nesting female turtles observed during the monitoring period. **Crawl:** A female turtle's emergence onto the beach to nest. Such counts may or may not include false crawls. **Year:** The year in which a given nesting season ended (e.g., data collected between late 2015 and early 2016 would be listed as year 2016).

Nesting data are reported here from the most recent available nesting season or as averages for the years reported. Beaches for which count data are not available are listed as "unquantified." A reported count of "N/A" indicates that no data were reported for that species at the respective site. Additional metadata are available for many of the data records and may be found online at http://seamap.env.duke.edu/swot or by viewing the original data source (if published).

ALBANIA

DATA RECORD 1
Data Source: Piroli, V., and I. Haxhiu. 2018. Nesting of loggerhead turtle (*Caretta caretta*) confirmed in Southeast Adriatic. In Lazar, B., and M. Jancic (eds.), *Book of Abstracts: 6th Mediterranean Conference on Marine Turtles*. Croatian Natural History Museum, Zagreb, Croatia.
Nesting Beaches: Divjaka, Kepi i Rodonit
Year: 2016
Species and Counts: *Caretta caretta*—1 clutch at each beach

CYPRUS

DATA RECORD 2
Data Source: Andrews, E. 2014. *Cyprus Turtlewatch 2014 Final Report*. University of Glasgow.
Nesting Beaches: Akrotiri, Episkopi
Year: 2014
Species and Counts: *Chelonia mydas*—2 and 0 clutches, respectively; *Caretta caretta*—89 and 17 clutches, respectively

DATA RECORD 3
Data Source: Broderick, A. 2017. Loggerhead nesting in Cyprus. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
Nesting Beaches: (1) Alagadi, **(2)** Ayphilon, **(3)** Balalan, **(4)** Dipkarpaz South, **(5)** Dolphin, **(6)** Doune, **(7)** Esentepe, **(8)** Golden, **(9)** Greenfields 1, **(10)** Greenfields 2, **(11)** Guzelyali, **(12)** Kantara, **(13)** Kaplica, **(14)** Lost, **(15)** Melons 1, **(16)** Melons 2, **(17)** Message in a Bottle, **(18)** Military, **(19)** Monster, **(20)** Monster North, **(21)** One Goat, **(22)** Peach, **(23)** Ronnas, **(24)** Secret, **(25)** Smalls, **(26)** Tatlisu, **(27)** Thyme, **(28)** Two House, **(29)** West 1 and 2, **(30)** Wolf 1, **(31)** Wolf 2, **(32)** Tatlisu Belediya
Year: 2017
Species and Counts: *Caretta caretta*—**(1)** 42, **(2)** 1, **(3)** 0, **(4)** 1, **(5)** 5, **(6)** 0, **(7)** 0, **(8)** 8, **(9)** 0, **(10)** 0, **(11)** 36, **(12)** 5, **(13)** 8, **(14)** 3, **(15)** 0, **(16)** 1, **(17)** 8, **(18)** 0, **(19)** 37, **(20)** 26, **(21)** 1, **(22)** 7, **(23)** 6, **(24)** 32, **(25)** 6, **(26)** 20, **(27)** 4, **(28)** 0, **(29)** 46, and **(30–32)** 0 clutches; *Chelonia mydas*—**(1)** 221, **(2)** 74, **(3)** 0, **(4)** 36, **(5)** 32, **(6)** 12, **(7)** 1, **(8)** 42, **(9)** 0, **(10)** 0, **(11)** 0, **(12)** 1, **(13)** 2, **(14)** 31, **(15)** 15, **(16)** 20, **(17)** 42, **(18)** 0, **(19)** 14, **(20)** 8, **(21)** 5, **(22)** 9, **(23)** 283, **(24)** 4, **(25)** 0, **(26)** 2, **(27)** 15, **(28)** 1, **(29)** 43, **(30)** 15, **(31)** 17, and **(32)** 0 clutches

DATA RECORD 4
Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Demetropoulos, A., and M. Hadjichristophorou. 2010. Cyprus-Region B. In Casale, P., and D. Margaritoulis (eds.), *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*, pp. 53–64. IUCN, Gland, Switzerland.
Nesting Beaches: Chrysochou Bay, West Coast
Years: 2011–2015
Species and Counts: *Caretta caretta*—658 and 249 average clutches per year, respectively; *Chelonia mydas*—N/A and 108 average clutches per year, respectively

EGYPT

DATA RECORD 5
Data Source: Clarke, M., A. C. Campbell, C. Simms, and W. S. Hameid. 2002. Observations on the ecology of marine turtles nesting on the Mediterranean coast of Egypt. In Mosier, A., A. Foley, and B. Brost (compilers), *Proceedings of the Twentieth Annual Symposium on Sea Turtle Biology and Conservation*, pp. 257–258. NOAA Technical Memorandum NMFS-SEFSC-477, National Marine Fisheries Service, Miami, FL.
Nesting Beaches: Beaches between Rhafa and Port Said
Year: 1999
Species and Counts: *Caretta caretta*—27 clutches

FRANCE

DATA RECORD 9
Data Source: Sénégas, J.-B., S. Hochscheid, J.-M. Groul, B. Lagarrigue, and F. Bentivegna. 2009. Discovery of the northernmost loggerhead sea turtle (*Caretta caretta*) nest. *Marine Biodiversity Records* 2: 1–4.
Nesting Beach: St. Elme (St. Tropez)
Year: 2006
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Flegra Bentivegna

DATA RECORD 10
Data Source: Delaugerre, M., and C. Cesarini. 2004. Confirmed nesting of the loggerhead turtle in Corsica. *Marine Turtle Newsletter* 142: 17–18.
Nesting Beach: Palombaggia (Corsica)
Year: 2002
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Michel Delaugerre

GREECE

DATA RECORD 11
Data Source: Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267.
Nesting Beach: Southern Kyparissia Bay
Years: 2013–2015
Species and Counts: *Caretta caretta*—1,403 average clutches per year

DATA RECORD 12
Data Source: Casale, P., and D. Margaritoulis (eds.). 2010. *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*. IUCN, Gland, Switzerland.
Nesting Beaches: (1) Bay of Chania, **(2)** Bay of Messara, **(3)** Beaches adjacent to Kyparissia Town, **(4)** Koroni, **(5)** Kos Island, **(6)** Kotychi, **(7)** Lakonikos, **(8)** Lefkas Island
Year: 2010
Species and Counts: *Caretta caretta*—**(1–6)** 50–100, **(7)** >100, and **(8)** 50–100 average clutches per year

DATA RECORD 13
Data Source: Comis, C., and N. Vallianos. 2014. Loggerhead nesting in Kefalonia, Greece. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
Nesting Beaches: (1) Kalamia, **(2)** Agia Kyriaki, **(3)** Agios Georgios, **(4)** Agios Ioannis, **(5)** Ai Chelis,

(6) Ammes, **(7)** Avithos, **(8)** Cape St. George, **(9)** Eglina, **(10)** Kanali, **(11)** Kounopetra, **(12)** Kounoupas, **(13)** Lepeda, **(14)** Loggos, **(15)** Lourdas, **(16)** Makris Gialos, **(17)** Megali Ammos, **(18)** Megali Petra, **(19)** Megas Lakkos, **(20)** Minies, **(21)** Paliostafida, **(22)** Platis Gialos, **(23)** Sissia, **(24)** St. Nicholas, **(25)** Trapazaki, **(26)** Vatsa, **(27)** Xi
Years: (1) 2014 and **(2–27)** 2018
Species and Counts: (1) 0, **(2)** 2, **(3)** 0, **(4)** 0, **(5)** 0, **(6)** 10, **(7)** 18, **(8)** 7, **(9)** 1, **(10)** 11, **(11)** 8, **(12)** 4, **(13)** 12, **(14)** 6, **(15)** 14, **(16)** 1, **(17)** 9, **(18)** 13, **(19)** 18, **(20)** 5, **(21)** 0, **(22)** 0, **(23)** 13, **(24)** 0, **(25)** 3, **(26)** 17, and **(27)** 1 clutches
SWOT Contact: Chanel Comis

DATA RECORD 14

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Margaritoulis, D. 2000. An estimation of the overall nesting activity of the loggerhead turtle in Greece. In Abreu-Grobois, F. A., R. Briseño-Dueñas, R. Márquez, and L. Sarti (eds.), *Proceedings of the Eighteenth International Sea Turtle Symposium*, pp. 48–50. NOAA Technical Memorandum NMFSSEFSC-436, U.S. Dept. of Commerce.
Nesting Beach: Kerkyra Island
Year: 1990
Species and Counts: *Caretta caretta*—20 clutches

DATA RECORD 15

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Margaritoulis, D. 2005. Nesting activity and reproductive output of loggerhead sea turtles, *Caretta caretta*, over 19 seasons (1984–2002) at Laganas Bay, Zakynthos, Greece: The largest rookery in the Mediterranean. *Chelonian Conservation and Biology* 4(4): 916–929. **(3)** Margaritoulis, D., A. F. Rees, C. J. Dean, and T. Riggall. 2011. Reproductive data of loggerhead turtles in Laganas Bay, Zakynthos Island, Greece, 2003–2009. *Marine Turtle Newsletter* 131: 2–6.
Nesting Beach: Laganas Bay (Zakynthos)
Years: 2005–2009
Species and Counts: *Caretta caretta*—938 average clutches per year

DATA RECORD 16

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Margaritoulis, D., and A. Panagopoulou. 2010. Greece. In Casale, P., and D. Margaritoulis (eds.), *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*, pp. 85–112. IUCN, Gland, Switzerland.
Nesting Beaches: (1) Romanos, **(2)** Ipirus Coast, **(3)** Kythira Island, **(4)** Rhodes Island (SE), **(5)** Rhodes Island (SW), **(6)** SE Peloponnesus (Astro)
Years: (1, 4, 5) 1998–1999, **(2, 3, 6)** 1990
Species and Counts: *Caretta caretta*—**(1)** 25 average clutches per year, **(2)** 40 clutches, **(3)** 4 clutches, **(4)** 4 average clutches per year, **(5)** 11 average clutches per year, and **(6)** 16 clutches

DATA RECORD 17

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Margaritoulis, D., and A. Rees. 2001. The Loggerhead Turtle, *Caretta caretta*, population nesting in Kyparissia Bay, Peloponnesus, Greece: Results of beach surveys over seventeen seasons and determination of the core nesting habitat. *Zoology in the Middle East* 24: 75–90.
Nesting Beach: Northern Kyparissia Bay
Years: 1985–1989
Species and Counts: *Caretta caretta*—102 average clutches per year

DATA RECORD 18

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Margaritoulis, D., R. Argano, I. Baran, F. Bentivegna, M. N. Bradai, J. A. Camiñas, P. Casale, G. De Metrio, A. Demetropoulos, G. Gerosa, B. J. Godley, D. A. Haddoud, J. Houghton, L. Laurent, and B. Lazar. 2003. Loggerhead turtles in the Mediterranean Sea: Present knowledge and conservation perspectives. In Bolten, A., and B. Witherington (eds.), *Loggerhead Sea Turtles*, pp. 175–198. Smithsonian Institution Press, Washington, DC.
Nesting Beach: Kefalonia (Mounda)
Years: 1993–1998
Species and Counts: *Caretta caretta*—29 average clutches per year

DATA RECORD 19

Data Sources: (1) Margaritoulis, D., A. F. Rees, and ARCHELON. 2007. Loggerhead nesting in Greece. In *SWOT Report—The State of the World's Sea Turtles*, vol. II (2007). **(2)** Margaritoulis, D., A. F. Rees, and K. Grimanis. 2005. Monitoring work and conservation efforts for the loggerhead sea turtle nesting population in Laganas Bay, Zakynthos Island, Greece, during 2005. Unpublished report. ARCHELON, the Sea Turtle Protection Society of Greece, Athens.
Nesting Beach: Rethymnon
Years: *Caretta caretta*—2005; *Chelonia mydas*—2007
Species and Counts: *Caretta caretta*—166 clutches; *Chelonia mydas*—1 clutch
SWOT Contact: Dimitris Margaritoulis

ISRAEL

DATA RECORD 20

Data Source: Levi, Y. 2019. Personal communication. In Hochscheid, S., Y. Kaska, and A. Panagopoulou (eds.), *Sea Turtles in the Mediterranean Region*. MTSG Regional Report 2018.
Nesting Beaches: Carmel, Hasharon, Pleshet, Southern Coastal Plains, West Galil
Years: 2010–2017
Species and Counts: *Caretta caretta*—33, 34, 15, 23, and 15 average clutches per year, respectively; *Chelonia mydas*—2, 7, 2, 7, and <1 average clutches per year, respectively.

DATA RECORDS 21

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Casale, P., G. Palilla, A. Salemi, A. Napoli, M. Prinzi, L. Genco, D. Bonaviri, A. Mastrogiacomo, M. Oliverio, and M. Lo Valvo. 2012. Exceptional sea turtle nest records in 2011 suggest an underestimated nesting potential in Sicily (Italy). *Acta Herpetologica* 7: 181–188. **(3)** ARCHELON. 2013. Ancora Giallonardo! Ecco il primo nido del 2012. ARCHELON blog, February 7, 2013. **(4)** Rini, G. 2012. Tartarughe marine, schiusa in Sicilia ripresa dal WWF. Ecoo. September 22, 2012. **(5)** WWF Italia. 2012. In Cicilia il primo nido di tartaruga marina segnalato grazie alla campagna 'Segui le Tracce' del WWF. WWF Italia, July 5, 2012.
Nesting Beach: Giallonardo
Year: 2012
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 22

Data Source: Bentivegna, F., M. B. Rasotto, A. De Lucia, E. Secci, M. Masaro, S. Panzera, C. Caputo, P. Carlino, G. Treglia, and S. Hochscheid. 2010. Loggerhead turtle (*Caretta caretta*) nests at high latitudes in Italy: A call for vigilance in the Western Mediterranean. *Chelonian Conservation and Biology* 9 (2): 283–289.
Nesting Beach: Cetraro Marina
Year: 2008
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 23

Data Source: Campese, C. 2012. Playa, tartaruga marina depone 45 uova. Volontari: "Non succedeva da 35 anni." *CTZen*, August 11, 2012.
Nesting Beach: Lido Le Palme
Year: 2012
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 24

Data Sources: (1) Caputo, C. 2011. Diario di una nascita, anzi ottantasei. *Naturalia* 25: 10–14. **(2)** Management Consortium of Torre Guaceto. 2011. Comunicato stampa: Un nido di *Caretta caretta* nell'Area Marina Protetta Porto Cesareo. Area Marina Protetta Riserva Naturale dello Stato: Torre Guaceto.
Nesting Beach: Torre Lapillo
Year: 2011
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 25

Data Source: Caputo, C. 2012. Il nido di Palmitello (TA). *Naturalia* 30: 4–5.
Nesting Beach: Palmitello
Year: 2011
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 26

Data Source: Caputo, C. 2012. Salento terra di tartarughe Fiocchi rosa e azzurri sulla spiaggia di Torre Specchia! *Naturalia* 29: 4.
Nesting Beach: Torre S. Andrea
Year: 2012
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 27

Data Source: Casale, P. 2012. Loggerhead nesting at Costa Rei, Camping Capo Ferrato. Personal communication via Antonio T. Mingozzi.
Nesting Beach: Costa Rei (Capo Ferrato)
Year: 2011
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 28

Data Source: Comunicalo. 2012. Le tartarughe Caretta 'scoprono' Eraclea Minoa, nido ricco di uova recintato dal WWF. Comuicalo.it, July 25, 2012.
Nesting Beach: Capo Bianco
Year: 2012
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 29

Data Source: Curella, L. 2011. Una "*Caretta caretta*" nelle spiagge di marina di Ragusa. Ragusaoggi.
Nesting Beach: Marina di Ragusa (Piazza Torre)
Year: 2011
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 30

Data Source: De Lucia, A. 2010. Personal communication via www.sardegnaambiente.it.
Nesting Beach: Funtanazza
Year: 2009
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 31

Data Source: Editorial Staff. 2011. A Sciacca si schiudono uova di *Caretta caretta*. *Sciacca Today*, September 1, 2011.
Nesting Beach: Capo San Marco (Lido Cocoloco)
Year: 2011
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 32

Data Sources: (1) Editorial staff. 2012. Lampedusa, la tartaruga marina *Caretta caretta* è tornata a deporre le uova. BlogSicilia. **(2)** Editors. 2012. Isola dei Conigli, la *Caretta caretta* torna a nidificare sulle spiagge di Lampedusa. *AgrigentoNotizie*.
Nesting Beach: Conigli Beach
Year: 2012
Species and Counts: *Caretta caretta*—2 clutches
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 33

Data Source: Maffucci, F., R. Corrado, L. Palatella, M. Borra, S. Marullo, S. Hochscheid, G. Lacorata, and D. Iudicone. 2016. Seasonal heterogeneity of ocean warming: A mortality sink for ectotherm colonizers. *Scientific Reports* 6: 23983.
Nesting Beach: Baia Domitia
Year: 2002
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Flegra Bentivegna

DATA RECORD 34

Data Source: Bentivegna, F., M. B. Rasotto, G. A. De Lucia, E. Secci, G. Massaro, S. Panzera, C. Caputo, P. Carlino, G. Treglia, and S. Hochscheid. 2010. Loggerhead turtle (*Caretta caretta*) nests at high latitudes in Italy: A call for vigilance in the western Mediterranean. *Chelonian Conservation and Biology* 9 (2): 283–289.
Nesting Beaches: Geremeas (Cala Serena), Lucrino, Torre dell'Orso
Years: 2006, 2008, and 2006, respectively
Species and Counts: *Caretta caretta*—1 clutch at each beach
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 35

Data Source: Insacco, G., A. Barlotta, F. Bentivegna, D. Scaravelli, F. Spadola, and S. Hochscheid. 2011. Sicily 2010 nest season: Bad weather and good news. In Bentivegna, F., F. Maffucci, and V. Mauriello (compilers), *Book of Abstracts: 4th Mediterranean Conference on Sea Turtles*, p. 78. Naples, Italy.
Nesting Beaches: (1) Cicerata, **(2)** Finale Torre Conche, **(3)** Marina di Noto, **(4)** Marzamemi
Year: 2010
Species and Counts: *Caretta caretta*—**(1)** 1, **(2)** 1, **(3)** 1, and **(4)** 2 clutches
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 36

Data Source: Libero Quotidiano. 2012. Animali: uova di tartaruga tra ombrelloni, squadre "salva-nidi" in Salento. Libero Quotidiano, July 11, 2012.
Nesting Beach: Marina di Salve
Year: 2012
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 37

Data Source: Marzano, G., S. Nanarelli, and C. Scarafino. 2010. Documentata nidificazione di *Caretta caretta* lungo il litorale leccese (Puglia). In *Atti VIII Congresso nazionale Societas Herpetologica Italica*, pp. 559–562. Ianieri Edizioni, Pescara, Italy.
Nesting Beach: San Foca
Year: 2007
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 38

Data Source: Mazara Online. 2012. Tartaruga marine *Caretta caretta* nidifica sulla spiaggia di Tonnarella a Mazara. Mazara Online, August 3, 2012.
Nesting Beach: Banna Tonnarella
Year: 2012
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 39

Data Source: Micò, A. 2012. *Caretta caretta* nesting at Campomarino Beach. Personal communication, via Antonio T. Mingozzi.
Nesting Beach: Campomarino
Year: 2011
Species and Counts: *Caretta caretta*—1 clutch
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 40

Data Sources: (1) Mingozzi, T., G. Masciari, G. Paolillo, B. Pisani, M. Russo, and A. Massolo. 2007. Discovery of a regular nesting area of loggerhead turtle *Caretta caretta* in southern Italy: A new perspective for national conservation. *Biodiversity and Conservation* 16: 3519–3541. **(2)** Bentivegna, F., M. B. Rasotto, G. A. De Lucia, E. Secci, G. Massaro, S. Panzera, C. Caputo, P. Carlino, G. Treglia, and S. Hochscheid. 2010. Loggerhead turtle (*Caretta caretta*) nests at high latitudes in Italy: A call for vigilance in the western Mediterranean. *Chelonian Conservation and Biology* 9 (2): 283–289. (3) Maffucci, F., R. Corrado, L. Palatella, M. Borra, S. Marullo, S. Hochscheid, G. Lacorata, and D. Ludicone. 2016. Seasonal heterogeneity of ocean warming: A mortality sink for ectotherm colonizers. *Scientific Reports* 6.
Nesting Beach: Pelagian Archipelago
Year: 2008
Species and Counts: *Caretta caretta*—4 clutches

DATA RECORD 41

Data Source: Mingozzi, T., and TartaCare Project. 2019. Loggerhead nesting in Italy. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
Nesting Beaches: (1) Riace Marina, **(2)** Siderno, **(3)** Sant'Ilario dello Ionio, **(4)** Strait of Messina, **(5)** Siculiana Marina, **(6)** Pozzolana di Ponente, **(7)** Cassano Ionio, **(8)** Isola di Capo Rizzuto, **(9)** San Sostene, **(10)** Cirò Marina, **(11)** Crotone, **(12)** Costa degli Aranci, **(13)** Cariati Marina, **(14)** Chiaro, **(15)** Rovello, **(16)** Santa Caterina Ionio, **(17)** Costa dei Gelsomini
Years: (1) 2005, **(2)** 2006, **(3–4)** 2007, **(5–9)** 2008, **(10–11)** 2009, **(12)** 2010, and **(13–17)** 2012
Species and Counts: *Caretta caretta*—**(1)** 1, **(2)** 1, **(3)** 1, **(4)** 3, **(5)** 1, **(6)** 3, **(7)** 1, **(8)** 1, **(9)** 1, **(10)** 1, **(11)** 1, **(12)** 1, **(13)** 1, **(14)** 1, **(15)** 1, **(16)** 3, and **(17)** 13 clutches
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 42

Data Source: Casale, P., G. Palilla, A. Salemi, A. Napoli, M. Prinzi, L. Genco, D. Bonaviri, A. Mastrogiacomo, M. Oliverio, and M. Lo Valvo. 2012. Exceptional sea turtle nest records in 2011 suggest an underestimated nesting potential in Sicily (Italy). *Acta Herpetologica* 7 (1): 181–188.
Nesting Beaches: Acqua dei Corsari (Palermo), Porto Palo di Menfi, Punta Grande
Year: 2011
Species and Counts: *Caretta caretta*—1 clutch at each beach
SWOT Contact: Antonio T. Mingozzi

DATA RECORD 43

Data Source: Hochscheid, S., and Stazione

Zoologica Anton Dohrn Marine Turtle Research Center. 2019. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
Nesting Beaches: (1) Ogliastro Marina, **(2)** Battipaglia, **(3)** Capaccio, **(4)** Caprioli, **(5)** Castelvolturno, **(6)** Marina di Camerota, **(7)** Acciaroli, **(8)** Pisciotta, **(9)** Eboli, **(10)** San Mauro del Cilento, **(11)** Ascea Marina, **(12)** Montecorice, **(13)** Palinuro, **(14)** Torre Annunziata
Years: (1) 2012, **(2)** 2013, **(3)** 2014, **(4–8)** 2016, **(9–10)** 2017, **(11–14)** 2018
Species and Counts: *Caretta caretta*—**(1)** 1, **(2)** 1, **(3)** 1, **(4)** 1, **(5)** 1, **(6)** 3, **(7)** 1, **(8)** 1, **(9)** 1, **(10)** 1, **(11)** 3, **(12)** 1, **(13)** 3, **(14)** 1 clutches
SWOT Contact: Sandra Hochscheid

DATA RECORD 44

Data Source: (1) World Wildlife Fund Sicily. 2006. Riserva Naturale Orientata, Torre Salsa. **(2)** World Wildlife Fund Italia. 2009. WWF Italia news.
Nesting Beaches: Lido di Fiori, Lido Forgia
Years: 2006 and 2007, respectively.
Species and Counts: *Caretta caretta*—1 clutch at each beach
SWOT Contact: Antonio T. Mingozzi

LEBANON

DATA RECORD 45

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Aureggi, M., C. Rizk, and L. Venizelos. 2005. Survey on sea turtle nesting activity South Lebanon, 2004. Joint report of MEDASSET and MedWetCoast. **(3)** Khalil, M., H. Syed, M. Aureggi. 2009. Impact of war on the south Lebanon sea turtle nesting population. *Testudo* 7.
Nesting Beaches: El Mansouri, Aabbasieh Gnejna
Years: 2002–2004
Species and Counts: *Chelonia mydas*—9 average clutches per year

DATA RECORD 46

Data Source: Cross, H., C. Rizk, M. Khalil, and L. Venizelos. 2005. *Marine Turtle Conservation in the Mediterranean: Population Status and Conservation Activities on Sea Turtle Nesting Beaches in South Lebanon, 2005*. Mediterranean Association to Save the Sea Turtles (MEDASSET).
Nesting Beach: Tyre Coast Nature Reserve
Year: 2005
Species and Counts: *Caretta caretta*—10 clutches
SWOT Contacts: Lily Venizelos, MEDASSET, Monica Aureggi, and Mona Khalil

DATA RECORD 47

Data Source: Khalil, M., H. Syed, and M. Aureggi. 2009. Impact of war on the south Lebanon sea turtle nesting population. *Testudo* 7
Nesting Beach: El Mansouri and El Koliala
Year: 2007
Species and Counts: *Caretta caretta*—41 clutches; *Chelonia mydas*—5 clutches
SWOT Contact: Mona Khalil

LIBYA

DATA RECORD 48

Data Source: Casale, P., and D. Margaritoulis (eds.). 2010. *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*. IUCN, Gland, Switzerland.
Nesting Beaches: Al Metefla, Al-Arbaeen
Year: 2007
Species and Counts: *Caretta caretta*—104 clutches and 84 clutches, respectively

DATA RECORD 49

Data Source: Hamza, A. 2010. Libya. In Casale, P., and D. Margaritoulis (eds.), *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*, pp. 157–170. IUCN, Gland, Switzerland.
Nesting Beaches: Ain Al Ghazala, Al Ghbeba, Al Thalateen, Ogla Misrata
Year: 2007
Species and Counts: *Caretta caretta*—36, 147, 80, and 2 clutches, respectively
SWOT Contact: Lily Venizelos

DATA RECORD 50

Data Source: Hamza, A., and H. Elghmati. 2005. *Conservation of Marine Turtles Nesting at Three Sites West of Sirte, Libya*. Environment General Authority (EGA), Marine Biology Research Center (MBRC), and Regional Activity Centre for Specially Protected Areas (RAC/SPA), United Nations Environment Programme Mediterranean Action Plan (UNEP/MAP).
Nesting Beach: Forteith
Year: 2005
Species and Counts: *Caretta caretta*—41 clutches
SWOT Contact: Abdulmaula Hamza, EGA Libya

DATA RECORD 51

Data Source: Hamza, A., B. Swayeb, R. Elhalloub, S. Beki, A. Alimal, and A. Saied. 2008. Loggerhead marine turtle *Caretta caretta* nesting activity and conservation in North West Gulf of Sirte. In *Book of Abstracts: 3rd Mediterranean Conference on Marine Turtles*, p. 24. Yasmine Hammamet, Tunisia.
Nesting Beach: Between Misratah and Bowerat Lahsoun
Year: 2007
Species and Counts: *Caretta caretta*—249 clutches
SWOT Contact: Lily Venizelos, MEDASSET

DATA RECORD 52

Data Source: Hamza, A., K. Mohamed, S. Abdulkarim, I. Abdallah, M. Hamad, and E. Bourass. 2008. Loggerhead nesting activity at Ain Al Ghazala and Boulfraies beaches in 2007, NE Libya. In *Book of Abstracts: 3rd Mediterranean Conference on Marine Turtles*, p. 30. Yasmine Hammamet, Tunisia.
Nesting Beach: Boulfraies
Year: 2007
Species and Counts: *Caretta caretta*—4 clutches
SWOT Contact: Lily Venizelos, MEDASSET

MALTA

DATA RECORD 53

Data Source: Mifsud, C. 2018. Is it really another exceptional sea turtle nesting record following the 2012 and 2016 nesting cases in Malta? In Lazar, B., and M. Jancic (eds.), *Book of Abstracts: 6th Mediterranean Conference on Marine Turtles*. Croatian Natural History Museum, Zagreb, Croatia.
Nesting Beaches: Ghajn Tuffieha, Gnejna
Year: 2016
Species and Counts: *Caretta caretta*—1 and 1 clutch, respectively
SWOT Contact: Carmen Mifsud

SPAIN

DATA RECORD 6

Data Source: Carreras, C., M. Pascual, J. Tomás, A. Marco, S. Hochscheid, J. J. Castillo, P. Gozalbes, M. Parga, S. Piovano, and L. Cardona. 2018. Sporadic nesting reveals long distance colonisation in the philopatric loggerhead sea turtle (*Caretta caretta*). *Scientific Reports* 8: 1435.
Nesting Beaches: Alicante, San Juan de los Terreros (Pulpi), Malgrat de Mar, Tarragona, Torrevieja (Alicante)
Year: 2017
Species and Counts: *Caretta caretta*—1, 1, 1, 2, and 1 clutches, respectively

DATA RECORD 7

Data Sources: Tomás, J., J. L. Mons, J. J. Martin, J. J. Bellido, and J. J. Castillo. 2002. Study of the first reported nest of loggerhead sea turtle, *Caretta caretta*, in the Spanish Mediterranean coast. *Journal of the Marine Biological Association of the United Kingdom* 82: 1005–1007.
Nesting Beach: Vera
Year: 2001
Species and Counts: *Caretta caretta*—1 clutch

DATA RECORD 8

Data Source: Tomás, J., M. Gael, C. Álvarez, P. Gozalbes, D. Perdiguero, J. A. Raga, and F. Alegre. 2008. Is the Spanish coast within the regular nesting range of the Mediterranean loggerhead sea turtle (*Caretta caretta*)? *Journal of the Marine Biological Association of the United Kingdom* 88 (7): 1509–1512.
Nesting Beach: Premia de Mar (Puzol)
Year: 2006
Species and Counts: *Caretta caretta*—1 clutch

SYRIA

DATA RECORD 54

Data Sources: (1) Casale, P., and D. Margaritoulis (eds.). 2010. *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*. IUCN, Gland, Switzerland. **(2)** Rees, A. F., A. Saad, and M. Jony. 2005. Tagging green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) in Syria. *Testudo* 6 (2): 51–55. **(3)** Rees, A. F., A. Saad, and M. Jony. 2008. Discovery of a regionally significant *Chelonia mydas* rookery in Syria. *Oryx* 42 (3): 456–459.
Nesting Beach: Latakia
Year: 2010
Species and Counts: *Chelonia mydas*—>100 average clutches per year
SWOT Contact: Mohammad Jony, Ibn Hani Marine Protected Area

DATA RECORD 55

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Rees, A. F., A. Saad, and M. Jony. 2010. Syria. In Casale, P., and D. Margaritoulis (eds.), *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*, pp. 233–243. IUCN, Gland, Switzerland.
Nesting Beaches: Area of Banias, Latakia, Ras el Basit, Tartous (and south), Um Toyour, Wadi Kandil
Years: 2004–2009
Species and Counts: *Caretta caretta*—2, 11, 1, 1, 0, and 2 clutches, respectively; *Chelonia mydas*—9, N/A, 4, 0, 3, and 7 clutches, respectively.

TUNISIA

DATA RECORD 56

Data Sources: (1) Ben Hassine, S., I. Jribi, M. N. Bradai, A. Bouain, and M. Girondot. 2011. The origin in variability of nesting period of the loggerhead turtle (*Caretta caretta*) in the Kuriat Islands, Tunisia. *Marine Turtle Newsletter* 131: 48–50. **(2)** Jribi, I., M. N. Bradai, and A. Bouain. 2002a. Marine turtles nesting in Kuriat islands (Tunisia) in 2000. *Marine Turtle Newsletter* 96: 4–6. **(3)** Jribi, I., M. N. Bradai, and A. Bouain. 2002b. The loggerhead turtle nesting activity in Kuriat islands (Tunisia) in 2001. *Bulletin de la Société Herpétologique de France* 102: 43–47. **(4)** Jribi, I., M. N. Bradai, and A. Bouain. 2002c. Caractéristiques biométriques et méristiques des tortues marines en Tunisie. *Bulletin de la Société Herpétologique de France* 101: 47–52. **(5)** Jribi, I., M. N. Bradai, and A. Bouain. 2006. The loggerhead turtle nesting activity in Kuriat islands (Tunisia): Assessment of nine years monitoring. *Marine Turtle Newsletter* 112: 12–13.
Nesting Beaches: Great Kuriat, Small Kuriat
Years: 2011
Species and Counts: *Caretta caretta*—16 and 8 average clutches per year, respectively

DATA RECORD 57

Data Source: Jribi, I. 2017. Loggerhead turtle *Caretta caretta* nesting activity in Chebba (Centre Tunisia): Assessment, problems and recommendations. *Indian Journal of Geo-marine Sciences* 46 (1): 163–169.
Nesting Beaches: Chebba-Sidi Messaoud
Years: 2013–2016
Species and Counts: *Caretta caretta*—4 average clutches per year

DATA RECORD 58

Data Source: Jribi, I., M. N. Bradai, and A. Bouain. 2006. Loggerhead turtle nesting activity in Kuriat Islands, Tunisia: Assessment of nine years monitoring. *Marine Turtle Newsletter* 112: 12–13.
Nesting Beach: Kuria Kbira, Kuria Sgira
Year: 2007
Species and Counts: *Caretta caretta*—11 clutches
SWOT Contact: Lily Venizelos

TURKEY

DATA RECORD 59

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Olgun, K., E. Bozkurt, S. Ceylan, M. Tural, S. Özcan, K. Ş. Karasüleymanoğlu, and Y. Geroğlu. 2016. Nesting activity of sea turtles, *Caretta caretta* (Linnaeus, 1758) and *Chelonia mydas* (Linnaeus, 1758) (Reptilia, Cheloniidae), at Patara beach (Antalya, Turkey) over four nesting seasons. *Turkish Journal of Zoology* 40: 215–222.
Nesting Beach: Patara Beach
Years: 2010 and 2012–2014
Species and Counts: *Caretta caretta*—180 average clutches per year

DATA RECORD 60

Data Source: Casale, P., and D. Margaritoulis (eds.). 2010. *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*. IUCN, Gland, Switzerland.
Nesting Beaches: Gazipasa, Tuzla
Years: 1994–1996 and 2006, respectively
Species and Counts: *Caretta caretta*—14 and N/A clutches, respectively; *Chelonia mydas*—N/A and 9 clutches, respectively

DATA RECORD 61

Data Source: Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267.
Nesting Beach: Akyatan
Years: 2007–2011
Species and Counts: *Chelonia mydas*—322 average clutches per year

DATA RECORD 62

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Aymak, C., S. Ergene-Gözükara, and Y. Kaska. 2009. Reproductive ecology of *Caretta caretta* and *Chelonia mydas* during 2002 and 2003 nesting seasons in Alata, Mersin, Turkey. In Demetropoulos, A., and O. Türkozan (eds.), *Proceedings of the Second Mediterranean Conference on Marine Turtles*, p. 44. **(3)** Ergene, S., C. Aymak, and A. H. Uçar. 2006. Nesting activity of the marine turtle (*Chelonia mydas* and *Caretta caretta*) during 2005 in Alata, Mersin-Turkey. In Frick, M., A. Panagopoulou, A. F. Rees, and K. Williams (eds.), *26th Annual Symposium on Sea Turtle Biology and Conservation*, p. 293, Athens.
Nesting Beach: Alata
Years: 2002–2003 and 2005–2006
Species and Counts: *Caretta caretta*—25 average clutches per year

DATA RECORD 63

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Başkale, E., Y. Katılmış, M. Azmaz, D. Sözbilen, F. Polat, M. Lambropoulos, C. Fellhofer-Mıhcıoğlu, M. Stachowitsch, and Y. Kaska. 2016. Monitoring and conservation of loggerhead turtle's nests on Fethiye beaches, Turkey. *Biharean Biologist* 10: 20–23.
Nesting Beach: Fethiye
Years: 2011–2013
Species and Counts: *Caretta caretta*—84 average clutches per year

DATA RECORD 64

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267.
Nesting Beach: Goksu Delta
Years: 2004–2008
Species and Counts: *Caretta caretta*—124 average clutches per year

DATA RECORD 65

Data Source: Canbolat, A. F., BTC Crude Oil Pipeline Project. 2005. Turkey Environmental Department Sea Turtle Expedition Project (STEP). In *SWOT Report—State of the World's Sea Turtles*, vol. II (2007).
Nesting Beach: Yumurtalık-Sugözü
Year: 2005
Species and Counts: *Caretta caretta*—7 clutches
SWOT Contact: Ali Fuat Canbolat, Hacettepe University

DATA RECORD 66

Data Source: Casale, P., and D. Margaritoulis (eds.). 2010. *Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities*. IUCN, Gland, Switzerland.
Nesting Beaches: Anamur, Belek, Demirtas, Finike-Kumluca, Kale, Kazanli
Year: 2010
Species and Counts: *Caretta caretta*—>100, >100, 50–100, >100, 50–100, and N/A average clutches per year, respectively; *Chelonia mydas*—>100 average clutches per year at Kazanli

DATA RECORD 67

Data Source: Casale, P., G. Abbate, D. Freggi, N. Conte, M. Oliverio, and R. Argano. 2008. Foraging ecology of loggerhead sea turtles *Caretta caretta* in the central Mediterranean Sea: Evidence for a relaxed life history model. *Marine Ecology Progress Series* 372: 265–276.
Nesting Beach: Sugozu
Year: 2008
Species and Counts: *Chelonia mydas*—213 clutches

DATA RECORD 68

Data Sources: (1) Kaska, Y., E. Başkale, and Ç. Fak. 2008. Monitoring and conservation project of the soft shelled Nile turtle (*Trionyx triunguis*) and sea turtle (*Caretta caretta*, *Chelonia mydas*) population during the 2011 nesting season on Dalyan-Iztuzu Beach, Köyceğiz-Dalyan Special Environmental Protection Area. Turkish Ministry of Environment and Forestry, Environmental Protection Agency for

Special Areas, Ankara, Turkey. **(2)** Kaska, Y., E. Başkale, and Ç. Fak. Unpublished project report.
Nesting Beaches: Dalaman and Dalyan
Year: 2011
Species and Counts: *Caretta caretta*—56 and 341 clutches, respectively.
SWOT Contact: Yakup Kaska

DATA RECORD 69

Data Source: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Oruç, A., O. Türkozan, and S. Yerli. 2007. Conservation, research and monitoring of the Nile soft shell turtle (*Trionyx triunguis*) and marine turtle (*Caretta caretta*) populations at Çıralı, Maden Bay, Beycik Cove, Boncuk Cove, Small Boncuk Bay and Tekirova Cove beaches. WWF, ÇOB, 24.
Nesting Beach: Çıralı
Years: 1994–2006 and 2010
Species and Counts: *Caretta caretta*—86 average clutches per year

DATA RECORD 70

Data Source: Ergene, S., M. Ergene, A. H. Uçar, C. Aymak, and Y. Kaçar. 2016. Identification of a new nesting beach in Mersin, Turkey: Nesting activity of green and loggerhead sea turtles over 6 nesting seasons (2009–2014) at Davultepe Beach. *Marine Turtle Newsletter* 149: 6–9.
Nesting Beach: Davultepe
Years: *Caretta caretta*—2010–2014; *Chelonia mydas*—2010–2014
Species and Counts: *Caretta caretta*—5 average clutches per year; *Chelonia mydas*—113 average clutches per year

DATA RECORD 71

Data Sources: (1) Casale, P., A. Broderick, J. A. Camiñas, L. Cardona, C. Carreras, A. Demetropoulos, W. J. Fuller, B. J. Godley, S. Hochscheid, Y. Kaska, B. Lazar, D. Margaritoulis, A. Panagopoulou, A. F. Rees, J. Tomás, and O. Türkozan. 2018. Mediterranean sea turtles: Current knowledge and priorities for conservation and research. *Endangered Species Research* 36: 229–267. **(2)** Türkozan, O. 2000. Reproductive ecology of the loggerhead turtle, *Caretta caretta*, on Fethiye and Kızılot beaches, Turkey. *Chelonian Conservation Biology* 3: 686–692.
Nesting Beach: Kızılot
Years: 1994–1998
Species and Counts: *Caretta caretta*—138 average clutches per year

DATA RECORD 72

Data Sources: (1) Yalçın-Özdilek, Ş., and B. Sönmez. 2010. The nesting characteristics of sea turtles on the Samandağ Beach, Turkey. In Blumenthal, J., A. Panagopoulou, and A. F. Rees (compilers), *Proceedings of the 30th Annual Symposium on Sea Turtle Biology and Conservation*, p. 148. **(2)** Yalçın-Özdilek, Ş., and B. Sönmez. 2011. Nesting characteristics at Samandağ and extended beaches, Turkey. *Marine Turtle Newsletter* 131: 7–9. **(3)** Casale, P., and D. Margaritoulis (eds.). 2010. Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN, Gland, Switzerland.
Nesting Beach: Samandag
Years: *Caretta caretta*—2005; *Chelonia mydas*—2010
Species and Counts: *Caretta caretta*—15 clutches; *Chelonia mydas*—>100 average clutches per year
SWOT Contacts: Şükran Yalçın-Özdilek, Çanakkale Onsekiz Mart University, and Bektaş Sönmez

TELEMETRY DATA CITATIONS

The following records refer to satellite telemetry datasets from tags that were deployed on sea turtles in the Mediterranean Sea, which were combined to create the maps on pages 28–29. These data were generously contributed to SWOT by the people and partners listed subsequently. Records that have a SWOT ID can be viewed in detail in the SWOT online database and mapping application at http://seamap.env.duke.edu/swot, which contains additional information about the projects and their methodologies.

To save space, we have used the following abbreviations in the data source fields below: (1) "STAT" refers to Coyne, M. S., and B. J. Godley. 2005. Satellite Tracking and Analysis Tool (STAT): An integrated system for archiving, analyzing and mapping animal tracking data. *Marine Ecology Progress Series* 301: 1–7; (2) "SWOT Online Database" refers to Kot, C. Y., E. Fujioka, A. DiMatteo, B. P. Wallace, B. J. Hutchinson, J. Cleary, P. N. Halpin, and R. B. Mast. 2015. The State of the World's Sea Turtles Online Database: Data provided by the SWOT Team and hosted on OBIS-SEAMAP. Oceanic Society, IUCN Marine Turtle Specialist Group, and Marine Geospatial Ecology Lab, Duke University. http://seamap.env.duke.edu/swot; and (3) "OBIS-SEAMAP" refers to Halpin, P. N., A. J. Read, E. Fujioka, B. D. Best, B. Donnelly, L. J. Hazen, C. Kot, K. Urian, E. LaBrecque, A. DiMatteo, J. Cleary, C. Good, L. B. Crowder, and K. D. Hyrenbach. 2009. OBIS-SEAMAP: The world data center for marine mammal, sea bird, and sea turtle distributions. *Oceanography* 22 (2): 104–115. When listed, these sources indicate that the dataset was contributed online through STAT, SWOT, or OBIS-SEAMAP.

DATA RECORD 1 | SWOT ID: 982

Project Title: ADRIA-Watch Project
Project Partners: Islameta Group; Department of Biology, University of Pisa and ADRIA-Watch
Metadata: 5 juvenile, 1 adult, and 1 subadult *Caretta caretta*; tags deployed between 2006 and 2008 at sites throughout the northern Adriatic Sea.
Data Sources: (1) Riccione, M. 2018. ADRIA-Watch project. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/982) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Marco Riccione

DATA RECORD 2 | SWOT ID: 1383

Project Title: Andalusia, Spain. Small loggerheads from a nest at Pulpí (Almería)
Project Partners: Doñana Biological Station, Consejo Superior Investigaciones Cientificas (CSIC); Universitat Politècnica de València; Unidad de Zoología Marina; Universidad de Valencia; Asociación Española de Herpetología; Environmental Office of Andalusia; Aquarium of Sevilla; NGO Equinac; Fundación Hombre y Territorio
Metadata: 9 juvenile *Caretta caretta*; tags deployed on headstarted turtles (<1 year old) in 2016–2017 that originated from a doomed nest in Pulpi, Andalusia, Spain, where they were also released.
Data Sources: (1) Marco, A., and E. Belda. 2017. Andalusia, Spain. Small loggerheads from a nest at Pulpí (Almería). Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1383) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contacts: Adolfo Marco and Eduardo Belda

DATA RECORD 3 | SWOT ID: 1680

Project Title: Bepi Project: Adriatic Sea
Project Partners: Islameta Group; Department of Biology, University of Pisa; Research and Educational Activities for Chelonian Conservation (ARCHE), Ferrara, Italy; Istituto Zooprofilattico Sperimentale della Lombardia e dell Emilia-Romagna "Bruno Ubertini," Ferrara Section
Metadata: 1 male *Caretta caretta* that had been injured and rehabilitated; tag deployed in 2003 from Porto Garibaldi, northern Italy.
Data Sources: (1) Luschi, P. 2018. Bepi Project: Adriatic Sea. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1680) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Paolo Luschi

DATA RECORD 4 | SWOT ID: 1686

Project Title: CARESAT
Project Partners: Islameta Group; Department of Biology, University of Pisa: Parco Regionale della Maremma (Maremma Regional Park)
Metadata: 3 juvenile and 2 subadult *Caretta caretta*; tags deployed on rehabilitated turtles in the waters of Tuscany, Italy, from 2014 to 2016.
Data Sources: (1) Luschi, P. 2018. CARESAT. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1686) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Paolo Luschi

DATA RECORD 5 | SWOT ID: 1401

Project Title: Conservación y Preservación de Tortugas Marinas
Project Partners: Fundación para la Conservación y Recuperación de Animales Marinos (CRAM), Universitat Politècnica de València
Metadata: 3 juvenile and 3 adult *Caretta caretta*; tags deployed in Tarragona, Spain in 2016; dataset includes an adult male loggerhead that traveled across the Atlantic to waters east of Florida, U.S.A.
Data Sources: (1) Fundación para la Conservación y Recuperación de Animales Marinos (CRAM). 2019. Conservación y preservación de tortugas marinas. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1401) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.

DATA RECORD 6 | SWOT ID: 1688

Project Title: Cyprus 2018
Project Partners: University of Exeter, Marine Turtle Research Group, Society for the Protection of Turtles (SPOT)
Metadata: 10 *Caretta caretta* and 11 *Chelonia mydas*; tags deployed in 2018 on foraging turtles in Famagusta Bay, Northern Cyprus.
Data Sources: (1) Exeter, R. 2019. Cyprus 2018. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1688) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Robin Exeter

DATA RECORD 7 | SWOT ID: 542

Project Title: First satellite tracking of sea turtles in Albania
Project Partners: MEDASSET, Albanian Herpetofauna Society, University of Tirana
Metadata: 3 subadult *Caretta caretta*; tags deployed on turtles that had been incidentally captured in the Patok area of Albania.
Data Sources: (1) Venizelos, L. 2017. First satellite tracking of sea turtles in Albania. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/542) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Lily Venizelos

DATA RECORD 8 | SWOT ID: 1822

Project Title: Green Turtles in Syria
Project Partner: ARCHELON, the Sea Turtle Protection Society of Greece
Metadata: 1 adult *Chelonia mydas*; tag deployed on a post-nesting female turtle in Latakia Beach, Syria in 2006.
Data Sources: (1) Rees, A. 2018. Green turtles in Syria. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1822) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Alan Rees

DATA RECORD 9 | SWOT ID: 1185

Project Title: Israel's sea turtle monitoring program
Project Partners: Israel National Nature and Parks Authority, Sea Turtle Rescue Center
Metadata: 16 *Caretta caretta* and 3 *Chelonia mydas*; tags deployed on rehabilitated turtles in Israel between 2014 and 2018.
Data Sources: (1) Israel Center. 2019. Israel's sea turtle monitoring program. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1185) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.

DATA RECORD 10 | SWOT ID: 1816

Project Title: Loggerhead satellite tracking data from Rethymno, Crete, Greece
Project Partners: Samir Patel, Drexel University; Coonamessett Farm Foundation
Metadata: 21 *Caretta caretta*; tags deployed on post-reproductive turtles (20 female and 1 male) in Rethymno, Crete, Greece during 2010 and 2011; only 20 tags transmitted successfully.
Data Sources: (1) Patel, S. H., S. J. Morreale, A. Panagopoulou, H. Bailey, N. J. Robinson, F. V. Paladino, D. Margaritoulis, and J. R. Spotila. 2015. Changepoint analysis: A new approach for revealing animal movements and behaviors from satellite telemetry data. *Ecosphere* 12: 1–13. **(2)** OBIS-SEAMAP.
SWOT Contact: Samir Patel

DATA RECORD 11 | SWOT ID: 980

Project Title: Loggerheads in the Adriatic Sea
Project Partners: Islameta Group; Department of Biology, University of Pisa; Research and Educational Activities for Chelonian Conservation (ARCHE), Ferrara, Italy; Istituto Zooprofilattico Sperimentale della Lombardia e dell Emilia-Romagna "Bruno Ubertini," Ferrara Section
Metadata: 2 adult and 1 juvenile *Caretta caretta*; tags deployed in the Adriatic Sea in 2004 and 2010.
Data Sources: (1) Luschi, P. 2018. Loggerheads in the Adriatic Sea. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/980) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Paolo Luschi

DATA RECORD 12 | SWOT ID: 1682

Project Title: Loggerheads in the Tyrrhenian Sea
Project Partners: Islameta Group; Department of Biology, University of Pisa; Centro Recupero Tartarughe Marine; Acquario di Grosseto (Italy)
Metadata: 7 juvenile and 2 adult *Caretta caretta*; tags deployed on turtles off the coast of Tuscany, Italy from 2005 to 2016.
Data Sources: (1) Islameta Group and Department of Biology, University of Pisa. 2018. Loggerheads in the Tyrrhenian Sea. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1682) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Paolo Luschi

DATA RECORD 13 | SWOT ID: 1294

Project Title: North Cyprus 2015: Green Turtles
Project Partners: Marine Turtle Research Group, MEDASSET, Albanian Herpetofauna Society, University of Tirana, United Nations Environment Programme, Regional Activity Centre for Specially Protected Areas (RAC/SPA) of UNEP/MAP, British Chelonia Group
Metadata: 2 male subadult *Caretta caretta*; tags deployed in 2009 on individuals caught in fishing nets.
Data Sources: (1) Bradshaw, P. 2018. North Cyprus 2015: Green Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1294) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Lily Venizelos

DATA RECORD 14 | SWOT ID: 1921

Project Title: North Cyprus 2017
Project Partners: Marine Turtle Research Group, Society for the Protection of Turtles in Northern Cyprus (SPoT)
Metadata: 10 adult *Caretta caretta*; tags deployed in mid-2017 and mid-2018 on nesting females on Alagadi Beach, Cyprus.
Data Sources: (1) Haywood, J. 2018. North Cyprus 2017. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1921) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Julia Haywood

DATA RECORD 15 | SWOT ID: 1897

Project Title: Northern Cyprus 2004: Loggerhead & Green Turtles
Project Partners: Marine Turtle Research Group, Society for the Protection of Turtles in Northern Cyprus (SPoT)
Metadata: 4 adult *Chelonia mydas* and 1 adult *Caretta caretta*; tags deployed in 2003 and 2004.
Data Sources: (1) Broderick, A. 2018. Northern Cyprus 2004: Loggerhead & Green Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1897) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Annette Broderick

DATA RECORD 16 | SWOT ID: 1899

Project Title: Northern Cyprus 2005: Loggerhead Turtles

Project Partners: Marine Turtle Research Group, Society for the Protection of Turtles in Northern Cyprus (SPoT)
Metadata: 3 adult *Caretta caretta*; tags deployed in 2005.
Data Sources: (1) Broderick, A. 2018. Northern Cyprus 2005: Loggerhead Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1899) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Annette Broderick

DATA RECORD 17 | SWOT ID: 1901

Project Title: Northern Cyprus 2006–2008: Loggerhead Turtles
Project Partners: Marine Turtle Research Group, Society for the Protection of Turtles in Northern Cyprus (SPoT)
Metadata: 6 adult *Caretta caretta*; 3 tags deployed in 2006, 2 in 2007, and 1 in 2008.
Data Sources: (1) Broderick, A. 2018. Northern Cyprus 2006–2008: Loggerhead Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1901) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Annette Broderick

DATA RECORD 18 | SWOT ID: 1909

Project Title: Northern Cyprus 2009
Project Partners: Marine Turtle Research Group, Society for the Protection of Turtles in Northern Cyprus (SPoT)
Metadata: 6 adult *Caretta caretta* and 1 adult *Chelonia mydas*; tags deployed in 2009.
Data Sources: (1) Broderick, A. 2018. Northern Cyprus 2009. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1909) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Annette Broderick

DATA RECORD 19 | SWOT ID: 1911

Project Title: Northern Cyprus 2010
Project Partners: Marine Turtle Research Group, Society for the Protection of Turtles in Northern Cyprus (SPoT)
Metadata: 6 *Chelonia mydas*; tags deployed in June and July of 2010 on nesting females.
Data Sources: (1) Broderick, A. 2018. Northern Cyprus 2010. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1911) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Annette Broderick

DATA RECORD 20 | SWOT ID: 1913

Project Title: Northern Cyprus 2012
Project Partners: Marine Turtle Research Group; Society for the Protection of Turtles in Northern Cyprus (SPoT); Biological Sciences Department, Eastern Mediterranean University
Metadata: 5 adult *Caretta caretta*; tags deployed in May and June of 2012.
Data Sources: (1) Broderick, A. 2018. Northern Cyprus 2012. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1913) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Annette Broderick

DATA RECORD 21 | SWOT ID: 1684

Project Title: Rehabilitated Loggerhead from Southern Italy
Project Partners: Islameta Group; Department of Biology, University of Pisa
Metadata: 1 adult *Caretta caretta*; tag deployed on a rehabilitated turtle that was released at the Brancaleone beach, Reggio Calabria.
Data Sources: (1) Italy, D. 2018. Rehabilitated loggerhead from southern Italy. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1684) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Paolo Luschi

DATA RECORD 22 | SWOT ID: 1846

Project Title: Rethymno Nesting Turtle
Project Partner: ARCHELON, the Sea Turtle Protection Society of Greece
Metadata: 1 adult *Caretta caretta*; tag deployed in 2005.
Data Sources: (1) Rees, A. 2018. Rethymno Nesting Turtle. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1846) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Alan Rees

DATA RECORD 23 | SWOT ID: 1550

Project Title: Seguimiento de 10 Crías de Tortuga Boba Nacidas en 2016 en el Litoral Balenciano, en el Marco del Proyecto LIFE 15 IPE ES 012
Project Partners: LIFE IP Intemares; Ministerio de Agricultura y Pesca, Alimentación y Medio Ambiente (Spain)
Metadata: 10 *Caretta caretta* hatchlings; tags deployed on hatchlings from a nest found in Las Palmeras in Sueca (Valencia) in 2016, which were transferred and released on the protected beach of La Punta (Parc Natural de l'Albufera).
Data Sources: (1) Belda, E. 2018. Seguimiento de 10 crías de tortuga boba nacidas en 2016 en el litoral valenciano, en el marco del Proyecto LIFE 15 IPE ES 012. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1550) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Eduardo Belda

DATA RECORD 24 | SWOT ID: 1146

Project Title: Spain Tags Merged
Project Partners: Fisheries Bycatch Research Group, NOAA, Kai Submon, UNCW
Metadata: 1 adult, 5 juvenile, and 20 subadult *Caretta caretta*; tags deployed between 2008 and 2012.
Data Sources: (1) Swimmer, Y. 2017. Spain tags merged. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1146) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Yonat Swimmer

DATA RECORD 25 | SWOT ID: 1310

Project Title: Spain-Balearic Islands 2015 Loggerhead Turtles
Project Partners: Fisheries Bycatch Research Group
Metadata: 2 subadult and 2 juvenile *Caretta caretta*; tags deployed in June and July of 2016.
Data Sources: (1) Swimmer, Y. 2018. Spain-Balearic Islands 2015 loggerhead turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1310) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Yonat Swimmer

DATA RECORD 26 | SWOT ID: 1820

Project Title: Telemetry of Loggerhead Turtles in Amvrakikos Bay
Project Partners: ARCHELON, the Sea Turtle Protection Society of Greece; Etanam (a local management agency of the Amvrakikos Bay region)
Metadata: 1 subadult, 2 adult, and 3 unknown-life-stage *Caretta caretta*; tags deployed in 2002 and 2003.
Data Sources: (1) Rees, A. 2018. Telemetry of loggerhead turtles in Amvrakikos Bay. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1820) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Alan Rees

DATA RECORD 27 | SWOT ID: 1314

Project Title: Tracking Small Loggerheads from Spanish Nests
Project Partners: Universitat Politècnica de València; Unidad de Zoología Marina, Universidad de Valencia (Spain); Research Institute Doñana Biological Station, CSIC; Fundación para la Conservación y Recuperación de Animales Marinos (CRAM); Generalitat Valenciana; Junta de Andalucia; Oceanogràfic de Valencia; Acuario de Sevilla; Xaloc Hermanos de Sal.
Metadata: 8 small-juvenile and 21 juvenile *Caretta caretta*; turtles born in Valencia (Spain) and Catalonia from natural nests found in Spain in 2014, Andalusia in 2015, and Valencia in 2016. The eggs were translocated, and the hatchlings were headstarted in five different centers.
Data Sources: (1) Belda, E. 2017. Tracking small loggerheads from Spanish nests. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1314) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Eduardo Belda

DATA RECORD 28 | SWOT ID: 1826

Project Title: WWF Italy
Project Partners: Sea Turtle Network, WWF Italy
Metadata: 10 adult *Caretta caretta*; tags deployed in 2006, 2007, and 2009.
Data Sources: (1) Casale, P. 2018. WWF Italy. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1826) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Paolo Casale

DATA RECORD 29 | SWOT ID: 1834

Project Title: WWF Italy–Manfredonia
Project Partners: WWF Italy; Centro Cultura del Mare Associazione di Promozione Sociale (APS); Lega Navale of Manfredonia; University of Rome la Sapienza
Metadata: 3 juvenile and 2 subadult *Caretta caretta*; individuals were incidentally caught by trawlers fishing in the Gulf of Manfredonia.
Data Sources: (1) Casale, P. 2018. WWF Italy–Manfredonia. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1834) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Paolo Casale

DATA RECORD 30 | SWOT ID: 1903

Project Title: Zakynthos 2007: Loggerhead Turtles
Project Partners: Marine Turtle Research Group; ARCHELON, the Sea Turtle Protection Society of Greece
Metadata: 11 adult *Caretta caretta*; tags deployed in July 2007.
Data Sources: (1) Zbinden, J. 2018. Zakynthos 2007: Loggerhead Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1903) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Judith Zbinden

DATA RECORD 31 | SWOT ID: 1923

Project Title: Zakynthos Nesting Turtles
Project Partners: Division of Conservation Biology (Judith Zbinden, Adrian Aebischer, Raphael Arlettaz) of the University of Bern, Switzerland; ARCHELON, the Sea Turtle Protection Society of Greece
Metadata: 6 *Caretta caretta*; tags deployed in 2004. The turtles tracked in this project are among the first loggerheads to be tracked during their post-nesting migration from a Greek nesting beach.
Data Sources: (1) Rees, A. 2018. Zakynthos Nesting Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1923) on December 4, 2018. **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Alan Rees

DATA RECORD 32

Project Title: Habitat Use by Foraging Sea Turtles in the Mediterranean
Project Partners: Stazione Zoologica Anton Dohrn, Marine Turtle Research Center
Metadata: 1 juvenile, 3 subadult, and 2 adult *Caretta caretta*; tags deployed in 2013 and 2014.
Data Sources: (1) Hochscheid, S., Marine Turtle Research Center, Stazione Zoologica Anton Dohrn, Naples, Italy. Unpublished data. **(2)** Uçar, A. H., F. Maffucci, S. Ergene, M. Ergene, Y. Katılmış, E. Başkale, Y. Kaska, and S. Hochscheid. A stranded loggerhead turtle tracked with satellite in Mersin Bay, eastern Mediterranean Sea, Turkey. *Marine Turtle Newsletter*, under review. **(3)** STAT.

DATA RECORD 33

Project Title: SZN: Movements of Rehabilitated Sea Turtles
Project Partners: Stazione Zoologica Anton Dohrn; Bagnolifutura; The Sea Turtle Rescue Center (DEKAMER); Centro Regionale di Recupero Fauna Selvatica e Tartarughe Marine, Comisio, Sicily
Metadata: 2 juvenile *Lepidochelys kempii*; 1 juvenile, 2 subadult, and 5 adult *Caretta caretta*; and 1 adult *Chelonia mydas*. Tags deployed on 10 rehabilitated and 1 hand-reared individual between 2008 and 2014.
Data Sources: (1) Hochscheid, S., Marine Turtle Research Center, Stazione Zoologica Anton Dohrn, Naples, Italy. Unpublished data. **(2)** Luschi, P., R. Mencacci, G. Cerritelli, L. Papetti, and S. Hochscheid. 2018. Large-scale movements in the oceanic environment identify important foraging areas for loggerheads in central Mediterranean Sea. *Marine Biology* 165: 4. **(3)** STAT.

DATA RECORD 34

Project Title: RAC/SPA-SZN Tracking of Mediterranean Marine Turtles
Project Partners: UNEP/MAP Regional Activity Centre for Specially Protected Areas (RAC/SPA); Malta Environment and Planning Authority (MEPA); Environmental General Authority (EGA), Libya; Marine Biology Research Centre (MBRC), Tajura; The Sea Turtle Rescue Center (DEKAMER); The Tyre Coast Nature Reserve (TCNR)
Metadata: 3 juvenile, 1 subadult, and 11 adult *Caretta caretta*; and 2 adult *Chelonia mydas*. Tags deployed between 2006 and 2013.
Data Sources: (1) Hochscheid, S., A. Saied, A. Hamza, A. Ouerghi, F. Bentivegna, Y. Kaska, F. Maffucci, N. Dakik, I. Jribi, M.N. Bradai, C. Mifsud, and Y. Levy. 2018. RAC/SPA-SZN Tracking of Mediterranean Marine Turtles. Personal communication in *SWOT Report—State of the World's Turtles*, vol. XIV (2019) **(2)** STAT.

DATA RECORD 35

Metadata: 6 *Caretta caretta*.
Data Source: Casale, P., A. C. Broderick, D. Freggi, R. Mencacci, W. J. Fuller, B. J. Godley, and P. Luschi. 2012. Long-term residence of juvenile loggerhead turtles to foraging grounds: A potential conservation hotspot in the Mediterranean. *Aquatic Conservation: Marine and Freshwater Ecosystems* 22: 144–154.
SWOT Contact: Paolo Casale

DATA RECORD 36

Metadata: 3 *Caretta caretta*.
Data Source: Luschi, P., R. Mencacci, C. Vallini, A. Ligas, P. Lambardi, and S. Benvenuti. 2013. Long-term tracking of adult loggerhead turtles (*Caretta caretta*) in the Mediterranean Sea. *Journal of Herpetology* 47: 227–231.
SWOT Contacts: Paolo Luschi and Resi Mencacci

DATA RECORD 37

Metadata: 3 *Caretta caretta*.
Data Source: Mencacci, R., A. Ligas, P. Meschini, and P. Luschi. 2011. Movements of three loggerhead sea turtles in Tuscany waters. *Atti della Societa Toscana di Scienze Naturali*, Serie B, 118: 117–120.
SWOT Contacts: Paolo Luschi and Resi Mencacci

DATA RECORD 38

Metadata: 4 *Caretta caretta*.
Data Source: Luschi, P., R. Mencacci, G. Cerritelli, L. Papetti, and S. Hochscheid. 2018. Large-scale movements in the oceanic environment identify important foraging areas for loggerheads in central Mediterranean Sea. *Marine Biology* 165: 4.
SWOT Contacts: Paolo Luschi and Resi Mencacci

DATA RECORD 39

Metadata: 3 *Caretta caretta*.
Data Source: Casale, P., A. C. Broderick, D. Freggi, R. Mencacci, W. J. Fuller, B. J. Gadley, and P. Luschi. 2012. Long-term residence of juvenile loggerhead turtles to foraging grounds: A potential conservation hotspot in the Mediterranean. *Aquatic Conservation: Marine and Freshwater Ecosystems* 22: 144–154.
SWOT Contacts: Paolo Luschi and Resi Mencacci

DATA RECORD 40

Metadata: 7 *Caretta caretta*.
Data Source: Mingozzi, T., R. Mencacci, G. Cerritelli, D. Giunchi, and P. Luschi. 2016. Living between widely separated areas: Long-term monitoring of Mediterranean loggerhead turtles sheds light on cryptic aspects of females spatial ecology. *Journal of Experimental Marine Biology and Ecology* 485: 8–17.
SWOT Contacts: Paolo Luschi and Resi Mencacci

DATA RECORD 41

Metadata: 4 *Caretta caretta*.
Data Source: Mencacci, R., and P. Luschi. 2018. Unpublished tracks. Personal communication in *SWOT Report—State of the World's Turtles*, vol. XIV (2019).
SWOT Contacts: Paolo Luschi and Resi Mencacci

DATA RECORD 42

Project Partner: Pamukkale University Sea Turtle Rescue Center (DEKAMER)
Metadata: 15 *Caretta caretta*.
Data Sources: (1) Sezgin, C. 2016. Investigation of the effects of temperature on the sex of loggerhead sea turtle (*Caretta caretta* L.) hatchlings and migration patterns of adults. MSc thesis. Pamukkale University Institute of Science, Denizli, Turkey. **(2)** Kaska, Y., and D. Sözbilen. 2018. Unpublished data. Deniz Kaplumbagaları Arastırma Merkezi (DEKAMER), Pamukkale University.
SWOT Contact: Yakup Kaska

DATA RECORD 43

Metadata: 57 *Caretta caretta*.
Data Source: Schofield, G., A. Dimadi, S. Fossette, K. A. Katselidis, D. Koutsoubas, M. K. S. Lilley, A. Luckman, J. D. Pantis, A. D. Karagouni, and G. C. Hays. 2013. Satellite tracking large numbers of individuals to infer population level dispersal and core areas for the protection of an endangered species. *Diversity and Distributions* 19 (7): 834–844.
SWOT Contact: Gail Schofield

DATA RECORD 44

Metadata: 1 adult *Caretta caretta*. Tag deployed on a rehabilitated individual.
Data Source: (1) Luschi, P., R. Mencacci, G. Cerritelli, L. Papetti, and S. Hochscheid. 2018. Large-scale movements in the oceanic environment identify important foraging areas for loggerheads in central Mediterranean Sea. *Marine Biology* 165: 4. **(2)** Hochscheid S., F. Bentivegna, A. Hamza, and G.C. Hays. 2010. When surfacers do not dive: Multiple significance of extended surface times in marine turtles. *Journal of Experimental Biology* 213: 1328–1337.

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Description: Loggerhead Turtle Foraging Areas
Data Source: Mazor, T., M. Beger, J. McGowan, H. Possingham, and S. Kark. 2016. The value of migration information for conservation prioritization of sea turtles in the Mediterranean. *Global Ecology and Biogeography* 25 (5): 540–552.

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AT RIGHT: A hawksbill turtle glides over a reef near Grand Cayman Island. © DOUG PERRINE; BACK COVER: A juvenile loggerhead swims to the surface on a rainy morning near Zakynthos Island, Greece. © KOSTAS PAPAFITSOROS

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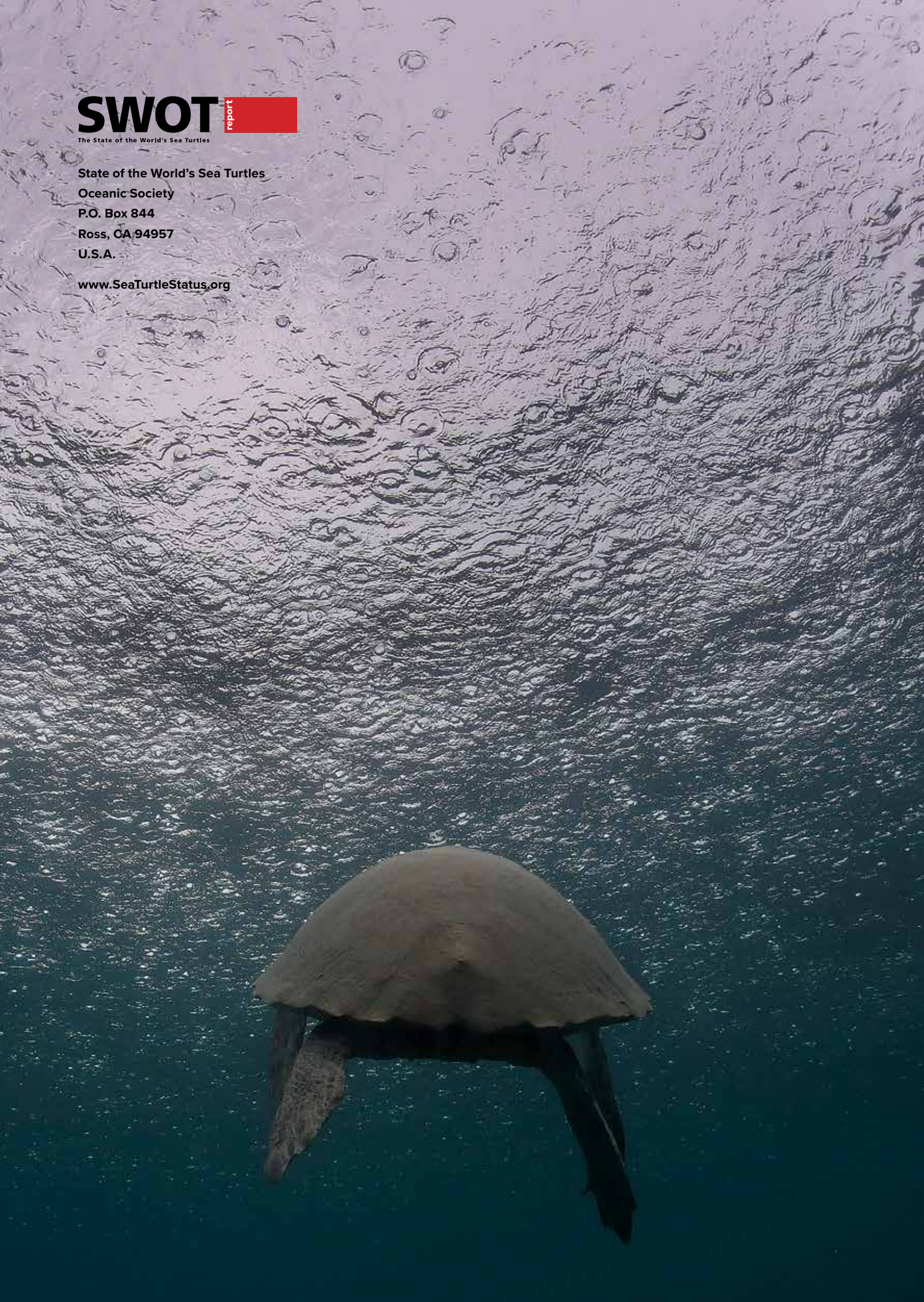

SWOT report

The State of the World's Sea Turtles

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