SWOT report

Volume XV

The State of the World's Sea Turtles

SPECIAL FEATURE

Sea Turtles of the Caribbean

INSIDE:

INDIAN OCEAN LOGGERHEADS
DRONES FOR CONSERVATION
JAGUARS
AND MORE ...

A bubble forms as a green turtle exhales at the surface. © Ben J. Hicks/benjhicks.com.
FRONT COVER: A leatherback turtle finishes her nesting process as day breaks in Grande Riviere, Trinidad. © Ben J. Hicks/benjhicks.com

A Nazca booby rests on the back of an olive ridley turtle who simultaneously provides shelter to small fish from airborne predators in Costa Rican waters. © Dhritiman Mukherjee

Editor's Note

No Sea Turtle Is an Island

Wise men and women throughout history have shown us that, "there is power in unity and there is power in numbers" (Martin Luther King Jr., 1963). That is certainly the case with the State of the World's Sea Turtles (SWOT) program, the world's largest volunteer network of sea turtle researchers, conservationists, and enthusiasts. This volume of *SWOT Report* unifies an enormous cast: from the hundreds of researchers in more than 20 countries, whose collective efforts can be seen in the first-ever global-scale map of loggerhead sea turtle telemetry (pp. 32–33), to the beach workers from the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and beyond, whose labors are seen in this issue's maps of sea turtle biogeography (pp. 24–27).

As you peruse these cartographic works of art, reflect for a moment on the time, effort, and passion that went into each of those tiny, tinted polygons of telemetry data or the myriad multicolored circles of nest abundance. Together they represent the labors of a multitude of beach workers, synergistically amassed to bring big-picture visualizations of sea turtle natural history to life as never before. As the famous saying goes, "No man is an island," and when our personal efforts are bridged and bound to one another by a common vision, the results have global-scale impacts far beyond the sum of the individual contributions.

And no sea turtle is an island either. Sea turtles are tiny threads in an immeasurably complex tapestry of global biodiversity. We've seen some encouraging reports of stable and even growing sea turtle populations in recent years, reflected in the improved status of some on the IUCN (International Union for Conservation of Nature) Red List of Threatened Species. Yet we must never forget that permanent recovery of sea turtles can be ensured only when all the threads of a turtle's existence are intact; when the oceans are healthy; and when nesting beaches, seagrass pastures, coral reefs, and migratory pathways remain safe and usable.

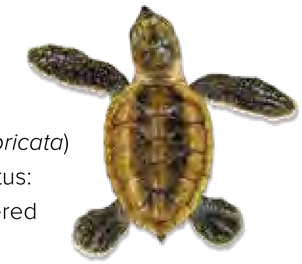
It was 65°F (18.3°C) in Antarctica as I wrote this, and an iceberg twice the size of Washington, DC, just broke off the Pine Island glacier there. Australia is reeling from devastating fires. Antiquated fishing techniques and management are pushing fish stocks to the brink of extinction and incidentally killing millions of turtles, seabirds, and marine mammals. All age classes of sea turtles everywhere are ingesting plastics. Drastic weather, rising and warming seas, and human development of once pristine ecosystems have become the norm. The tapestry is rapidly becoming threadbare.

So it is urgent that we now focus on saving not only sea turtles, but also the seas that sustain them. Changing the countless human behaviors that threaten the oceans is a complicated challenge, but it begins with a simple question—"How can I do better?" I urge our global "SWOT Team" to ask that question, begin the conversation, and use the power of our numbers and unity to move the needle on ocean health.

Roderic B. Mast
Chief Editor

meet the turtles

The seven sea turtle species that grace our oceans belong to an 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!

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VOLUME XV

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SWOT
The State of the World's Sea Turtles

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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!

THIS PAGE: © Jason Washington/Coral Reef Image Bank; **ILLUSTRATIONS, AT LEFT:** © Dawn Witherington

DRONES
IN SEA TURTLE CONSERVATION
The Sky Is the Limit

By Miguel Rodrigues Varela and ALan F. Rees

Recent advances in drone technology—also called unmanned aerial vehicles (UAVs) or unmanned aircraft systems (UASs)—have made such devices increasingly cost-effective, easy to operate, and widely accessible. Alongside many other tools and techniques, drones are transforming sea turtle conservation and research. Yet even with drone technology advancing quickly, we have only begun to scratch the surface of its potential.

CURRENT USES OF DRONES IN SEA TURTLE CONSERVATION

A number of sea turtle studies involving drones have been published in the scientific literature since 2015, and they provide a range of novel insights. Drone studies carried out on sea turtles have primarily focused on obtaining estimates of population abundance, distribution, and density by using aerial imagery to count nesting females, their tracks or nests, or turtles in the water. To date, these studies have primarily taken place in breeding areas, where sea turtles predictably gather in large numbers in accessible, nearshore waters. From the initial, more basic studies that monitored turtles in the water and recorded behavior, drone research has progressed to collect increasingly advanced data. Some examples include (1) identifying the operational sex ratios of turtles gathering at the start of a breeding season or (2) incorporating semiautomatic counts of turtles aggregating offshore at an *arribada* (mass nesting) beach using artificial intelligence.

Although drones come in many different styles, shapes, and sizes, relatively small fixed-wing and rotary-wing aircraft are the types that are most frequently used to gather video and photographic data, and they have been most commonly used for sea turtle research. Larger drones can be equipped with larger, heavier sensors such as compact thermal vision cameras, hyperspectral sensors, and laser scanning devices such as LiDAR (Light Detection and Ranging).

Beyond drones' use in studying sea turtles themselves, drones were recently used to model a sea turtle population's nesting beach using photogrammetry. *Photogrammetry* is the computationally intense process of generating detailed three-dimensional (3D) models from a series of overlapping images, whereby the relative location of different points on the various images are used to determine the shape of the photographed subject. Researchers created very accurate 3D models of sea turtle nesting beaches with less than 15 centimeters (6 inches) of elevation error. They then projected different sea-level rise scenarios resulting from climate change onto the model to estimate habitat loss caused by flooding and to assess the potential for the beach to retreat in the future. Such 3D models can also be updated yearly to detect patterns of coastal erosion, to better understand beach dynamics, and to ultimately predict how the habitat may shift over the next 50 or 100 years.

FUTURE DIRECTIONS FOR DRONES IN SEA TURTLE CONSERVATION

Drones carrying lightweight cameras and even multispectral sensors can provide professional mapping at a fraction of the cost of previous photogrammetric techniques that required piloted aircraft. Such studies can also be combined with information about sea turtle population sex ratios and remotely sensed surface temperatures to predict new suitable (and unsuitable) areas for nesting in the coming decades. By integrating research that predicts suitable nesting areas into coastal planning, we can better understand which areas should be protected from coastal development to make sure suitable sea turtle nesting habitats will be available as the impacts of climate change progress.

Other exciting innovations that have come about recently include the use of *fluid lensing*, an experimental algorithm that uses light wavelengths that transmit through water to analyze submarine structures and thereby create detailed underwater maps that are accurate to within a centimeter. The principle is the same as in the

An aerial photo taken with a drone shows the tracks of leatherback turtles that emerged in Grande Riviere, Trinidad, the night before. Drones are giving field biologists new ways to collect sea turtle data. © Ben J. Hicks/benjhicks.com. AT LEFT: Drones can be outfitted with thermal imaging accessories to capture nighttime imagery such as this thermal image of a turtle returning to the sea after nesting. © Miguel Rodrigues Varela

photogrammetry study mentioned earlier, but fluid lensing technology makes it possible to map underwater habitat rather than beach habitat. Such maps could be used to monitor foraging areas used by sea turtles during their nesting period or to monitor known shallow, nonbreeding areas. Thus, they could help answer a range of research questions, such as why sea turtles prefer a particular area over another or how and why different species select certain habitats. When combined with other data types, for example, information from the remote tracking of sea turtles and fishing vessels, such underwater habitat mapping could provide a new understanding of threats to turtles, such as how they interact with local small-scale fisheries. Although this technology is too costly to be used widely today, the same could have been said about the use of drones just 10 years ago!

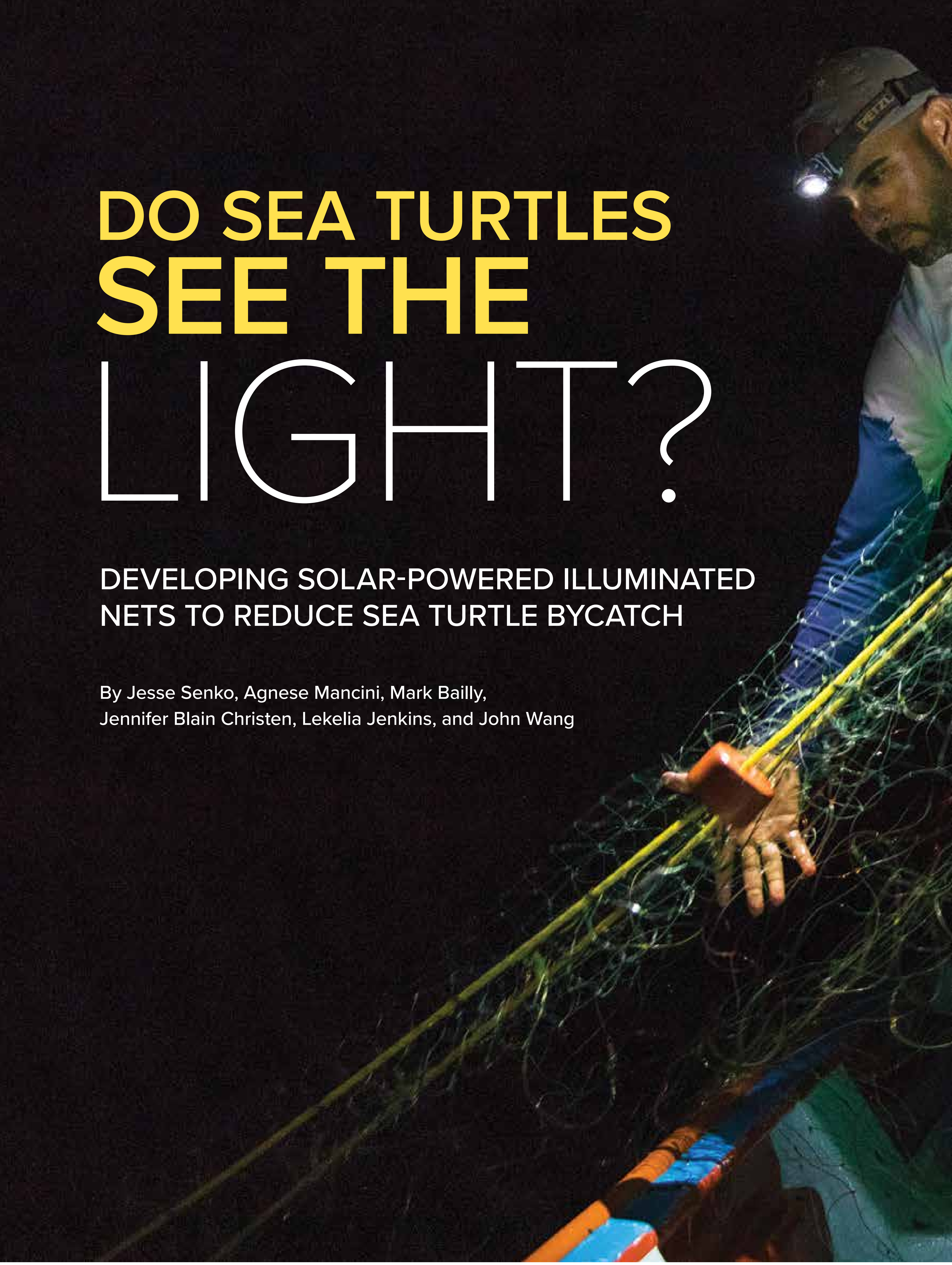
Another new and rapidly developing technique combines off-the-shelf drones with artificial intelligence to detect animals or objects in near real time. Data are interpreted while they are gathered through synchronization with a live video stream. The system is capable of working on a wide variety of devices, from cell phones to desktop computers, because it requires an extremely low frame rate of just two frames per second to accurately detect objects. It has been tested already with rhinoceroses and cars for different conservation-related purposes, but it has not yet been used for sea turtle conservation. Although several challenges remain, it will soon be possible to process images on board the drone and transmit the results in real time or to transmit the live feed directly to a base station that processes images in real time for animal detection. Using either standard or thermal cameras, this technique could be useful for monitoring large and inaccessible areas for the presence of turtles or for antipoaching surveillance.

Hyperspectral sensors are yet another technological tool that may revolutionize sea turtle research and conservation when combined with drones. Unlike standard cameras that sense three wavelengths of visible light (red, green, and blue) and commonly use multispectral image sensors that measure visible light and reflected energy from the electromagnetic spectrum, hyperspectral sensors measure energy in narrower and more numerous bands that can yield images with as many as 200 or more contiguous spectral bands. As a result, they produce images that contain much more data, thereby making it possible to discern differences between land and water features. For example, multispectral imagery can be used to detect and map forested areas, whereas hyperspectral imagery can be used to identify and map individual tree species within the forest. For sea turtle research, hyperspectral imagery could be used to map vegetation species along the nesting beach and, when combined with data on nesting success or emergence success of hatchlings under the canopy, allow researchers to better understand the influence of vegetation on nesting. It also could be used to monitor the spread of invasive plant species in nesting areas or to map the density of vegetated habitats that can't be mapped effectively using traditional photogrammetry. A range of other applications are also possible.

Despite the growing capabilities of drones in terms of sensor quality and flight times, some big challenges must also be overcome:

- **Data processing and storage.** The geospatial, imagery, and other sensor data collected by a drone can quickly grow to very large file sizes.
- **Costs.** Licenses for specialized processing software can be expensive.
- **Legal constraints.** Restrictions on the use of drones vary from location to location and include visual line of site obligations, no-fly zones, and so on.
- **Adverse weather conditions.** Drones can't safely operate in bad weather, thus limiting their usability for certain tasks.

The combination of technological advances and the inventiveness of researchers will no doubt lead to more and more uses for drones in sea turtle conservation and research over the years ahead. When it comes to using drones in sea turtle conservation, the sky is the limit! •



DO SEA TURTLES SEE THE LIGHT?

DEVELOPING SOLAR-POWERED ILLUMINATED NETS TO REDUCE SEA TURTLE BYCATCH

By Jesse Senko, Agnese Mancini, Mark Bailly, Jennifer Blain Christen, Lekelia Jenkins, and John Wang

Small-scale or coastal fisheries are vital for food supply, food security, nutrition, income, and livelihoods worldwide. However, both overfishing and incidental catch (bycatch) of nontarget species in coastal fisheries can jeopardize their long-term viability and create problems for threatened species and sensitive habitats, as well as for the coastal communities that depend on those fisheries. Bycatch of sea turtles in gillnet and entangling net fisheries has been linked to declines in sea turtle populations worldwide and has also led to costly closures of fisheries in coastal communities that have few economic alternatives.

Unlike studies of industrial-scale fisheries, limited research has been done to evaluate bycatch and develop technologies that reduce bycatch impacts in coastal fisheries. But that is beginning to change. Recent research has found that net illumination—using battery-powered light-emitting diodes (LEDs) or chemical lightsticks—is capable of reducing bycatch of sea turtles (by 40–74 percent) as well as small cetaceans (by 70 percent) and seabirds (by 85 percent) in coastal net fisheries at night while maintaining catch rates of target fish species. Although the exact reasons why this technology is effective are not yet known, net illumination is believed to provide a visual cue that alerts sea turtles and other nontarget species to the presence of nets or otherwise deters them.

… we are working to make solar-powered net illumination more accessible on a global scale.

Testing of net illumination has expanded into multiple coastal fisheries worldwide, but broader implementation has been hindered by the lack of a sustainable method to illuminate nets that addresses energy demands, as well as a design that matches the specific needs of gillnet fishers. In particular, light levels in LEDs that are currently used begin to diminish after a few weeks of continual use, and the energy demand means that batteries must be changed monthly to maintain their effectiveness in reducing bycatch. This results in high costs for coastal fishers as well as environmental concerns over battery disposal. For example, LEDs used in previous bycatch-reduction research used two AA batteries per LED. One gillnet fishing vessel with 1 kilometer length of net with LEDs spaced every 10 meters would use 100 LEDs, so 200 AA batteries would be needed for every change of batteries. Moreover, previously tested designs of LED lights were not optimized for net fishery operations, causing frequent snags and weighing down the net.

DEVELOPING SOLAR-POWERED NET ILLUMINATION

To address the challenges associated with current net illumination technology, we partnered with coastal fishers to develop a novel way to illuminate nets by harvesting renewable energy. Involving fishers in developing new gear and practices is an important step toward achieving fisher adoption and compliance of bycatch reduction technologies. Indeed, the most widely adopted gear modifications in commercial fisheries were developed by, or with strong input from, local fishers. Thus, in January 2018, we held our first of three workshops with local fishery leaders from northwestern Mexico to discuss developing a renewable-powered solution.

At the beginning, we considered both mechanical and solar energy sources. All of the mechanical energy designs that did not risk failure because of biofouling (for example, turbines) had low power outputs that precluded them from generating a reasonable intensity of light. We therefore chose to use photovoltaics, which have no moving parts, provide high power output compared with other renewable energy sources, and require little human intervention to operate effectively. However, we still needed to design a system that effectively oriented the solar cells, as well as establish a flash rate for the LEDs that would minimize energy consumption while still deterring sea turtles.

First, we decided to mimic the design of a float line buoy. The idea came from the first fisher

PREVIOUS SPREAD: Fisher leader Juan Pablo Cuevas retrieves a solar-powered illuminated net at Isla El Pardito in the Sea of Cortez, Baja California Sur, Mexico. **AT RIGHT:** Arizona State University professor Jesse Senko (far right) activates a solar-powered light (left) on an illuminated net with fisher leaders Felipe and Juan Pablo Cuevas at Isla El Pardito in the Sea of Cortez, Baja California Sur, Mexico. **ALL IMAGES:** © Lindsay Lauckner Gundlock

workshop we held, where several fishers suggested we build a lighted buoy. The light is designed to be threaded onto the float line of a gillnet and is buoyant just like a traditional buoy. This method seamlessly integrates the technology into existing fishing gear, making it easy to use and therefore improving the likelihood that fishers would adopt it. Because the light system also functions as a buoy, it can offset the costs of actual buoys, which make up about 20 percent of the total cost of building a gillnet.

Second, to design a light that could remain illuminated longer than 12 to 24 hours without needing to be charged, we needed to make the light flash intermittently. We chose a moderate flash rate that we believed would still effectively illuminate the net for sea turtles—a flash rate between an emergency light and a street sign or roadwork light. The light that we developed can self-charge in sunlight and can be programmed to automatically emit either static or flashing light. Depending on the configuration, it can remain charged for up to one week after 30 to 60 minutes of charging in direct sunlight.

We chose a clear cylinder shape to house the LEDs because it required the least amount of change from a tube, which is similar to the midsection of a traditional float line buoy. This shape was also the most conducive to solar panel integration, and the end pieces of each tube were designed to create a shock absorbing effect. In contrast to existing LEDs, which require a complex locking mechanism to replace batteries, our design is sealed and can run for years without opening.

Instead of the AA batteries that are used in current LED-illuminated net designs, we used rechargeable cells that can hold more than 500 charge cycles, with a lifetime cost of roughly 1 cent per charge. This choice substantially reduces costs over nonrechargeable cells, particularly over an entire fishing season. Converting from AA battery power to solar also made the whole unit considerably lighter, and it eliminated the need for a sealed release mechanism, which can be difficult to maintain, and often has a cumbersome waterproof seal that needs to be opened and resealed with each battery exchange. Moreover, placing the LEDs in a buoy allowed us to substitute high-efficiency green LEDs that consume less power at the same light output.

STUDYING HOW SEA TURTLES REACT TO SOLAR-POWERED LIGHTED BUOYS

Following the design phase, during the summer of 2019 we tested the solar-powered buoys with flashing green lights. For the test, we chose entangling net fisheries off the Gulf of California coast of Baja California Sur, Mexico. Initial field experiments found that the solar-powered illuminated nets significantly reduced sea turtle bycatch rates, by 65 percent at night, a finding that is in line with previous studies of net illumination that used battery-powered, static green light. Most importantly, these field tests showed that the flashing lights also reduced sea turtle bycatch, a necessary step for harvesting solar energy and eliminating the need to actively recharge or change the lights. Overall, our fisher partners were pleased with how the lights performed. We are excited by these preliminary results, which suggest that solar-powered net illumination and the use of flashing lights represent a promising solution for mitigating sea turtle bycatch, with global applicability for passive net fisheries. To further evaluate the viability of the solar-powered buoys, we plan on testing the lights' effects on target fish catch and composition during the spring of 2020.

FUTURE DIRECTIONS

Now that we have developed a solar-powered light with a flash rate that is energy efficient and reduces sea turtle bycatch, we are working to make solar-powered net illumination more accessible on a global scale. This next phase includes partnering with industry and fishing communities to develop a range of improved lights that can be tested in global sea turtle bycatch hotspots and eventually implemented at scale. These lights will leverage new, high-efficiency solar cells that are being developed by Arizona State University's Solar Power Laboratory for SpaceX and NASA. Given their paper-thin width, light weight, and durability, these cells may allow us to develop a more streamlined buoy that is 30 percent to 50 percent smaller than the existing buoys while maintaining their current efficiency. •

Where Turtles Meet Jaguars

By Luis G. Fonseca, Stephanny Arroyo-Arce, Ian Thomson, Wilberth Villachica, Eduardo Rangel, and Roldán A. Valverde

A DEADLY JUXTAPOSITION

Sea turtles and jaguars are both flagship species, important icons for the conservation of oceans and tropical forests, respectively. However, where tropical forests come in contact with beaches in the Americas, jaguars sometimes prey on nesting sea turtles, which presents an unusual conservation challenge involving both animals.

Although such interactions have certainly occurred for millennia, the first published report of a jaguar attack on a sea turtle came from Suriname in 1963 at Bigisanti Beach in the Wia Wia Nature Reserve, where jaguars attacked green, olive ridley, and leatherback turtles. In the mid-1970s, jaguars were also reported to kill nesting leatherbacks in French Guiana and Guyana. The first reports of jaguar predation on sea turtles in Central America came from Costa Rica in the 1980s, specifically in Tortuguero National Park and Pacuare Nature Reserve in the Caribbean, as well as in Santa Rosa National Park (Nancite Beach) and Corcovado National Park in the Pacific. Elsewhere in the Americas, jaguar predation of sea turtles has been documented only in Mexico's Yucatán Peninsula.

Directly observing jaguar behavior can be difficult because of their elusive nature. Camera traps simplify such studies; they are not intrusive, the technology is inexpensive, and they produce high-quality visual data. For those reasons, we were able to conduct a 10-year study (2010–2020) using infrared camera traps to document the deadly nighttime juxtaposition of these two flagship species at the interface of terrestrial and marine wilderness in a remote corner of Costa Rica.

THE GUANACASTE CONSERVATION AREA: AN OASIS FOR JAGUARS AND RIDLEYS

The Guanacaste Conservation Area (Área de Conservación Guanacaste, or ACG) in the Pacific Northwest of Costa Rica encompasses Santa Rosa, Rincón de la Vieja, and Guanacaste National Parks. Lands that once were used for livestock and agriculture and subjected to large-scale deforestation and unregulated hunting were, in 1971, gradually consolidated into 43,000 hectares of terrestrial protected area and 12,000 hectares of marine protected area (166 square miles and 46 square miles, respectively) that now make up the ACG. Its 110 kilometers (68 miles) of coastline has nine sandy beaches, including Nancite Beach, one of only a handful of sites worldwide where olive ridley *arribadas* occur (*SWOT Report*, vol. X, pp. 18–23). Because the ACG's beaches are remote—some of them

Camera traps have allowed researchers to study interactions between jaguars and sea turtles along protected, jungle-lined beaches in Costa Rica. This encounter between a jaguar and a green turtle was captured in Tortuguero National Park on Costa Rica's Caribbean coast. © Ian Thomson

can be accessed only by boat—the resulting absence of human activities has allowed wildlife to flourish.

Jaguars, which are largely nocturnal, are the keystone predators in the ACG. Solitary animals for most of their lives, jaguars are rarely seen together, interacting only as family groups (cubs stay with their mother for usually two years) or coming together for courtship and mating.

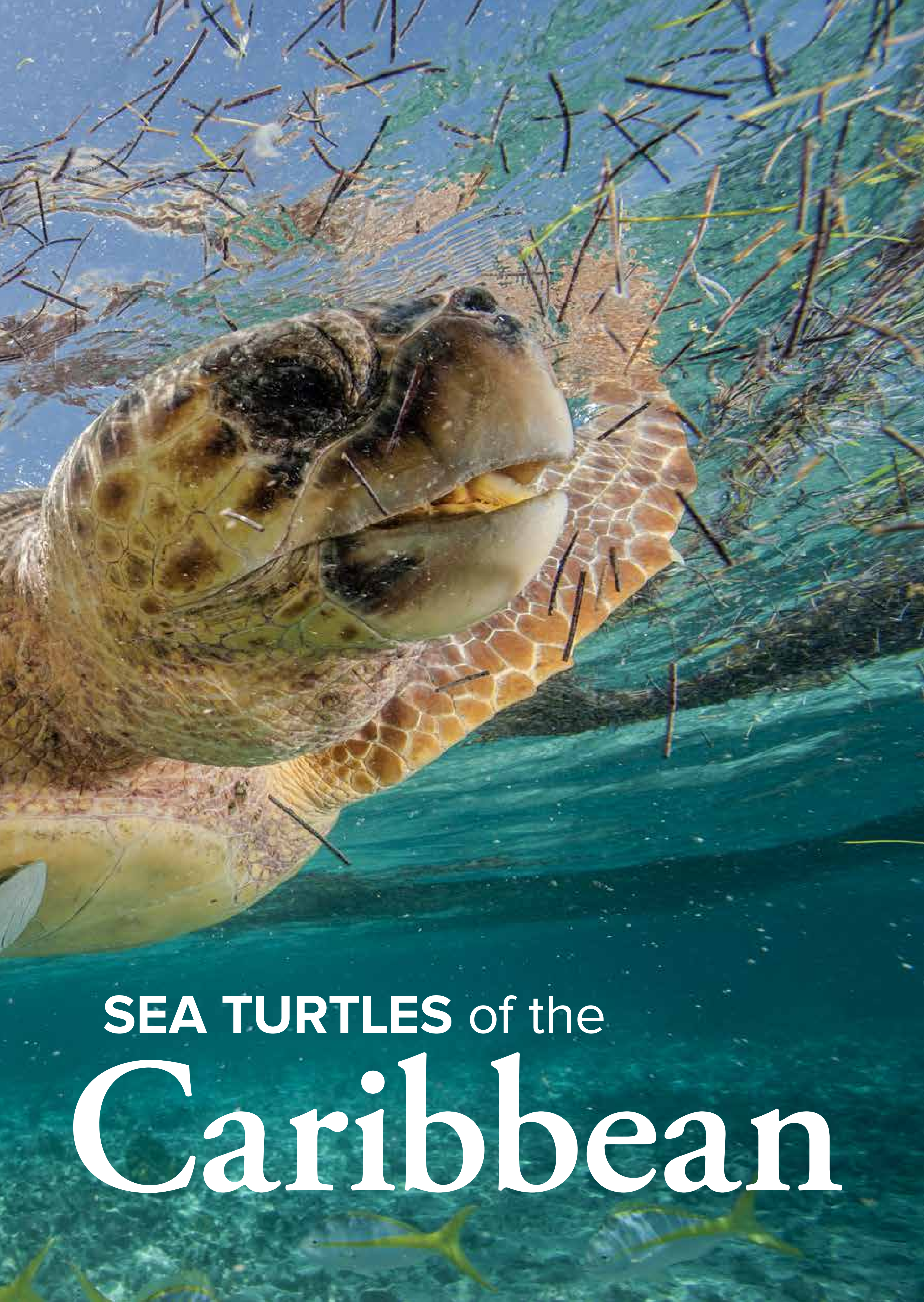
When night falls on the ACG, lone jaguars patrol the beach in search of nesting sea turtles. While hunting, they often take breaks to sit or lie down for anywhere from a few minutes to several hours. When a jaguar discovers a nesting sea turtle, it usually attacks with a crushing bite to the head or neck that kills the animal instantly. The jaguar will then drag the carcass into the vegetation by biting the head, neck, or flippers and walking backward or by lifting it slightly and walking forward. Occasionally jaguars will drag their prey up to 300 meters (328 yards) inland! Jaguars do not eat the whole turtle at once; rather they consume part of the animal and then return later that night or over a period of several nights. At Nancite Beach, one jaguar was observed returning for five consecutive nights to feed on the same carcass!

When the jaguars abandon their kill, researchers can then enter to set up two or three camera traps, positioned to observe the animals as they gather to eat. Individual jaguars can easily be identified by the rosettes in their coat, or pelage; no two jaguars are alike, with unique patterns that are much like fingerprints. By observing these feeding events and comparing images to an existing database, researchers can rapidly develop an understanding of group structure and dynamics.

This study reveals jaguar social behavior that has been reported in only a very few locations across the Americas. For example, multiple unrelated jaguars feeding from the same carcass have now been recorded, including one observation where three different individuals (two of them males) shared a single carcass at the same time. And scenes have been documented of mothers teaching their cubs how to hunt and eat sea turtles.

CAN JAGUARS AND SEA TURTLES COEXIST?

Since 2010, at Nancite Beach (less than 1 kilometer, 0.6 miles, of shore), jaguar predations on sea turtles have averaged between 20 and 50 per year, and the project has identified around 20 individual jaguars. Although some may view these high numbers of jaguars as a reason for concern, the actual number of turtles killed represents less than 1 percent of the local nesting population. Between 2014 and 2019, an average of 37,000 sea turtles nested annually, but jaguars killed only 140. This finding suggests that sea turtles and jaguars can continue to coexist on Nancite Beach, demonstrating how both marine and terrestrial conservation efforts are linked to secure long-term survival of species and their habitats. •



SEA TURTLES of the Caribbean

The countless tranquil beaches of the Caribbean, with their gently lapping waves and fringing palm trees, give the feeling of permanence. Although you could be excused for thinking that these ecosystems—and their sea turtle inhabitants—have remained largely untouched for millennia, this is far from the truth. Sea turtles have provided the people of the Caribbean with a source of food, wealth, and cultural inspiration for more than 2,500 years. They even helped feed the countless European explorers that arrived in the region more than 500 years ago, making foreign colonization possible.

Unfortunately, this pressure has led to considerable declines in the region's sea turtle populations. It is estimated that green turtle populations in the Wider Caribbean Region (WCR) have declined by over 97 percent since precolonial times, and local extinctions of nesting turtles have been widespread in the region. On top of this, more contemporary threats, such as fisheries bycatch, marine pollution, and coastal development, have had a major impact on the turtles of the Caribbean. Yet despite it all, some populations have exhibited impressive recoveries. Today, a devoted network of conservation initiatives are working to restore Caribbean sea turtles to their historic abundance.

The WCR is bounded to the north, west, and south by the continental American landmass, extending from the Florida Peninsula to the northern coast of South America. Running through the center and extending to the east lie a sweeping arc of island states collectively known as the Greater Antilles and the Lesser Antilles. The largest of the Greater Antilles, Cuba, divides the WCR, with the Gulf of Mexico to the northwest and the Caribbean Sea to the southeast. The Gulf of Mexico is approximately 1.55 million square kilometers (about 600,000 square miles), and the Caribbean Sea is almost twice that size at approximately 2.75 million square kilometers (about 1 million square miles). Together with the Lucayan Archipelago (The Bahamas and the Turks and Caicos Islands) to the northeast and the Guianas (Guyana, Suriname, and French Guiana) to the southwest, the Caribbean Sea and the Gulf of Mexico are united in a geopolitically complex region of 43 states and territories known as the WCR.

Six of the world's seven sea turtle species inhabit the diverse marine habitats of the WCR (only the flatback, endemic to Australia, is absent). Green turtles nest at more than 700 sites in the WCR, with Tortuguero, in Costa Rica, hosting the largest aggregation in the region, with more than 100,000 nests per year. Loggerheads primarily nest in the region's northern and southern extremes; the largest nesting aggregation of loggerheads on Earth is found in Florida, U.S.A. Hawksbill turtles nest at more than 1,000 sites, yet most of these populations are very small, and only 10 beaches host more than 1,000 crawls per year. Leatherback turtles nest at more than 450 sites; however, recent reports confirm that nest numbers are declining. The Kemp's ridley is largely confined to the Gulf of Mexico, with only minor nesting on the east coast of Florida, giving it the most restricted nesting range of any sea turtle species globally. Olive ridleys are the least common species, with significant nesting occurring only in French Guiana.

GULF OF MEXICO

The Gulf of Mexico is almost entirely encircled by the continental United States and Mexico, with a combined coastline that extends more than 4,500 kilometers (2,800 miles). The island nation of Cuba lies in the narrow mouth of the Gulf, spanning the gap between Florida and the Yucatán Peninsula. The geography of the Gulf of Mexico leaves it rather isolated from both the Atlantic Ocean and the Caribbean Sea. Thus, it may not be surprising that the Gulf of Mexico hosts its own endemic sea turtle species, the Kemp's ridley (see sidebar, p. 18), which nests predominantly in Tamaulipas, Mexico, with a secondary nesting site in Texas, U.S.A. Kemp's ridley numbers continue to slowly rise from historic lows, though the total nesting population is still a ghost of its 1947 estimated size.

The Gulf of Mexico also harbors some of the largest populations of green, hawksbill, and loggerhead turtles in the WCR. Loggerhead turtles primary nest on both coasts of the Florida Peninsula, hawksbills are more common on the Yucatán Peninsula, and green turtles are found throughout the Gulf. Leatherbacks feed extensively in the Gulf, yet they only nest sporadically on the Yucatán and Florida Peninsulas. The olive ridley has been reported in the region, but it is considered a very rare visitor.

The region's entire continental shelf is a multispecies migratory corridor, foraging zone, and developmental habitat for hawksbills, greens, Kemp's ridleys, and loggerheads. Post-nesting turtles are also known to congregate in several common foraging areas in both the northern and southern Gulf of Mexico, sometimes sharing these feeding zones with postnesting females from the Cayman Islands, Colombia, Costa Rica, and Cuba. The intrinsic spatial dynamics of the Gulf of Mexico as a multispecies, multiuse nexus of sea turtle connectivity for the WCR makes it a unique melting pot and a critical conservation priority.

Because of the abundance and diversity of sea turtles in the Gulf of Mexico, several conservation and monitoring programs have been active in the region for more than five decades. Those ongoing efforts, including a binational head-start initiative (1978–1993) for the Kemp's ridley, have contributed key information on the biology and management of this endemic population while simultaneously helping to restore the once depleted populations of this species.

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AT LEFT: A critically endangered Kemp's ridley sea turtle, a species endemic to the Gulf of Mexico, rests on the seafloor while surrounded by remoras near Pensacola, Florida, United States. © Erin Chandler/@Girlmeetsshark. PREVIOUS SPREAD: A loggerhead turtle swims amid sargassum in Belize's Hol Chan Marine Reserve, with a remora hitching along. © Brian J. Skerry

THE GULF OF MEXICO'S ONLY ENDEMIC SEA TURTLE

The smallest sea turtle in the world, with the tiniest home range and the lowest overall population numbers, the Kemp's ridley has the dubious distinction of being the world's most critically endangered sea turtle.

The uniqueness of the Kemp's ridley stems from the fact that its biology and ecology are fully adapted to the Gulf of Mexico. It is well known for inhabiting coastal and estuarine environments at the base of the numerous river systems that contribute water and nutrients to the Gulf of Mexico. Furthermore, it feeds on invertebrates such as blue crabs that flourish in those nutrient-rich estuarine environments. But the most distinctive aspect of the Kemp's ridley is its reproductive biology. The entire species migrates to a single primary nesting beach near Rancho Nuevo, Mexico, where it exhibits a daytime mass nesting (*arribada*) behavior that can involve thousands of turtles coming ashore nearly simultaneously on one small stretch of beach. This unique phenomenon enhances the production and survival of hatchlings, which are carried by currents away from Rancho Nuevo and eventually into developmental habitats throughout the Gulf of Mexico and along the Atlantic coast of the United States.

The Kemp's ridley also has a cultural history that spans the entire Gulf of Mexico. Although all major nesting occurs in the far western Gulf of Mexico, this species was initially described far to the east, in the Florida Keys, in 1880. The discovery started a scientific riddle (an abundant species with no known nesting beach?) that took more than 80 years to solve. By the time the Kemp ridley's remote Mexican nesting beach was finally discovered by the scientific community in 1963, the population was already in steep decline, and by the mid-1980s the species was on the brink of extinction, with only a few hundred females nesting each year at Rancho Nuevo. Its spiral toward extinction launched one of the most comprehensive and successful conservation efforts on record.

The binational program included heroic efforts by a wide variety of agencies, organizations, and individuals; an expensive and risky binational experiment to establish nesting beaches in Texas, U.S.A.; and even a massive program to implement the use of turtle excluder devices on shrimp boats throughout the Gulf and southeast Atlantic coast of the United States. By the early 2000s, the effects of these valiant efforts were obvious; the Kemp's ridley was on an exponential recovery trajectory that was expected to continue for decades. However, the recovery hit an unexpected slowdown in 2010. The reasons for this latest riddle in the ridley story are not clear, but the binational conservation efforts are continuing, and for now, the Gulf of Mexico continues to embrace its own unique species of sea turtle, the Kemp's ridley.

Yet, as in the rest of the WCR, sea turtles in the Gulf of Mexico still face a variety of cumulative and growing threats, ranging from fisheries bycatch to sometimes extreme recreational use of beaches; urban and coastal infrastructure; pollution (solids, chemicals, and even light and sound); climate change impacts (increasingly intense storms, beach erosion, coral bleaching, and more); and devastating stony coral tissue loss disease. Perhaps the most alarming threat is the specter of large-scale hydrocarbon exploration and extraction, which in 2010 resulted in the disastrous Deepwater Horizon oil spill (see *SWOT Report*, vol. VI, pp. 16–21). The scale of that event was such that, even a decade later, its impacts on sea turtles are not yet fully understood.

CENTRAL AMERICA

The Caribbean coastline of Central America, stretching south about 3,875 kilometers (2,400 miles) from Cancún, Mexico, on the Yucatán Peninsula through Belize, Guatemala, Honduras, Nicaragua, Costa Rica, and Panama, forms the western boundary of the Caribbean Sea. In general, this coastline hosts relatively small nesting turtle populations, with the major exceptions of Costa Rica and Panama. In Costa Rica, Tortuguero hosts more than 100,000 nests each year, making it one of the largest green turtle nesting sites in the world. The conservation and research program at this site was initiated by Dr. Archie Carr and has been carried out continuously by the Sea Turtle Conservancy since 1959, making it the longest-running and one of the most iconic sea turtle conservation initiatives in the world. In Panama, a cluster of beaches in the Bocas del Toro region hosts large nesting populations of both hawksbill and leatherback turtles. A monitoring program carried out by the Conservancy documents more than 2,000 hawksbill nests and more than 5,000 leatherback nests each year in the region.

The Caribbean coastline of Central America features countless estuaries, nearshore islands, coral reefs, and deep-ocean habitats, providing vital migratory corridors, nesting beaches, and foraging areas for sea turtles. The Mesoamerican Barrier Reef, which stretches more than 1,000 kilometers (620 miles) along the northernmost four countries of the region and the expansive continental coast of Nicaragua, provides extensive shallow-water foraging habitats for marine turtles. Indigenous and ethnic coastal communities have been fishing turtles for hundreds of years for subsistence, trade, and commerce, and very likely turtles were the first fishery export for many Caribbean nations. Although some of this activity is legal, illegal take also persists well beyond the exemptions for traditional use granted by authorities in Belize and Nicaragua. Today, at least 7,000 green turtles are killed annually in the Nicaraguan fishery, down from a high of 10,000 annually in the mid-1990s. Turtles captured with tags from research and conservation programs throughout the WCR are carefully monitored by a dedicated team from the Archie Carr Center for Sea Turtle Research at the University of Florida.

Of particular concern for both sea turtles and their protectors is the overlap between sea turtle nesting and narcotics trafficking. In 2013, a dedicated volunteer, Jairo Mora Sandoval, was brutally murdered in Costa Rica while protecting leatherback nests. Drug trafficking in other Central American nations also hinders regular monitoring of nesting beaches and is often associated with illegal sea turtle commerce. Recent investigations by SEE Turtles and its "Too

The conservation and research program … was initiated by Dr. Archie Carr and has been carried out continuously … making it the longest-running and one of the most iconic sea turtle conservation initiatives in the world.

Rare to Wear" campaign found that the hawksbill shell trade remains a threat in Costa Rica and all countries in the region, even though the species is protected by law in most.

In general, active threats mirror those encountered elsewhere in the WCR, including unsustainable (and often illegal) fisheries bycatch; direct take for meat and eggs; habitat loss and degradation; and the less quantifiable impacts of climate change, pollution, and disease. In recent years, the region has experienced dramatic influxes of *Sargassum*, a genus of brown algae that has blanketed pelagic waters and beaches. These blooms, likely a result of increases in agricultural runoff, have smothered many WCR nesting beaches, caused turtle drownings, and made it difficult for adults to nest and hatchlings to crawl to the ocean. Long-standing issues with urban expansion and beachfront development continue to displace nesting females, artificial coastal lighting lures thousands of hatchlings to their deaths, and shoreline erosion and the erection of sea walls contribute to the disappearance of historic nesting grounds.

Many government agencies, nonprofits, and community organizations are working diligently to conserve the Mesoamerican sea turtle fauna; still, population recovery efforts often face seemingly insurmountable challenges and opposition from stakeholders, as well as legal loopholes that make protecting sea turtles and their habitats difficult. Making the case for conservation increasingly requires collaborative research—such as that undertaken by Pronatura Península de Yucatán, Cinvestav Unidad Mérida, Universidad Autónoma del Carmen, ECOMAR, Marymount University, Hawksbill Hope, ProTECTOR Inc., Wildlife Conservation Society, and Sea Turtle Conservancy—into using satellite telemetry to monitor sea turtle migrations. Data from such research have helped to focus attention on migratory hotspots and other critical habitats.

NORTHERN SOUTH AMERICA

Extending east from the Isthmus of Panama, the nations of Colombia and Venezuela form the southern border of the Caribbean Sea. The annual southern Caribbean upwelling system brings nutrient-filled waters from the deep ocean onto the continental shelf, nurturing highly productive commercial and artisanal fisheries. While providing an important local source of nutrition and income, many of these fisheries also incur substantial sea turtle bycatch. Tackling this issue while safeguarding depleted nesting populations is among the many complex problems that must be addressed before sea turtle recovery can be achieved.

Historical reports indicate significant numbers of nesting sea turtles on the coasts of Colombia and Venezuela, yet today these numbers are very low and, despite persistent conservation efforts, continue to decline. For example, on the Paria and Guajira Peninsulas, several hundred loggerheads were estimated to have nested annually in the first half of the 20th century, yet today fewer than 50 individuals nest there annually. The widespread harvest of eggs and intentional take by artisanal fisheries are implicated in the demise (see pp. 34–35).

Current sociopolitical and economic challenges in Venezuela are hampering sea turtle conservation efforts nationwide. Nonetheless, several university groups, conservation organizations, and government agencies are striving to maintain vital protection efforts through a combination of nest monitoring, environmental education, and general outreach efforts. These organizations include the Ministerio del Poder Popular para el Ecosocialismo (formerly the Ministerio del Ambiente); the Centro de Investigación y Conservación de Tortugas Marinas (CICTMAR, the lead organization for the Wider Caribbean Sea Turtle Conservation Network [WIDECAST] in Venezuela); ConBiVe (Asociación Civil para la Conservación de la Biodiversidad Venezolana); Fundación La Tortuga; Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela; the University of Zulia; and other organizations in Colombia.

Offshore to the northwest of Venezuela's capital city, Caracas, lie the "ABC" islands, the Dutch islands of Aruba, Bonaire, and Curaçao. All three islands have strong local sea turtle research and conservation histories led by WIDECAST affiliates TurtugAruba, Sea Turtle Conservation Bonaire, and Sea Turtle Conservation Curaçao, respectively. The longest running of these organizations has led in-water and nesting beach monitoring programs for decades in Bonaire and is now working to curtail the invasive seagrass *Halophila stipulacea*. Among its many creative endeavors, Sea Turtle Conservation Curaçao is making significant strides in reducing pollution by taking local action in repurposing postconsumer plastic.

Unlike the shorelines of Colombia and Venezuela, the eastern countries of Guyana, Suriname, and French Guiana host substantial nesting populations of green, leatherback, and olive ridley sea turtles. These countries, collectively known as the Guianas, contain the largest remaining expanse of coastal wilderness in the tropics and are well known for their muddy mangrove coasts and shifting shorelines. Influenced by the North Brazil Current, entire stretches of beaches can be deposited or vanish within a matter of weeks, leading to significant geographic shifts in nesting habitat within and between seasons. Situated across the Gulf of Paria from Venezuela, Trinidad and Tobago host the hemisphere's largest remaining nesting assemblage of leatherback turtles on Trinidad's north (Grand Riviere) and east (Matura) beaches, monitored by community-based organizations.

The most significant anthropogenic threat to sea turtles along the northern tier of South America is from fisheries bycatch. Although the use of turtle excluder devices (TEDs) by shrimp trawlers has been required by law in Guyana and Suriname for more than 20 years, this requirement has only recently had the force of law in French Guiana.

Trawling has been illegal since 2009 in Venezuela, though artisanal fisheries are still responsible for notable sea turtle mortalities. Specifically, Wayuu indigenous communities capture more than 3,800 mostly juvenile green turtles each year on the Venezuelan side of the Guajira Peninsula (see *SWOT Report*, vol. XIII, pp. 34–35); the numbers may be higher on the Colombian side. Bycatch data are scarce for Colombia, which has been one of the main drivers for the recent creation of a National Comanagement Committee for Bycatch, led by the National Fisheries Authority (Autoridad Nacional de Acuicultura y Pesca, or AUNAP) and the Marine and Coastal Research Institute (Instituto de Investigaciones Marinas y Costeras, or INVEMAR), along with a number of Colombian nongovernmental organizations.

LESSER ANTILLES AND AVES RIDGE

A sweeping island arc known as the Lesser Antilles forms the eastern boundary of the Caribbean Sea. A complex sociopolitical mix of nations and overseas territories, the Lesser Antilles provide nesting habitat for green, loggerhead, hawksbill, and leatherback turtles, as well as a variety of shallow- and deep-water habitats. The countries of the Lesser Antilles face many issues common to the WCR, including coastal development (loss of coastal vegetation and increased beachfront lighting), beach erosion, beach remediation activities that alter the incubation environment, direct and incidental capture by nearshore fisheries, pollution, and climate change. Research shows that biodiversity loss and the threat of localized extinction is heightened in small island developing states, where a diversity of cultural, political, and ecological landscapes add layers of complexity to conservation initiatives.

The coral island of Barbados hosts the largest nesting population of hawksbills in the Lesser Antilles, with more than 600 females recorded annually. The population has increased considerably over the past 30 years, a result of legislation banning direct harvest as well as ongoing conservation actions led by the WIDECAST-affiliated Barbados Sea Turtle Project (BSTP) at the University of the West Indies. Sea turtles are a major tourist attraction for the island, and BSTP's Marine Turtle Tagging Centre provides free flipper tags, equipment, and training to field projects throughout the region.

Aves Island (Venezuela) hosts nesting green turtles in numbers that exceed all other islands in the Lesser Antilles and most locations on the South American continent, along with significant numbers of males and females that congregate for courtship and mating (see *SWOT Report*, vol. XIII, pp. 10–11). In less than 30 years, monitoring data collected by FUDENA (Fundación para la Defensa de la Naturaleza), the Ministerio del Poder Popular para Ecosocialismo, and the Venezuelan Institute of Scientific Research (Instituto Venezolano de Investigaciones Científicas, or IVIC) have shown that the number of nesting green turtles on Aves Island has doubled to more than 1,000 turtles per year.

Saint Vincent and the Grenadines has made significant progress in sea turtle conservation by legally protecting all life stages of all species of sea turtles in national waters since January 2017. The Ministry of Agriculture, Forestry, Fisheries, and Rural Transformation, in collaboration with the National Parks, Rivers, and Beaches Authority and partners such as the Saint Vincent and the Grenadines Environment Fund and the Saint Vincent and the Grenadines National Trust, is using best practices developed by the WIDECAST network in education, outreach, and sustainable livelihoods.

Saint Lucia is one of only a handful of nations in the WCR that still sanctions an annual open season (October–December) for hunting sea turtles. It is based on minimum size limits and includes

A leatherback turtle finishes camouflaging her nest as the sun rises in Grande Riviere, Trinidad. © Ben J. Hicks/benjhicks.com

all hard-shelled species. Marine protected area managers, in particular at the Pointe Sable Environmental Protection Area, are working to collect sea turtle and habitat monitoring data. The Saint Lucia National Trust shares nesting beach monitoring findings in infographic format to bring greater accessibility to data that can help to drive more sustainable sea turtle management practices.

Grenada hosts the largest population of nesting leatherbacks in the Lesser Antilles and also provides prime nesting, foraging, and developmental habitats for hawksbills, greens, and loggerheads. Over the past 20 years, several hundred leatherback nests have been recorded annually at Levera Beach by Ocean Spirits, a local nonprofit that relies entirely on volunteers. Ocean Spirits has a strong presence in local schools, and more than 7,000 students have heard its conservation message. National legislation has protected leatherback turtles since 2001, but Grenada has a seasonal fishery for hard-shelled species, and it is the only country in the region that legally allows the sale of turtle shell products.

Sint Eustatius in the northern Lesser Antilles hosts small nesting populations of green and hawksbill turtles. The island's characteristic black volcanic sand beaches are hot, which has been found to give rise to a female hatchling bias. Projections indicate that only 2.4 percent of green turtle hatchlings will emerge as male by 2030. The St. Eustatius National Parks Foundation (STENAPA) has been at the forefront of sand temperature research and the development of management strategies to artificially lower incubation temperatures by watering, shading nests, or relocating nest clutches to deeper depths.

Antigua hosts one of the region's longest-running research and monitoring programs, the Jumby Bay Hawksbill Project, a WIDECAST initiative that has studied a protected population of nesting hawksbills since 1987 with funding from a local homeowners association. Recent data suggest that after more than a decade of growth, the population may be in significant decline, and understanding the cause of this decline is a crucial direction for future research.

Further north in the British Virgin Islands, in-water monitoring of hawksbills and other species is undertaken by the Association of Reef Keepers (ARK), with the involvement of the government and private sectors. ARK emphasizes social entrepreneurship for conservation.

Alongside these diverse local scenarios, there is a persistent tension with the region's largest economic driver—tourism. "Swim with the turtles" and related hand-feeding operations are becoming an increasingly common method to artificially maintain localized turtle aggregations for viewing in water. Although these activities can bring sustainable livelihoods for local communities, turtles may suffer from improper diet, compromised migratory movements, and an affinity for humans that can lead to boat strikes, gear entanglement, injury, and disease. The social media thirst for "turtle selfies" is a complicating factor, making it difficult to manage this new tourism product.

GREATER ANTILLES

The Greater Antilles make up nearly 90 percent of the landmass of the entire West Indies, as well as over 90 percent of its population on the islands of Cuba, Hispaniola (Haiti and the Dominican Republic), Puerto Rico, and Jamaica, as well as the Cayman Islands. People in the region have been actively harvesting sea turtles for centuries, causing local extinctions in many areas.

The longest-running conservation program is in Cuba, which began monitoring the impacts of harvesting on four turtle species more than 40 years ago. Cuba closed its sea turtle fishery in 2008, and conservation efforts have increased considerably since then. Cuban and international partners have expanded outreach campaigns and undertaken studies of illegal trade, in addition to important research on genetics, migration, and climate change. Seventy-nine beaches are monitored, and upward trends are observed in some areas.

Among the islands of the Greater Antilles, Hispaniola has arguably seen the largest declines in nesting turtles. Today, only sporadic reports of nesting occur in Haiti, and a small rehabilitation center operated by the Haiti Ocean Project has recently opened to address issues of entanglement and injury. Several programs monitor and protect the

WIDECAST

The Wider Caribbean Sea Turtle Conservation Network

WIDECAST, the Wider Caribbean Sea Turtle Conservation Network, is the largest regional network of sea turtle research and conservation actors in the world. Volunteer country coordinators serve in 45 nations and territories, and the network emphasizes science-based tools in research; policymaking; and community conservation, outreach, and microenterprise development.

Founded in 1981, WIDECAST is a Regional Activity Network of the United Nations Caribbean Environment Programme and serves as a framework to promote policies and practices that advance sea turtle recovery regionwide. The network develops and mentors projects, promotes standardized data collection and sharing, and promotes links between science, policy, and public participation at a variety of scales. With country coordinators strategically located throughout the Wider Caribbean Region, WIDECAST is uniquely positioned to facilitate conservation action within and between range states. By strengthening national and regional regulatory regimes, encouraging community engagement, and raising public awareness, the network has had measurable impacts on the protection and sustainable management of sea turtles.

In partnership with WIDECAST, most Caribbean nations have developed and implemented national sea turtle recovery action plans—and most important, these efforts are working. Steady declines have been seen in poaching and illegal product sales across the Caribbean, major nesting beaches are protected, and the region's largest breeding colonies are regularly monitored. Moreover, through WIDECAST's powerful network of country coordinators and local project affiliates, sea turtles are more likely to be considered in national policy debates, and alternative livelihood models are further reducing pressure on remnant populations.

nests of leatherback, hawksbill, and green turtles across the border in the Dominican Republic, and in-water surveys conducted since 1997 have identified hawksbill foraging areas on the southwest coast.

Puerto Rico has seen an increase in conservation efforts since the Department of Natural and Environmental Resources began delegating sea turtle management and conservation to community-based groups in 2010. The partnership has promoted beach cleanups, developed a stranding and rehabilitation response protocol, and expanded efforts to safeguard nests and adults from poachers and invasive species. Data from these local efforts have also contributed to the designation of protected areas, and long-term in-water surveys of green and hawksbill turtles at Mona and Culebra islands have greatly increased our understanding of sea turtle population dynamics in Puerto Rico and beyond. The collaboration between government agencies and community-based groups has been a powerful force for management and conservation, which we hope will lead to measurable population recoveries.

Green, hawksbill, loggerhead, and leatherback turtles once nested throughout Jamaica. Today, only 10 Jamaican beaches receive more than an occasional hawksbill nest. Green and leatherback nesting is very rare, and loggerheads are gone. Concern over the effects of an unregulated take was expressed at an early stage in Jamaica's history (the first law controlling the collection of eggs was introduced in 1711), but sea turtle meat remained important to the Jamaican diet well into the 20th century. Aerial, interview, and ground surveys began in 1981 to catalog what remained, and sea turtles were fully protected in 1982. A partnership with WIDECAST produced a comprehensive national recovery plan in 2011 that continues to guide conservation efforts.

The Cayman Islands, which hosted globally important nesting populations of sea turtles over two centuries ago, has seen these populations reduced to only a few hundred individuals, and in 2013, full protection of sea turtles was mandated by law. The well-known Cayman Turtle Centre was established as a commercial turtle farm in 1968, and a captive herd annually breeds tens of thousands of green turtle hatchlings that, through a still controversial program, are released to the wild. Genetic studies have shown that the majority of wild nesting individuals in the Caymans are now related to these farm-reared individuals. Since 1998, the Department of Environment has been conducting systematic beach surveys and has learned that hawksbills hover at the edge of extinction. However, loggerhead and green turtle populations are showing signs of recovery, increasing from fewer than 50 nests in the early years of monitoring to more than 600 nests in 2017.

LUCAYAN ARCHIPELAGO

The Lucayan Archipelago consists of the Commonwealth of The Bahamas and the Turks and Caicos Islands (TCI), the latter a British Overseas Territory. The archipelago is instantly identifiable from satellite imagery owing to the Bahama Banks, which are shallowly submerged carbonate platforms that make the waters of the region appear a distinct peacock blue. The numerous seabed and mangrove systems are inhabited by abundant populations of juvenile green turtles. Loggerhead and hawksbill turtles are also common, although they are seen mainly in deeper coral reefs. Understandably, almost all sea turtle monitoring in the region has focused on in-water data collection. Although substantial numbers of tags have been deployed, most monitoring efforts are relatively opportunistic, and long-term datasets in fixed habitats are rare.

The Bahamas comprises 700 islands distributed over 259,000 square kilometers (100,000 square miles) of ocean. The archipelago has never been thoroughly surveyed for sea turtle nesting, but the data suggest that green, loggerhead, and hawksbill turtles nest at low densities at several sites; leatherbacks are rare. All have been fully protected since 2009. Threats include poaching of eggs and turtles, beachfront lighting, coastal development, seagrass and coral reef degradation, entanglement in fishing gear, and marine pollution. The Bahamas National Trust sponsors a broad portfolio of conservation and research projects, often in partnership with universities or the government. Such projects include a long-term study of foraging green turtles at Great Inagua, conducted with colleagues at the Archie Carr Center for Sea Turtle Research at the University of Florida. The Bahamian government is committed to protecting at least 20 percent of its nearshore marine environment by 2020, including many critical turtle foraging areas.

The 8 main islands and more than 22 smaller islands that make up the TCI have a total land area of only 616 square kilometers (238 square miles). There has been a long tradition of harvesting sea turtles for meat in the Lucayan Archipelago, and this practice is still legal in TCI, where a seasonal fishery for hawksbill and green turtles is bounded by minimum and maximum size limits. More progressive than the minimum size limits that typically characterize Caribbean sea turtle fisheries, maximum size limits offer a degree of protection to reproductively active adults, arguably the most ecologically valuable animals in any population.

A number of research projects have been conducted in TCI in recent years, often in partnership with the Marine Conservation Society, the Cape Eleuthera Institute, and the University of Exeter in the United Kingdom. The projects include mark and recapture; genetic sampling; mixed stock analysis; and studies of diet (stable isotopes), sex ratios, and seasonality of occurrence. The genetic sampling suggests that more than half of all foraging green turtles originate in Costa Rica, whereas the majority of hawksbills originate in Cuba and the U.S. Virgin Islands. The primary threat to stock recovery is the ongoing—legal and illegal—take of eggs and turtles. A new threat is the emergence of stony coral tissue loss disease affecting coral reefs of the territory.

CONCLUSION

The history of humans and sea turtles in the WCR is inextricably intertwined. Providing a staple food for both indigenous peoples and colonists, sea turtles became an important component of many local cultures. Yet direct harvest over hundreds of years has driven many sea turtle populations to near extinction. In recent decades, renewed commitment to protective legislation, safeguarding of habitat, and antipollution initiatives have reversed the fortunes of many sea turtle populations, helping put them back on the road to recovery.

The hard work of conservationists has paid off in numerous policy accomplishments. Intergovernmental meetings devoted to addressing shared management concerns have been convening in the region for more than three decades. The majority of WCR nations and territories now fully protect sea turtles both on land and at sea. All six WCR sea turtle species are on the IUCN (International Union for Conservation of Nature) Red List of Threatened Species, with loggerheads, leatherbacks, and Kemp's ridleys now listed at the regional management unit (subpopulation) scale. All species are also listed in Annex 2 (full protection) of the Protocol Concerning Specially Protected Areas and Wildlife to the Cartagena Convention, as well as Appendix 1 (full protection) of the Convention on Migratory Species and Appendix 1 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. They also fall under the aegis of the Inter-American Convention for the Protection and Conservation of Sea Turtles.

Although legal exceptions for traditional or subsistence use are recognized in some cases, illegal harvest is reported, to varying degrees, regionwide. That said, extraterritorial trade in turtle products (meat and shell), mainly to Asia, has stopped, and direct take is declining in many cases as a result of stronger regulations, generational shifts in conservation attitude, and greater recognition that sea turtles are generally worth more alive than dead. Other threats remain entrenched, including fisheries bycatch; coral reef, beach, and seagrass degradation; pollution (oil spills, chemical waste, and persistent plastic and other marine debris); and climate change. These are regionwide problems, and they require solutions at scale. Sea turtle survival will ultimately hinge on the success of international collaborations between the region's diverse continental states and small islands. The networking model embraced by WIDECAST is an example of a long-term, successful collaboration that has reaped considerable rewards, not only for sea turtles but also for the communities that traditionally relied on them. As collaboration continues to grow, we expect that the WCR will once again become a haven for future generations of sea turtles. •

FEATURE MAPS

Biogeography of Sea Turtles in the Caribbean Sea

The maps on pp. 24–27 display available nesting and satellite telemetry data for the six sea turtle species found in the Wider Caribbean Region.

Nesting Map

The map of nesting biogeography (pp. 24–25) is based almost exclusively on nesting data that were provided by members of the WIDECAST network (see sidebar, p. 21) to create the *Atlas of Sea Turtle Nesting Habitat for the Wider Caribbean Region* (Eckert and Eckert 2019). That exhaustive digital inventory documented more than 1,341 nesting beaches representing 2,667 species-specific nesting sites among the 45 nations and territories that comprise the WIDECAST network.

For the purposes of the map on pp. 26–27, we chose to display data on all six species that nest within the Caribbean region on a single map. Although they were included in the *WIDECAST Atlas*, we chose to exclude Brazil and Bermuda in order to simplify the extent of the map (see *SWOT Report*, vol. XI, pp. 20–21 for a summary of nesting in Brazil). Additional data were incorporated from the SWOT database for large nesting sites (those with >10,000 crawls per year) to further distinguish between nesting sites with 10,001–100,000 crawls per year and those with greater than 100,000 crawls per year (from all species combined). Complete data citations for all source data can be found on pp. 46–51 of this report.

Nesting sites are represented by dots that are colored according to the species present. The proportion of nesting by each species is indicated by the colors shown within the dot. The dots are scaled according to the total nesting abundance for all species at that site.

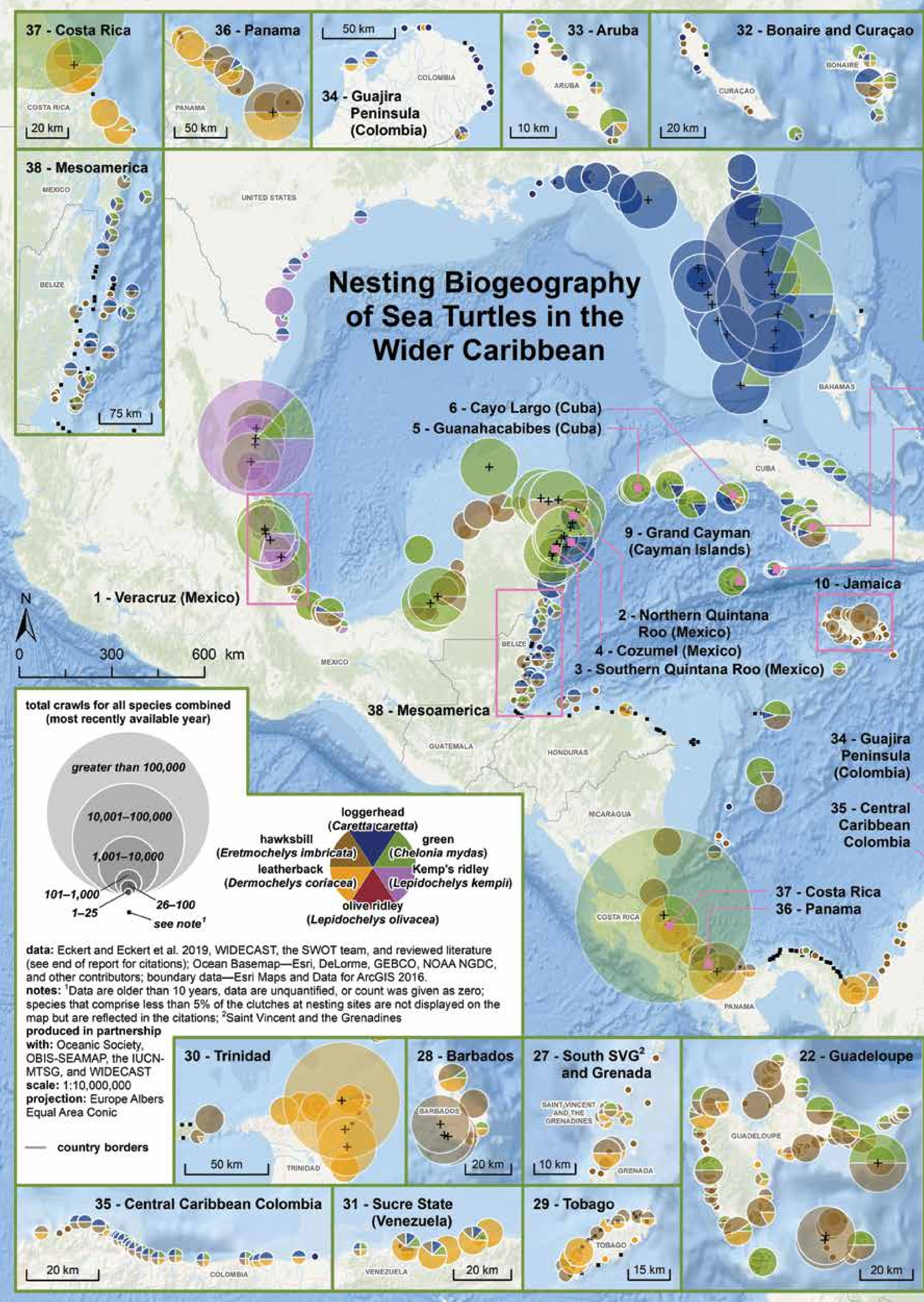
For a more comprehensive presentation of sea turtle nesting data in the Wider Caribbean Region, including species-specific maps, trend data, and detailed supplementary information, see the *WIDECAST Atlas* at https://widecast.org/widecast-publications.

Satellite Telemetry Map

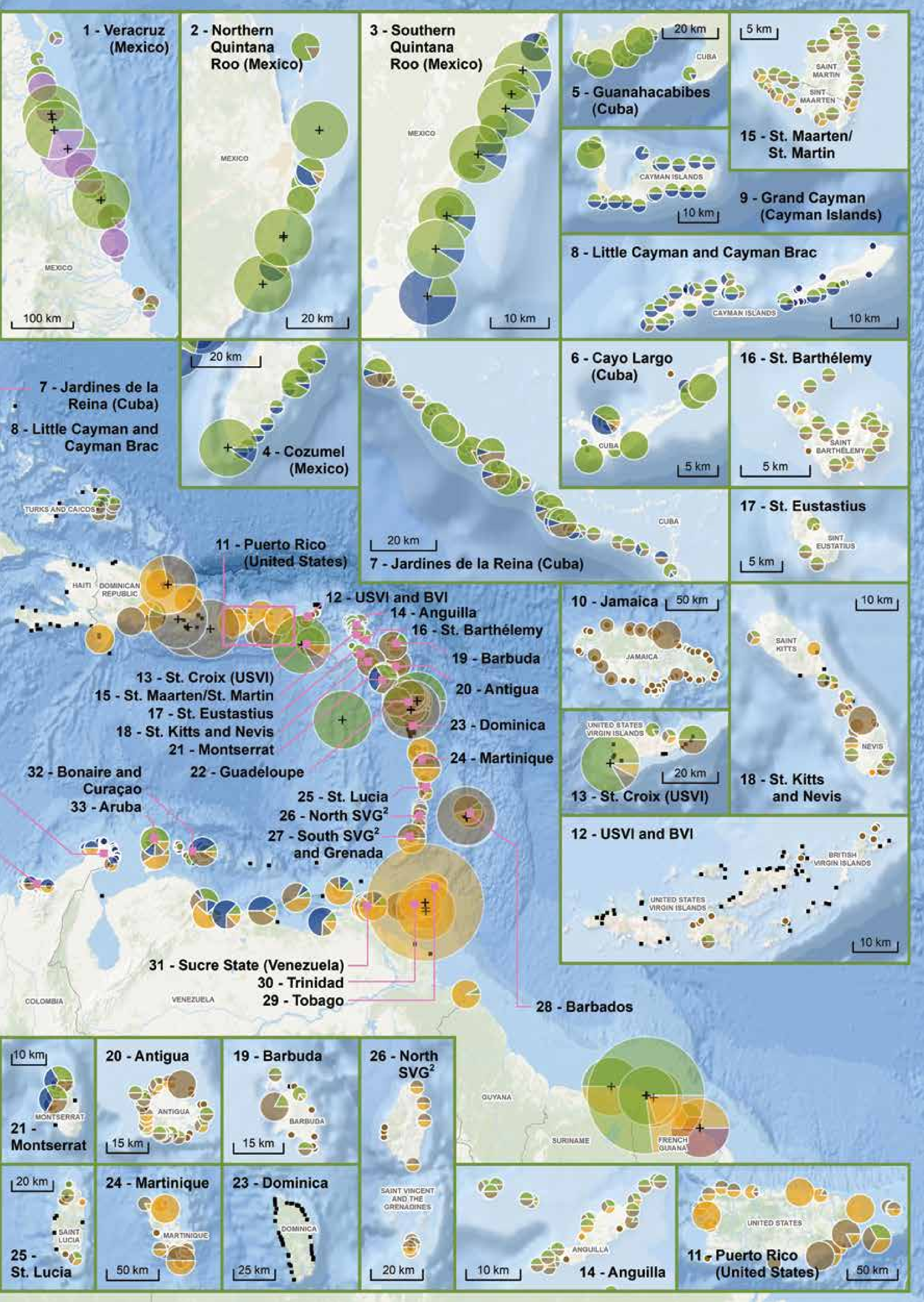
The map of sea turtle satellite telemetry data on pp. 24–25 summarizes all available telemetry data from tags deployed in the Wider Caribbean Region. The data consist of more than 350,000 locations from 626 individually tracked turtles and were contributed by more than 36 different partners (see data citations, pp. 46–51). 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. For a complete list of data providers and available metadata, see pp. 46–51.

The maps on the lower right of p. 27 show the six regional management units (or subpopulations) of the six sea turtles residing in the Wider Caribbean Region, overlain with species-specific satellite telemetry data. The regional management units were defined by Wallace et al. in 2010 by combining telemetry, genetics, tagging, and nesting data.

We are deeply grateful to all of the data contributors and projects that participated in this effort, and especially to the WIDECAST network, Dr. Karen Eckert, and Adam Eckert for their collaboration. Please see the complete data citations for all maps beginning on p. 46 for details.

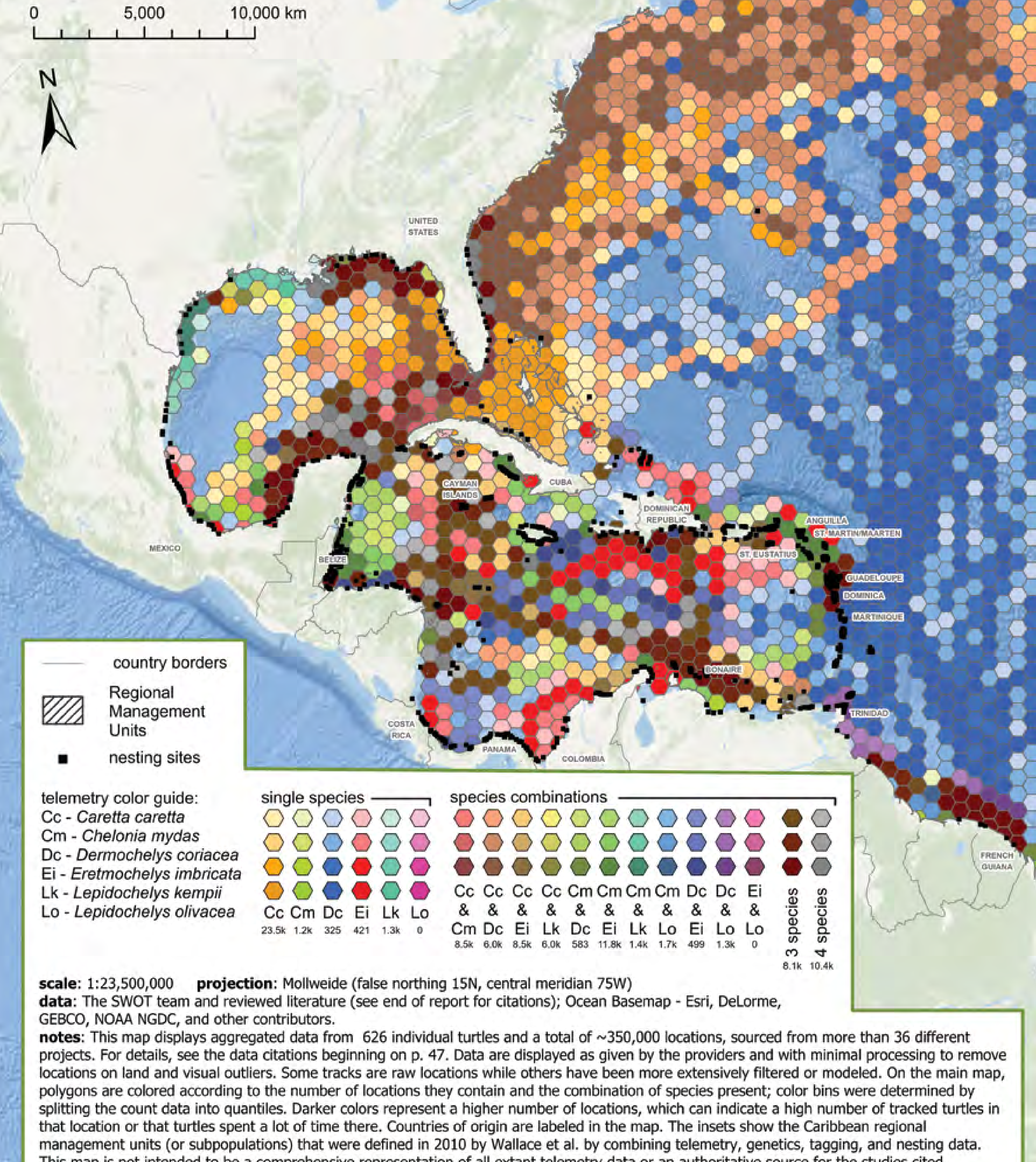


Nesting Biogeography of Sea Turtles in the Wider Caribbean
37 - Costa Rica
COSTA RICA
20 km
36 - Panama
PANAMA
50 km
50 km
34 - Guajira Peninsula (Colombia)
COLOMBIA
33 - Aruba
ARUBA
10 km
32 - Bonaire and Curaçao
BONAIRE
CURAÇAO
20 km
38 - Mesoamerica
MEXICO
BELIZE
75 km
UNITED STATES
BAHAMAS
CUBA
6 - Cayo Largo (Cuba)
5 - Guanahacabibes (Cuba)
9 - Grand Cayman (Cayman Islands)
10 - Jamaica
1 - Veracruz (Mexico)
2 - Northern Quintana Roo (Mexico)
4 - Cozumel (Mexico)
3 - Southern Quintana Roo (Mexico)
38 - Mesoamerica
N
0
300
600 km
MEXICO
BELIZE
GUATEMALA
HONDURAS
NICARAGUA
COSTA RICA
PANAMA
34 - Guajira Peninsula (Colombia)
35 - Central Caribbean Colombia
37 - Costa Rica
36 - Panama
total crawls for all species combined (most recently available year)
greater than 100,000
10,001–100,000
1,001–10,000
101–1,000
26–100
1–25
see note[1]
loggerhead (Caretta caretta)
hawksbill (Eretmochelys imbricata)
green (Chelonia mydas)
leatherback (Dermochelys coriacea)
Kemp's ridley (Lepidochelys kempii)
olive ridley (Lepidochelys olivacea)
data: Eckert and Eckert et al. 2019, WIDECAST, 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; species that comprise less than 5% of the clutches at nesting sites are not displayed on the map but are reflected in the citations; [2]Saint Vincent and the Grenadines
produced in partnership with: Oceanic Society, OBIS-SEAMAP, the IUCN-MTSG, and WIDECAST
scale: 1:10,000,000
projection: Europe Albers Equal Area Conic
country borders
30 - Trinidad
TRINIDAD
50 km
28 - Barbados
BARBADOS
20 km
27 - South SVG[2] and Grenada
SAINT VINCENT AND THE GRENADINES
GRENADA
10 km
22 - Guadeloupe
GUADELOUPE
20 km
35 - Central Caribbean Colombia
COLOMBIA
20 km
31 - Sucre State (Venezuela)
VENEZUELA
20 km
29 - Tobago
TOBAGO
15 km



1 - Veracruz (Mexico)
2 - Northern Quintana Roo (Mexico)
3 - Southern Quintana Roo (Mexico)
5 - Guanahacabibes (Cuba)
15 - St. Maarten/ St. Martin
9 - Grand Cayman (Cayman Islands)
8 - Little Cayman and Cayman Brac
4 - Cozumel (Mexico)
6 - Cayo Largo (Cuba)
16 - St. Barthélemy
17 - St. Eustastius
7 - Jardines de la Reina (Cuba)
10 - Jamaica
13 - St. Croix (USVI)
18 - St. Kitts and Nevis
12 - USVI and BVI
11 - Puerto Rico (United States)
14 - Anguilla
19 - Barbuda
20 - Antigua
21 - Montserrat
22 - Guadeloupe
23 - Dominica
24 - Martinique
25 - St. Lucia
26 - North SVG[2]
27 - South SVG[2] and Grenada
28 - Barbados
29 - Tobago
30 - Trinidad
31 - Sucre State (Venezuela)
32 - Bonaire and Curaçao
33 - Aruba
MEXICO
CUBA
CAYMAN ISLANDS
SAINT MARTIN
SINT MAARTEN
SAINT BARTHÉLEMY
SINT EUSTATIUS
TURKS AND CAICOS
HAITI
DOMINICAN REPUBLIC
JAMAICA
UNITED STATES VIRGIN ISLANDS
BRITISH VIRGIN ISLANDS
SAINT KITTS
NEVIS
COLOMBIA
VENEZUELA
GUYANA
SURINAME
FRENCH GUIANA
MONTSERRAT
ANTIGUA
BARBUDA
SAINT VINCENT AND THE GRENADINES
SAINT LUCIA
MARTINIQUE
DOMINICA
ANGUILLA
UNITED STATES
100 km
20 km
10 km
5 km
50 km
15 km
25 km

Sea Turtle Satellite Telemetry Data in the Wider Caribbean

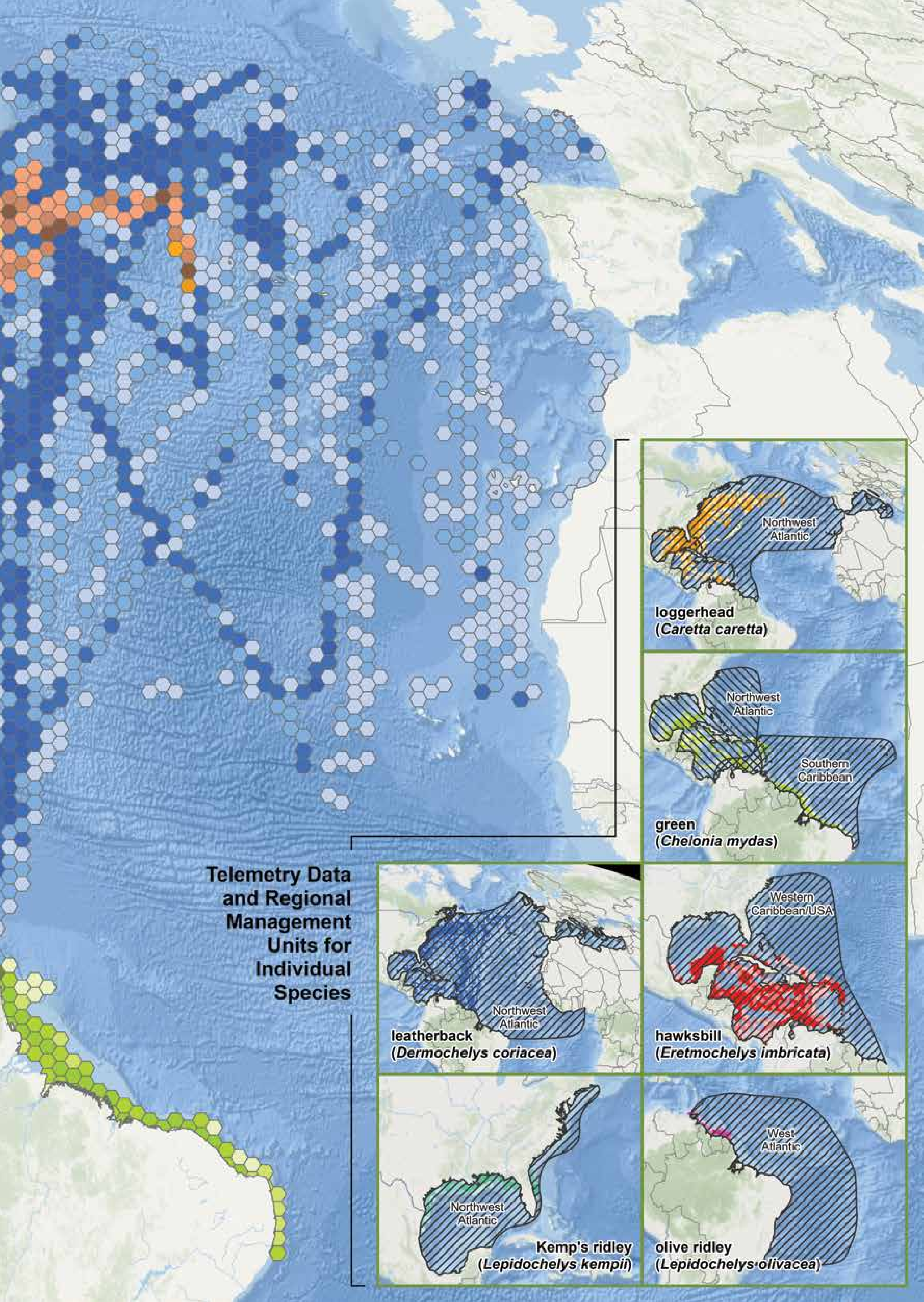


scale: 1:23,500,000 **projection**: Mollweide (false northing 15N, central meridian 75W)

data: The SWOT team and reviewed literature (see end of report for citations); Ocean Basemap - Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors.

notes: This map displays aggregated data from 626 individual turtles and a total of ~350,000 locations, sourced from more than 36 different projects. For details, see the data citations beginning on p. 47. Data are displayed as given by the providers and with minimal processing to remove locations on land and visual outliers. Some tracks are raw locations while others have been more extensively filtered or modeled. On the main map, polygons are colored according to the number of locations they contain and the combination of species present; color bins were determined by splitting the count data into quantiles. Darker colors represent a higher number of locations, which can indicate a high number of tracked turtles in that location or that turtles spent a lot of time there. Countries of origin are labeled in the map. The insets show the Caribbean 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 extant telemetry data or an authoritative source for the studies cited.

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


Telemetry Data and Regional Management Units for Individual Species
Northwest Atlantic
loggerhead (Caretta caretta)
Northwest Atlantic
Southern Caribbean
green (Chelonia mydas)
Northwest Atlantic
leatherback (Dermochelys coriacea)
Western Caribbean/USA
hawksbill (Eretmochelys imbricata)
Northwest Atlantic
Kemp's ridley (Lepidochelys kempii)
West Atlantic
olive ridley (Lepidochelys olivacea)

Indian Ocean Loggerheads

By Ronel Nel, Mayeul Dalleau, Diane Le Gouvello, Michael G. Hart-Davis, Tony Tucker, ALan F. Rees, Andrea D. Phillott, and Scott Whiting, and Sabrina Fossette

Recent issues of the *SWOT Report* have contained articles about the natural history, status, and distribution of loggerhead turtles in the Pacific Ocean (vol. XIII), as well as in the Atlantic Ocean and Mediterranean (vol. XIV), including maps of at-sea biogeography for these three large ocean biomes. Data have now been compiled from the Indian Ocean as well, to complete the first global map of loggerhead telemetry (pp. 32–33). This is the unique story of Indian Ocean loggerheads, in the final chapter in this series of ocean-scale overviews.

A loggerhead turtle that was accidentally hooked by a longline recovers in Kélonia's care center (Réunion Island) after hook removal surgery. © Hendrik Sauvignet/Ocean-OBS

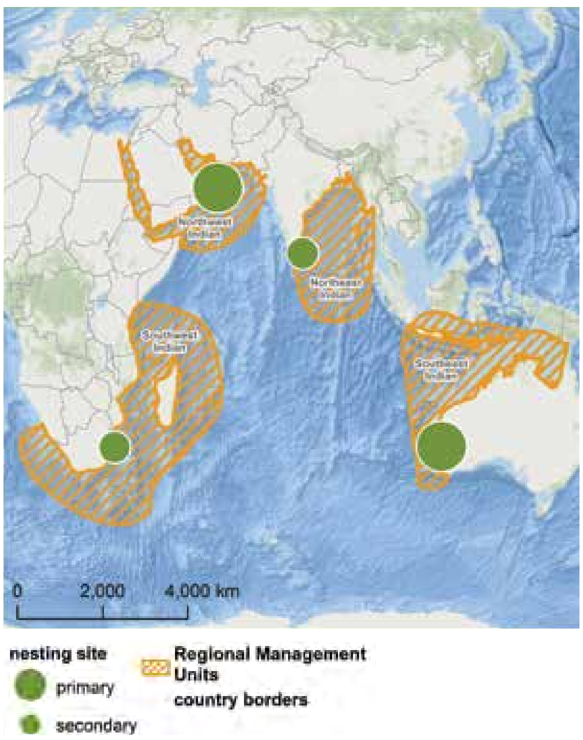
Global distributions of the loggerhead have been divided into 10 regional management units, or RMUs (*SWOT Report*, vol. XII, pp. 30–33). Four of these RMUs are in the Indian Ocean, the largest being in the northwest (figure 1). The Northwest Indian Ocean RMU surrounds the islands of Masirah (Oman) and Socotra (Yemen), where several tens of thousands of females nest. Next in rookery size is the Southeast Indian Ocean RMU, around Western Australia, which has about 2,500 nesting females annually. Then comes the Southwest Indian Ocean RMU, whose rookeries are shared between South Africa and Mozambique, with fewer than 1,000 annual nesters. These three RMUs are globally ranked as second, third, and fourth, respectively, in terms of the abundance of nesting female loggerheads. The Northeast Indian Ocean RMU, in the Bay of Bengal, is ranked as the world's smallest rookery, with likely fewer than 50 annual nesters.

The most conspicuous aspect of the movement of loggerheads among the largest three of these rookeries, as shown by telemetry studies, is the commonly observed movement of the turtles along a north-south transequatorial axis. This movement contrasts with the east-west migrations of loggerheads typical to the northern and southern hemispheres of both the Atlantic and Pacific Oceans, where turtles typically do not cross the equator. Rather, they follow the currents of their respective north and south oceanic gyres between feeding, breeding, and developmental habitats. The atypical loggerhead movement patterns in the Indian Ocean may derive from the fact that the Indian Ocean is the only major basin that is closed in the north by a continental shelf, thereby creating unique oceanographic and atmospheric phenomena.

This north-south migration of Indian Ocean loggerheads is best documented in juveniles from the Mascarene Plateau (55° S latitude), which have been tracked north to Oman and even to the Arabian Gulf, where they likely originated (*SWOT Report*, vol. VII, pp. 10–11; vol. XIV, pp. 6–7). Unsurprisingly, adult loggerheads in Western Australia also migrate northward with the Western Australian Current, taking them to the warmer waters of the Timor and Arafura Seas. Preliminary analysis of recent tracking of neonate loggerhead turtles indicates that they do not take the same path as adults. More peculiar is that the eastern edge of the Indian Ocean loggerhead distribution seems to truncate, and the animals do not venture into the Pacific Ocean. This border is where Southeastern Indian Ocean RMU loggerheads meet those nesting in Queensland, which forage off the Great Barrier Reef (the Southwestern Pacific RMU). This apparent abrupt separation may be due to the limitations of our loggerhead tracking efforts to date, or could be caused by some other unknown factor that restricts their distribution. However, given that this RMU boundary lies roughly along a north-south line formed by the Torres Strait Islands, a narrow waterway that was previously a land bridge between Papua New Guinea and Cape York in northern Australia, it is likely a biogeographic relic from before the last ice age, when these islands and the current maze of shallow reefs and surrounding seas were above sea level.

The situation along the Southern African continent is very different. The fast-flowing Agulhas Current hugs the coast, flowing in a southwesterly direction toward the colder coast at Cape Agulhas, the continent's southernmost point. Here it spins off partially into the Atlantic Ocean, or turns on itself and flows eastward again, to just north of the Arctic Circumpolar Current (figure 2). Modern tools such as ocean particle modeling can be used to predict the distribution of posthatchlings from the time they leave the nesting grounds. In one such model based on 2018 conditions, southwestern Indian Ocean loggerheads were shown to disperse with the Agulhas Current and end up either in the Agulhas Retroflection or in the Benguela Current (on the west coast of South Africa), with a portion ending up in the cold Southern Ocean. These locations have a high probability of mortality.

Despite those useful modeling tools, there is still considerable uncertainty about the duration of the lost years or the location of the ontogenetic shift from the pelagic phase to the neritic, nor is it known with certainty which rookery these young loggerheads would reach as adults. However, what we do observe from global sea surface temperatures is that the western Indian Ocean is a much more



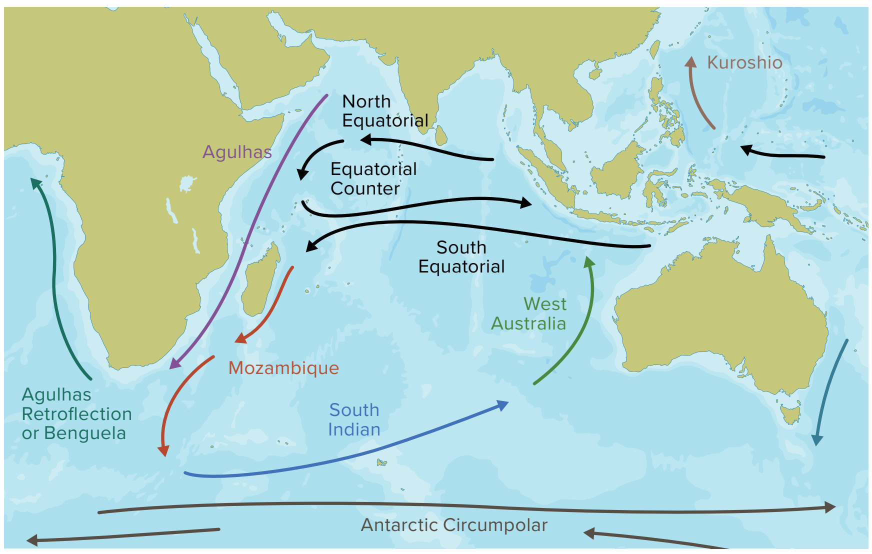


FIGURE 1 (AT LEFT). Map showing the Indian Ocean's four regional management units for loggerhead turtles, with scaled circles indicating main nesting locations. FIGURE 2 (ABOVE). The ocean currents of the Indian Ocean affect both the migration of adult loggerhead turtles and the dispersion of loggerhead hatchlings.

The release of a loggerhead from Réunion Island attracts tourists and locals. The tag on the turtle's back will simultaneously track her migration, most probably to Oman some 4,500 kilometers away, and record ocean temperatures. © Hendrik Sauvignet/Ocean-OBS

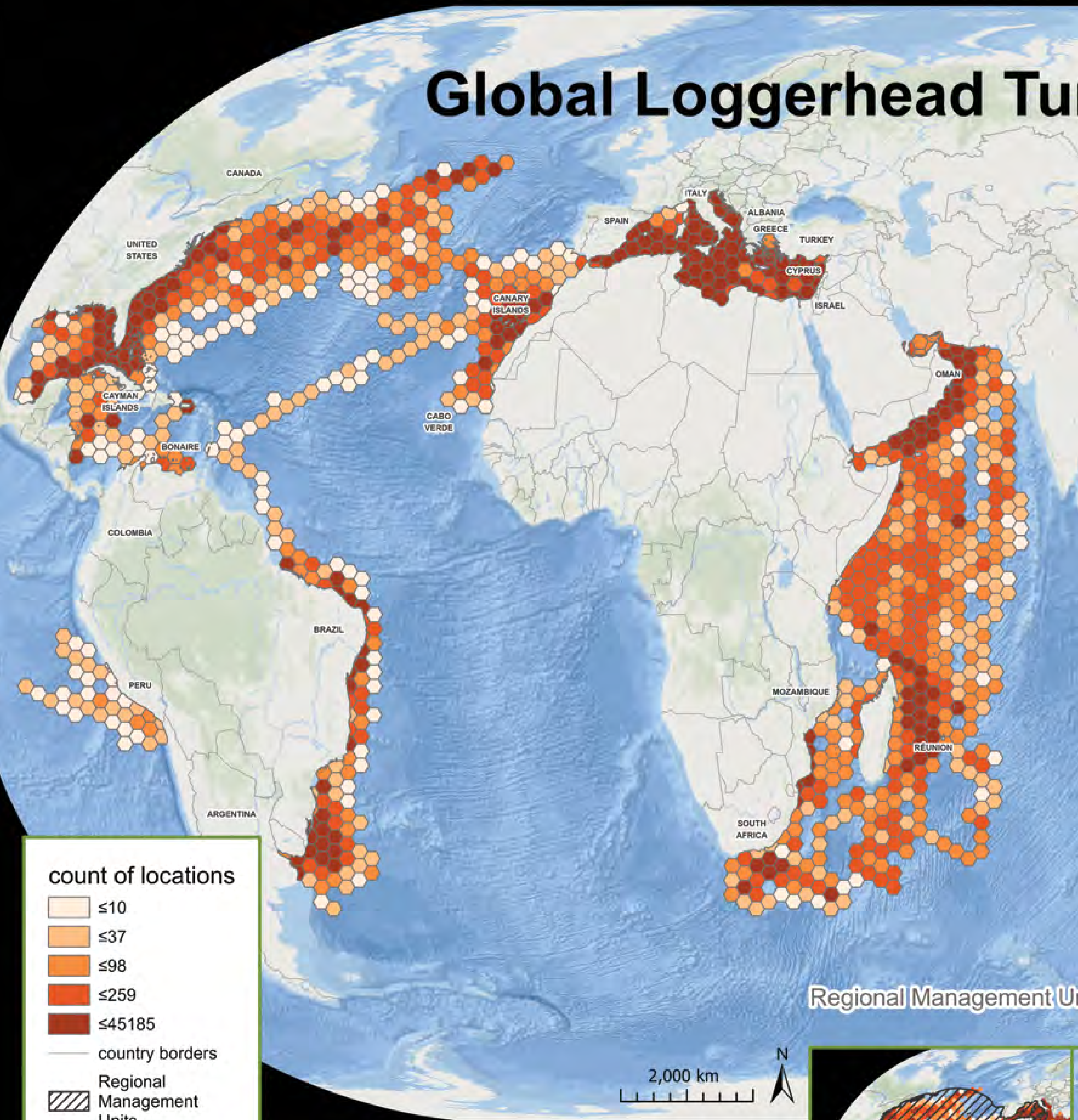
favorable habitat for loggerheads than either (a) the southern or southwestern edges of the African continent or (b) the southwest coast of Australia, since posthatchling turtles are unlikely to survive long-term or abrupt exposure in those cold waters. Indeed, the juvenile and adult turtles that have been tracked in the past tended to avoid the cold water of the Atlantic and Southern Oceans and appeared to be strong enough swimmers to navigate the currents and avoid the southern seas, which are notorious for their strong westerly winds and high waves.

Also curious to note is that the southwestern and southeastern Indian Ocean loggerhead rookeries are both located at about 27°S latitude, with the closest southernmost tips of their respective continental landmasses also lying at approximately the same latitude (that is, Cape Agulhas, South Africa, and a point near Albany, Western Australia, both at about 35°S latitude, the latter being the southwesternmost point of Australia). So far south are these two rookeries, when compared with other loggerhead rookeries globally, that it is easy to assume some migration of animals into the other ocean basins, yet such migration does not seem to happen.

Sea turtles that manage to avoid the troubled cold waters to the south and stay in the warmer seas of the Indian Ocean still face many challenges, two significant ones being fisheries bycatch and plastic pollution. Many of the sea turtle tracks from the southwest Indian Ocean that are presented in the global map (pp. 32–33) were from rehabilitated juvenile and subadult turtles caught in commercial fisheries near La Réunion. They are the lucky turtles, because they were rescued, rehabilitated at Kélonia (the sea turtle rescue center of Réunion), and released to the wild. However, an estimated 3,500 interactions between sea turtles and longline fisheries take place each year in the Indian Ocean, and whereas fishing pressures in the exclusive economic zones of most countries are managed, the high-seas impacts of turtle bycatch are believed to be shockingly high. Moreover, plastic pollution is ubiquitous throughout the Indian Ocean and presents a noteworthy threat to all age classes of loggerheads. Interestingly, studies have shown that a large amount of plastics found in the west actually originated on the eastern side of the ocean basin, where some of the most polluting countries are located. The impact of these turtle and plastic interactions has not yet been properly quantified, but unlike many of the fishing activities that are often size selective, with larger turtles being more vulnerable, plastic is an indiscriminate killer. Sea turtles of all sizes, including posthatchlings from their first days of feeding, have been seen to ingest or become entangled in plastics, which can result in malnutrition, disease, intestinal blockage, and often death.

Scientists working on loggerheads in both the Atlantic and the Pacific Oceans have generated vast amounts of original knowledge in recent decades, making those loggerheads among the best studied sea turtle populations on Earth. Meanwhile, the Indian Ocean still has many unique features to explain and rare mysteries to tackle, and her loggerhead turtles exhibit striking patterns not seen anywhere else. There is still much to learn about loggerhead turtles in this very special ocean basin, and new information is needed to implement effective cross-jurisdictional management actions for the priority threats to all Indian Ocean sea turtles. •

Global Loggerhead Tu

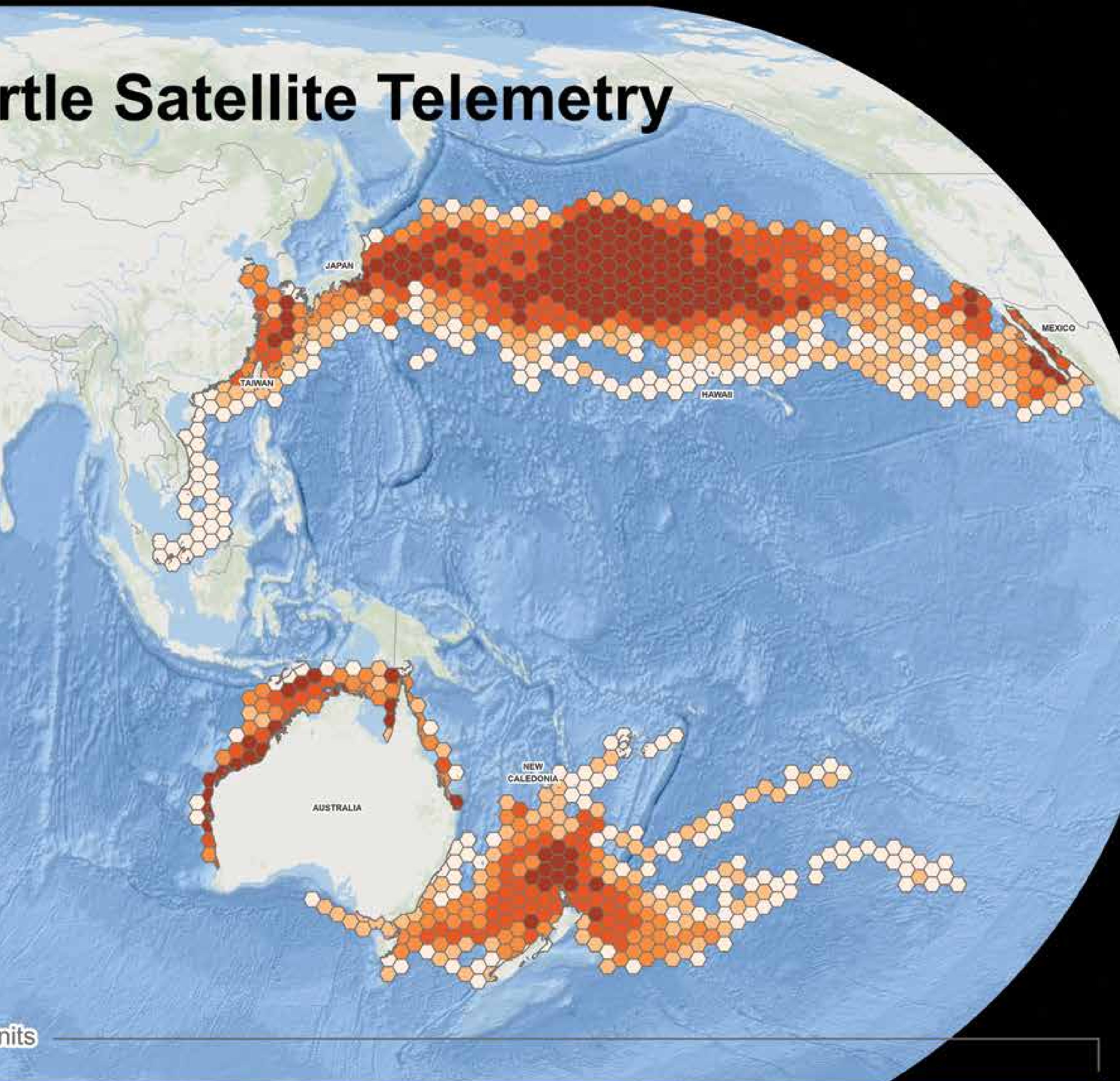


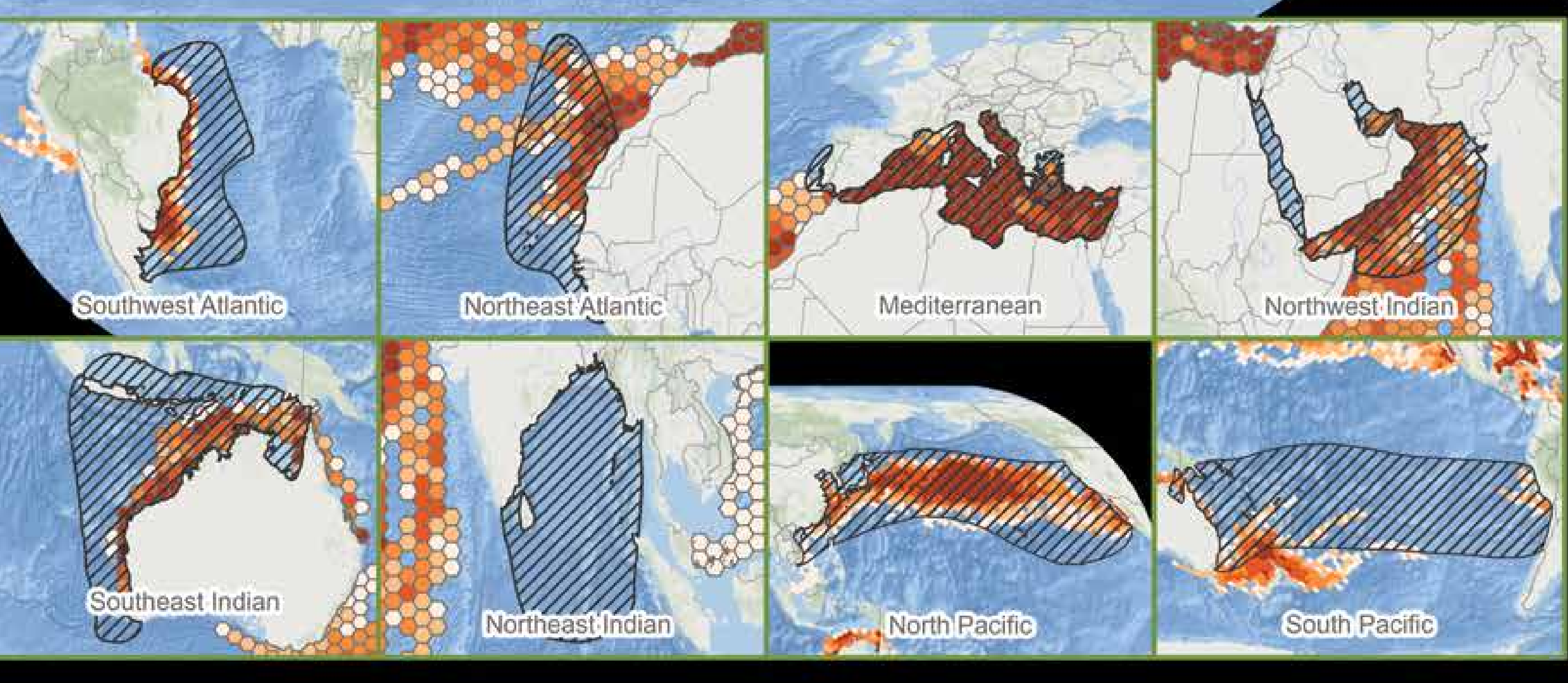
count of locations

- ≤10
- ≤37
- ≤98
- ≤259
- ≤45185
- country borders
- Regional Management Units

Regional Management U

notes: This map displays aggregated data from 1,273 individual loggerhead turtles and a total of 650,000 locations, sourced from more than 80 different projects. For details, see the data citations beginning on p. 49. Data are displayed as given by the providers and with minimal processing to remove locations on land and visual outliers. Some tracks are raw 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 a high number of tracked turtles in that location or that turtles spent a lot of time there. Countries of origin are labeled in the map. The insets show the 10 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 extant telemetry data or an authoritative source for the studies cited. **scale:** 1:73,000,000 **projection:** Eckert IV (central meridian—80W) **data:** The SWOT team and reviewed literature; Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors. **produced in partnership with:** Oceanic Society, Duke University, OBIS-SEAMAP, and the IUCN-MTSG


rtle Satellite Telemetry
JAPAN
TAIWAN
HAWAII
MEXICO
NEW CALEDONIA
AUSTRALIA
nits


Southwest Atlantic
Northeast Atlantic
Mediterranean
Northwest Indian
Southeast Indian
Northeast Indian
North Pacific
South Pacific

Changing the Future for Colombia's Sea Turtles

By Juan M. Rguez-Baron, Diego Amorocho, Luz Elvira Angarita, Efraín Ballesteros Garcés, Lilian Barreto-Sánchez, Karla G. Barrientos-Muñoz, Héctor Barrios-Garrido, Jorge Bernal-Gutiérrez, Amalia M. Cano-Castaño, Juan Castellanos, Claudia P. Ceballos, Luis Chasqui, Aureliano Córdoba, María C. Diazgranados, Diego Duque, Rebeca Franke-Ante, Aminta Jáuregui, Gustavo A. Lara, Héctor Martínez-Viloria, Alvaro Moreno-Munar, Leison Palma García, Vanessa Paredes, Juan Patiño-Martínez, Emigdio Pertuz Buendía, Carlos Pinzón, Julieth A. Prieto, Cristian Ramírez-Gallego, Tito Rodríguez, José Vicente Rodríguez-Mahecha, Jhovany Rosado, Patricia Saldaña, Nestor Sánchez, Diana Tarazona, Rafael Vieira, Carlos A. Zuluaga, and Roderic B. Mast

A HISTORY OF ABUNDANCE AND DECLINE

Spanish chroniclers nearly half a millennium ago spoke of an abundance of sea turtles in what is now the northern coast of Colombia, where nesting turtles were taken by native peoples for food, ornaments, and superstitious rites. The remains of sea turtles are still being unearthed by archaeologists alongside human remains, making it clear that they have always played an important role in the lives of people there.

Since the 1950s, scientists have noted drastic declines in Colombia's sea turtles. Authors Nicéforo Maria, Federico Medem, Archie Carr, Larry Ogren, C. Tufts, E. Ramírez, Reinhard Kaufmann, and Jorge Hernández-Camacho were among the first to warn about the dire situation. In a study conducted in the mid-1980s to measure the socioeconomic value of sea turtles along Colombia's Caribbean coast, Roderic Mast reported commonly hearing the phrase "Tortuga vista es tortuga muerta" (a turtle we see is a turtle that dies) from fishermen and villagers, who prized the turtles for their eggs, meat, oil, and shell. Up until the early 1990s, it was common to find sea turtle on the menus of restaurants, and a sea turtle slaughterhouse operated in Riohacha, where the infamous Doña Fefa sold green turtle meat, oil, and *chicharrón* (deep fried fat) to individuals, markets, and restaurants up and down the coast. Hawksbills were also widely harvested for their shell, which was used for jewelry, trinkets, and even furniture. In addition to direct capture, turtles were—and still are—caught incidentally by fishers. The Colombian National Natural Parks Service (locally referred to as *Parques*) estimates that an average of 129 turtles were caught annually just in the Corales del Rosario and San Bernardo National Natural Park from 1998 to 2003.

Loggerheads in the coastal states of Magdalena and Guajira have been especially hard hit. In the 1970s, Reinhard Kaufmann estimated that about 200 females nested on those beaches each year. By 1997, a study done by Wider Caribbean Sea Turtle Conservation Network (WIDECAST) Colombia, Parques, and the Palomino Fishermen Association counted as few as 25 nests in the same area, representing fewer than 10 nesting females. And later, the Sea Turtle and Marine Mammal Conservation Program (ProCTMM) observed an average of only five loggerhead nests annually from 2014 to 2018. The 1997 study also showed only eight nesting leatherbacks and three hawksbills, a distinct drop from numbers reported in the 1970s. Moreover, green turtles, which once nested in all seven Colombian coastal departments (states), now nest in only three and have the lowest nesting density of any species in Caribbean Colombia. By the early 2000s, the Marine and Coastal Research Institute (INVEMAR) had generated maps showing all known and historic nesting beaches and at-sea turtle sightings on the Caribbean and Pacific coast of Colombia, and these declines became empirically clear.

THE TIDE TURNS FOR SEA TURTLES

Despite centuries of pressure, four sea turtle species still thrive in Colombia's Caribbean waters and nest on the country's 1,626 kilometers (1,010 miles) of continental coasts and on adjacent islands: leatherback (known locally as *caná*, in reference to the deep canals between the carapace keels); hawksbill (called *carey*); green (*verde* or *blanca*); and loggerhead (*gogó*). All these species have been protected by law since the 1960s.

Today, many coastal residents whose parents or grandparents once may have killed "every turtle they saw" now actively protect nests, adults, and hatchlings in an unprecedented generational turnaround in attitudes and behaviors. Moreover, the use and commercialization of turtles in Colombia is far more controlled than it was just a few decades ago. Doña Fefa and her slaughterhouse have both passed on, sea turtle meat is seldom seen on restaurant menus, and trade in hawksbill shell has significantly dropped off thanks to decades of work done by Parques and many other institutions, including the Iniciativa Carey (Hawksbill Initiative), a program led by the World Wide Fund for Nature (WWF) and the Fundación Tortugas del Mar (Marine Turtle Foundation). Moreover, public aquariums serve an important role in the study of sea turtles in captivity, including the Research, Education, and Recreation Center (Centro de Investigación, Educación y Recreación, or CEINER), Mundo Marino at the Jorge Tadeo Lozano University, and the Rodadero Aquarium in Santa Marta. Parques monitors beaches and feeding grounds, enforces protection, and oversees broad education and outreach programs in nine federally protected areas that ensure critical habitat for sea turtles.

The Caribbean coast and surrounding islands also host important feeding grounds for green turtles in places such as the Guajira Peninsula and the San Bernardo Archipelago. Hawksbill nesting is sparse but widespread on dozens of Colombian beaches, and protected beaches in the Gulf of Darién form the core of what is considered the fourth-largest leatherback nesting population in the world. The San Bernardo Islands and coastal areas eastward to Cartagena and beyond have numerous active community-based groups dedicated to sea turtle protection. And all four sea turtle species found from Santa Marta eastward to Venezuela have conservation initiatives led by enthusiastic university students, government employees, ecotourism businesses, indigenous communities, and even the military.

TOP-DOWN AND BOTTOM-UP CONSERVATION

Like politics, virtually all conservation is local. Yet for decades, sea turtle research and protection in Colombia were overseen by national and departmental agencies in capital cities, whose policies, programs, and support did not always reach the field. Most of Colombia's sea turtle nesting beaches are in remote areas that are regularly accessed only by local fishers, farmers, and indigenous people, and many of these residents have also shifted from being poachers to conservation leaders in the past generation. Colombian citizens are now taking charge of conservation at the local level, working hand-in-hand with national agencies such as Parques and Minambiente (the Ministry of Environment and Sustainable Development), as well as seven autonomous regional corporations, including those of La Guajira (Corporguajira), Urabá (Corpourabá), and Magdalena (Corpamag).

In Caribbean Colombia's extreme west, where leatherback research in the Gulf of Darién was led by Bogotá-based agencies in the 1980s, conservation is now overseen by local residents and nongovernmental organizations (NGOs); community councils including Cocomasur, Cocomaseco, and Cocomanorte; and the Darién and Mamá Basilia Foundations. Experts from the latter monitor Colombia's most important leatherback beach, La Playona, and lead education and tourism activities with help from Parques. On the opposite side of the Gulf of Darién, in the Regional Integrated Management District of Ensenada de Río Negro, a group of enthusiastic farmers, Acaetur, monitors Bobalito Beach and other nearby sea turtle nesting sites. This community-based group works alongside Corpourabá and the NGO Fundación Conservación Ambiente Colombia (the Colombia Environment Conservation Foundation).

In the Corales del Rosario and San Bernardo National Natural Park, patrolling and outreach led by an engaged fisherman, Bernardo Medrano, with support from CEINER, have significantly advanced a dialogue about sea turtle conservation among the region's fishers that has resulted in greater egg protection and nest oversight for hawksbills. This effort has also provided environmental education for youth that is motivating permanent interest in turtle protection and conservation.

Continuing eastward, between Barranquilla and Santa Marta, the Aecepex Association has rescued and released more than 50 hawksbill and green turtles in the towns of Tasajera, Pueblo Viejo, and Ciénaga. And at the foot of the Sierra Nevada de Santa Marta, Colombia's highest mountain range, monitoring of sea turtle nesting beaches has been led by several groups, including the Fundación Tortugas Marinas de Santa Marta, WIDECAST Colombia, and ProCTMM, all of which have worked effectively alongside Corpamag and a local fishers' association. Similarly, in Dibulla and La Punta de los Remedios, fishers from the Asopamudi Association now voluntarily release sea turtles caught in their gillnets, while further to the east, another NGO, Campesina, has done similar work since 2015 in collaboration with ProCTMM and Corpoguajira.

The Guajira Peninsula, located in the far northeastern portion of the country, is also inhabited by the indigenous Wayuu people, whose ancestral territory overlaps the border between Colombia and Venezuela. Since 2009, members of this community, together with Conservation International–Colombia, Corpoguajira, and the international coal company Cerrejón, have participated in an effort to curtail turtle exploitation by helping the Wayuu to develop income alternatives through ecotourism and the sale of native products.

COMMITMENTS FOR THE FUTURE OF COLOMBIA'S SEA TURTLES

Over the years, Colombian government agencies, NGOs, and universities have dedicated significant resources in sea turtle research. They are also investing in the training of a new generation of scientists who will be adept at understanding genetics, climate change, hatchling sex ratios, foraging area delineation, and an array of tools and techniques for effective marine turtle conservation. Many of these groups and individuals have actively partnered with SWOT to gather, update, and publish information on the biogeography of Colombia's sea turtles (*SWOT Report*, vol. XI, pp. 14–27), and several have received SWOT small grants since 2006.

The National Program for the Conservation of Marine and Continental Turtles (2002) and the National Plan for Migratory Species (2009) emphasize the need to produce up-to-date, accurate, and comprehensive data on sea turtles and to implement a system of data management and data sharing. In response to this need, Minambiente formed the National Working Group on Sea Turtles in 2017.

In December 2018, a meeting organized by SWOT and the JUSTSEA Foundation was held among a variety of interested parties and organizations at the Fifth Colombian Zoology Congress to discuss a path forward for Colombian sea turtle conservation. The main achievement of the meeting was an agreement among Minambiente, INVEMAR, and SWOT to pursue a platform for the standardization and sharing of Colombian data that can better conserve sea turtles. If all goes as planned, in early 2020 a joint Framework Agreement for Cooperation (Convenio Marco de Cooperación) will be ratified by Minambiente, INVEMAR, and the Oceanic Society—as the legal representative of SWOT—to promote a series of national and regional efforts that aim to establish a standardized sea turtle monitoring program for Colombia. This program will include all the relevant national actors in the gathering of data for sea turtle conservation planning and monitoring, and it will ensure that these data serve not only Colombia's conservation efforts, but also the efforts of other regional and global-scale sea turtle conservation programs.

All of Colombia's sea turtle researchers, conservationists, and enthusiasts see a brighter future for sea turtles and fervently hope that this new program will blossom, grow, and serve as an example to other countries that are equally passionate and committed to ensuring that sea turtles continue to thrive in healthy oceans everywhere. •

Turtles Help Tackle **Ocean Plastic Pollution** in Europe

By Claude Miaud and Gaëlle Darmon

A new directive adopted by the European Union aims to reduce marine litter impacts on sea turtles and other species throughout European waters. © Jérôme Bourjea

Plastic litter is now ubiquitous in the world's oceans, and it has considerable impacts on marine wildlife. More than 700 species are known to be affected by litter, primarily through ingestion and entanglement, including all species and age classes of sea turtles globally.

To address this growing problem, and other threats to the marine environment across Europe, in 2008 the European Union (EU) adopted the Marine Strategy Framework Directive (MSFD), which commits EU member states to actions that improve ocean health. Among the 11 descriptors outlined by the MSFD, the aim is to tackle this scourge by reducing the amount of marine litter so that it "no longer cause[s] harm to the coastal and marine environment." Several indicators were developed to assist in monitoring the distribution, abundance, and impacts of plastic litter in the oceans.

Sea turtles, especially loggerheads, are valuable indicators of ocean health in EU waters because they have large spatial distributions and use many different marine habitats throughout their lives. In the case of plastic litter, sea turtles ingest plastic both directly, by confusing it with their natural prey, and indirectly, when it is mixed in with their natural food items. Although plastic ingestion is rarely found to have been a certain, direct cause of death for turtles, it has many negative health impacts. Thus, sea turtles were chosen as a focal species for monitoring the marine litter component of the MSFD.

To support the MSFD, as well as the Regional Sea Conventions (the Oslo/Paris-Macaronesia Convention in the Atlantic Ocean, the Barcelona Convention in the Mediterranean, and the Helsinki Commission in the Baltic), a two-year, EU-funded project was launched in 2017 to evaluate marine litter impacts on sea turtles. The project, called INDICIT (Implementation of Indicators of Marine Litter on Sea Turtles and Biota in Regional Sea Conventions and Marine Strategy Framework Directive Areas) began by developing and disseminating standardized tools for monitoring litter impacts on turtles, including a multilingual monitoring protocol, observation forms, and other data recording tools. To help stakeholders use the new protocols, INDICIT launched an online video tutorial that detailed field and laboratory methods for properly handling turtles and recording data concerning ingested litter.

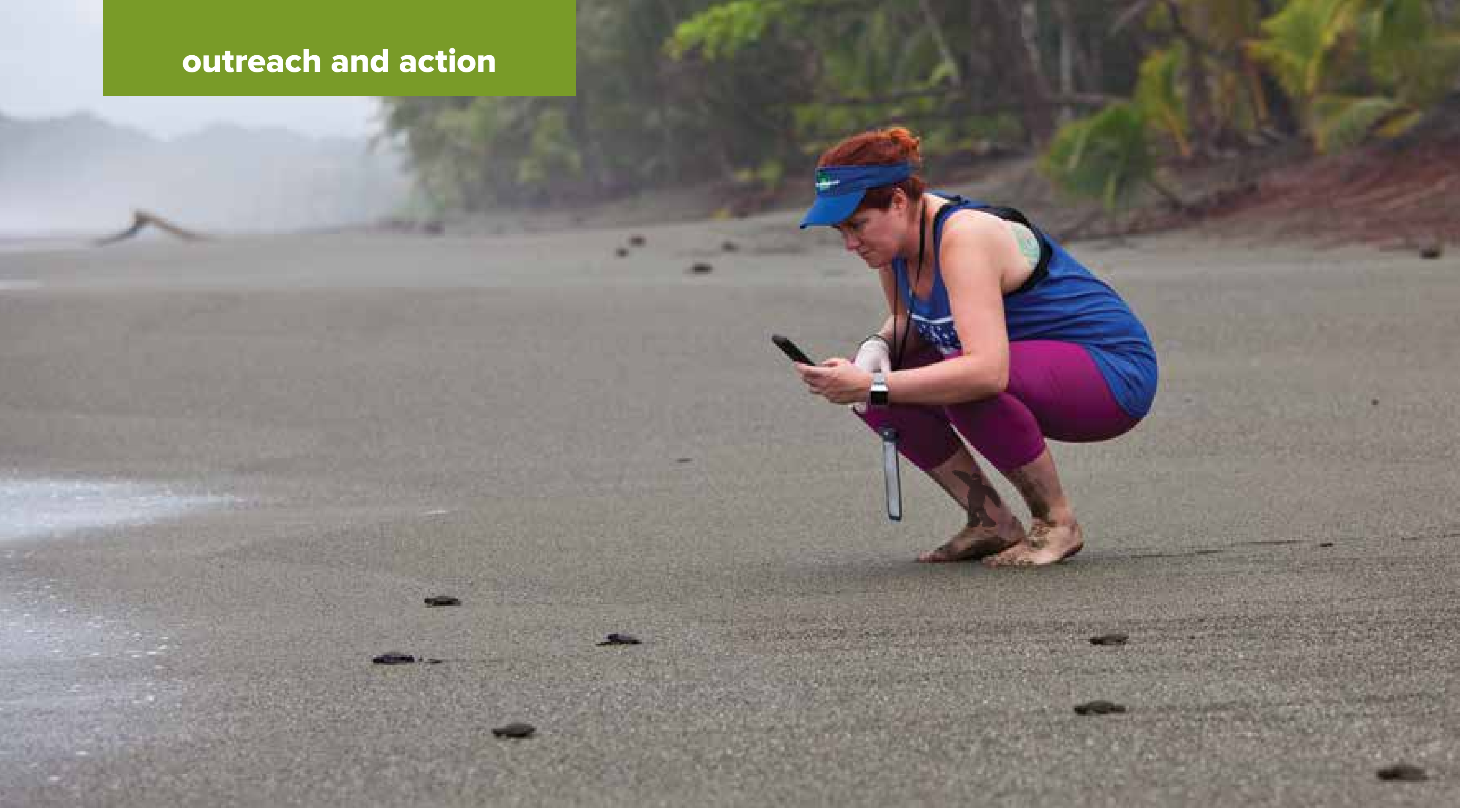
More than 100 institutions, including stranding networks, rescue centers, veterinary institutes, and research laboratories, participated in measuring litter impacts on sea turtles using the INDICIT protocol during 2017–19. Data were collected on the digestive tract contents of more than 1,000 sea turtles found throughout EU waters. Alarmingly, plastic litter was found in more than 60 percent of autopsied turtles, and locally the occurrence can reach 100 percent. The plastics were often single-use items and consisted of fragments of hard plastics, sheet-like packaging, plastic bags, and threadlike materials that generally come from fishing gear. INDICIT's findings have clearly demonstrated the extent of marine litter impacts on wildlife in EU waters, and they provide a strong justification for European countries to take action to address the problems through a variety of actions, such as imposing limits on single-use plastics.

On the basis of these findings, the INDICIT consortium—made up of 10 partner institutions in seven countries, supported by an advisory board of member state representatives and experts—developed marine litter impact indicators to monitor the effectiveness of measures to address marine litter impacts on marine fauna. For the indicator of "litter ingested by sea turtles," the consortium also proposed thresholds below which marine litter is supposed to no longer cause harm to individual sea turtles' health ("good environmental status" may be reached).

A second two-year project, called INDICIT II, was launched in early 2019 to better understand how to deliver measurable impacts in lowering "litter ingested by sea turtles" by reducing plastic litter, such as through bans of single-use plastics. The project will also study the impacts of litter ingestion on individual turtles' health. Beyond sea turtles, INDICIT II aims to develop indicators related to entanglement and ingestion of microplastic particles (smaller than 5 millimeters).

The greatest hope of INDICIT's hundreds of partners across Europe is that their work can advance efforts to reduce the threats to the ocean posed by plastic litter and thereby improve the lives of sea turtles, ocean biodiversity, and people everywhere. •

To access the monitoring tools developed by INDICIT and view a short documentary about the project, visit https://indicit-europa.eu/. The INDICIT II consortium is seeking new collaborators to help collect more data on litter impacts, not only in the areas targeted by the project, but also on a larger scale. To join, send an email to coordination@indicit-europa.eu.



Top Smartphone Apps for Sea Turtle Work

By Craig Turley

Smartphones and tablets have the potential to revolutionize the way we collect data on sea turtles and other species by putting powerful technology in the palms of our hands when and where we need it most. Although this field is still growing, a variety of mobile applications (apps) have already been developed to harness mobile technology for sea turtle research and conservation, taking advantage of the standard sensors and other tools that are found in today's mobile devices.

Apps offer a number of advantages to traditional paper-based data collection. They can minimize data input errors; reduce time-consuming manual data entry; quickly and automatically generate spreadsheets; capture lots of data automatically (e.g., time, date, location, photos, videos, and sound recordings, as well as weather, moon phase, and more); and automatically upload data to the cloud to reduce the risks of data loss. They also offer features and potential uses that traditional data collection methods do not, such as the ability to create and use interactive maps, to facilitate collaboration by uploading data to a shared database, and to harness the power of citizen scientists on a large scale.

HOW TO CHOOSE AN APP

With a growing number of mobile apps on the market, it can be difficult and time consuming to research the strengths and weaknesses of each and to determine the best app to support your goals. Many projects consider developing their own apps, but it is worth first exploring what already exists. This article provides an overview of some of the most popular apps that are currently available for sea turtle research and conservation, and it can be used as a starting place for researchers looking to incorporate this technology into their programs. Here are a few important things to consider when choosing an app:

Data accessibility and storage. Some researchers may need exclusive access to their data to allow for a more detailed analysis and eventual publication. They may therefore want to avoid apps that make data publicly available through open-source databases. However, apps that do make data publicly available can offer the potential for greater collaboration and public outreach and can also attract broader contributions of useful data. Some open-source apps make higher-resolution data available by request, using data protection protocols that ensure exclusivity when needed.

AT LEFT: A citizen scientist uses her smartphone to photograph olive ridley hatchlings on Piró Beach, Costa Rica. © Brian J. Hutchinson

Cost and convenience. App development can be costly and time consuming, and it often requires technical know-how beyond that of most sea turtle researchers. Using an off-the-shelf app that is available through the Google Play Store or the Apple App Store may be the best choice for budget-constrained projects. However, there will generally be trade-offs, and paying more for a customized experience definitely has its advantages. Beyond the apps themselves, buying (and replacing) mobile phones or tablets can be a large investment, and access to mobile networks can require subscription fees.

Stability, support, and longevity. Before committing to an off-the-shelf app, it is a good idea to do some homework about the app developer and to research how widely used the app is. Some apps have huge communities of users, robust technical support, and a developer that is committed to maintaining the platform (for example, iNaturalist), whereas others may have been built by a small team with no plans or funding for future maintenance and little or no capacity for user support. With the high frequency of updates to mobile operating systems and to mobile devices themselves, unsupported apps are more likely to develop bugs over time.

TODAY'S SEA TURTLE APP OPTIONS

The table below summarizes some of the apps now available for sea turtle research and conservation and provides a brief overview of key features. This guide is not exhaustive, and the pace of technology makes it a moving target, but it can be a starting place for researchers and conservationists exploring using this valuable technology to enhance their work in 2020. Nearly all of the apps can be found online or in either the Apple App Store or Google Play Store. Instructions are provided for requesting those apps that are not readily available. •

AN OVERVIEW OF SEA TURTLE APPS

NESTING AND IN-WATER CENSUS	**RASTR (Records Assistant for Sea Turtle Researchers)**	This app collects data on nesting, bycatch, and turtle products, with fields for morphometry, biological samples, and more. (iOS)
	Siren Turtles	This app is used to centralize and standardize nesting data for comparative studies using SWOT minimum standards. (Android)
	Nest Tracker	Designed by the Cayman Islands Department of Environment (DOE) to monitor all turtle-related data collection (nesting, excavations, disorientations, and more), features include mobile network backup, as well as daily autogenerated spreadsheets sent directly to DOE staff. Available by request to nesttracker.ky@gmail.com. (iOS)
	Clutch Keeper	Able to monitor all aspects of beach monitoring and nest tracking, this app uses an interactive map alert when excavation is required. (Android and iOS)
	Iris	Designed for at-sea aerial surveys, this app allows users to simply and quickly record sightings data on multiple taxa, including sea turtles. For a copy, email info@mrf-asia.org. (Android)
CITIZEN SCIENCE	**Turtles Uniting Researchers and Tourists (TURT)**	This app is designed for use in reporting turtle sightings, and products using an interactive web-based map. (Android and iOS)
	eTurtle	Users can report sea turtle sightings in the Mediterranean. (Android)
	SEAlly	This app allows users to report sea turtle and shark sightings, bycatch, and entanglement in the Mediterranean region, and is linked to an online interactive map. (Android and iOS)
	Cero Carey	This app allows tourists in Cartagena, Colombia, to identify and report hawskbill products, in Spanish, directly to the environmental police. (Android)
	iNaturalist	Not specific to sea turtles, this widely used app allows users to identify, report, and catalog biodiversity using a personal profile linked to a global network of other users. (Android and iOS)
	HerpMapper	Used for reptile and amphibian sightings, this app can be customized for sea turtle–specific projects. (Android and iOS)
	Ghost Gear Reporter	Designed for fishers, divers, and citizen conservationists, this app allows users to report sightings, bycatch, or ghost gear entanglement. (Android and iOS)
CUSTOM PLATFORMS	**Fulcrum**	This highly customizable platform requires a monthly subscription and has 20 GB of cloud storage. (Android and iOS)
	Open Data Kit (ODK) Collect	This free, open-source app is powerful and customizable. (Android & iOS)

= AUTHOR'S PICK

FAQs ABOUT Sea Turtles

With their specialized biology and their unique behaviors, sea turtles tend to inspire 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 decades of scientific study, sea turtles are still mysterious in many ways.

Increasingly, however, advances in technology and 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, yet others still are answerable only with our best guess. With such continuing mysteries in mind, last year we launched this new segment in *SWOT Report* by inviting experts to weigh in with current perspectives about some of the most frequently asked questions concerning sea turtles. This year we tackle two new questions. Read on to hear what the experts had to say.

? IS THAT TURTLE A BOY OR A GIRL?

By Itzel Sifuentes-Romero and Jeanette Wyneken

How can we tell if a sea turtle is female or male? In adults, it's relatively easy—a male has a long tail that extends well beyond the carapace, with a cloacal opening near the tip. In comparison, a female has a short tail with a cloacal opening near the base. With hatchling and sub-adult turtles, it's not possible to determine their sex simply by looking at them; they are not sexually dimorphic, meaning that they do not have any external features to distinguish males from females. They lack such features because the hormones that are responsible for changing the anatomy are not present in high enough amounts to trigger those differences until they reach sexual maturity—and that can take decades!

Sexual identification of young sea turtles is further complicated by the fact that, unlike mammals, they don't have sex chromosomes (no X or Y); therefore they lack sex-specific genes that could be used to determine sex with a DNA sample. In mammals, for example, the *sry* gene is only on the Y chromosome, and its presence or absence can be used to determine sex. In contrast, sea turtles' sex is determined by the incubation temperature they experience as embryos—warmer incubation temperatures produce females, and cooler temperatures produce males. But, if not through sex chromosomes, how does that system work? We have found that temperature is able to trigger a gender-specific cascade of genes that directs the embryo to differentiate the reproductive tract and gonads (ovaries or testes) and instruct the formation of ducts that will carry eggs or sperm later in life.

Though small, these gender-specific differences in turtles' reproductive tracts can be seen by looking inside young, posthatchling turtles (120 grams, about 82–97 centimeter straight carapace length, depending on species) using a procedure called *laparoscopy*. In female posthatchling turtles, a laparoscope allows us to see a white ovary and a big, mobile, immature oviduct (called the Müllerian duct) with a very well-defined lumen. If the young turtle is a male, then we see cream-colored gonads, usually with a network of very small blood vessels. Male turtles also lack a complete Müllerian duct; it may be entirely absent or simply incomplete.

Unfortunately, hatchling turtles are too small for a laparoscope. So how can we tell if a hatchling is male or female? The answer relies on the sex-specific proteins that are induced by the incubation temperature. The majority of those proteins are produced in the gonads. We discovered that one protein, known as anti-Müllerian hormone, is released into the blood stream *only in males*. That hormone, therefore, makes it possible to identify the sex of hatchlings by analyzing a small blood sample. Currently, we know that this test works for loggerhead hatchlings, and we are beginning to test it on

other sea turtle species as well. Our next goal is to develop this assay into a field kit, so that measuring the primary sex ratio of any species can be done in the field and not just in the lab. This next step would be a huge breakthrough for sea turtle conservation research, because sex ratio is a fundamental piece of demographic information that will allow us to help plan future management strategies in the face of climate change. •

HOW MANY SEA TURTLES ARE THERE?

By Bryan P. Wallace

Sea turtles swim in all of the ice-free areas of the world's oceans. Their generations span several decades, so populations comprise turtles of many sizes and ages. What's more, we humans catch only fleeting glances of them in the ocean, seeing mostly the females that come ashore to nest, so typically we can count just egg-laying adult females and their offspring. With all this in mind, making defensible estimates of the total number of sea turtles in the ocean requires math, modeling, assumptions, and a lot of creativity. But let's give it a try!

Others have tried estimating the number of turtles in the sea when trying to paint a picture of what marine resources looked like historically. For example, studies of historical harvesting and fishing records from 300 to 500 years ago estimated that between 33 million and 39 million, or even as many as 91 million, adult green turtles existed in the Caribbean before Columbus's fleet, and those that followed it, took their toll. The historical abundance of sea turtles is the stuff of legends: there were so many green turtles in the Caribbean that the sounds of turtles breathing and the bonking of their carapaces against the ships' wooden hulls were cues used by sailors to navigate around islands when visibility was poor.

For Europeans invading the Caribbean, sea turtles were free, they were relatively easy to catch, and they could be kept alive for weeks with minimal care, thus serving as a seemingly endless source of fresh meat and eggs. Europeans were unfamiliar with the region, and most islands did not readily provide agricultural resources to support new settlements, so it is no exaggeration to say that sea turtles fueled European invasion, exploitation, and colonization of the Americas. Think about that: one of the most consequential turning points in human history might not have happened if the sea wasn't full of turtles.

Historical depletion by European exploitation is now a well-documented theme in the Caribbean and elsewhere, so we know that today's populations of green turtles—and all other species—are far smaller than before Europeans got a taste for them. But how much have populations been depleted? And how many are there today? There is no robust estimate, and for the reasons raised above, generating an accurate number is probably impossible. However, a 2011 paper (Wallace et al. 2011) provided defensible estimates of nesting population abundance (in average annual ranges) for all sea turtle regional management units worldwide. If we sum up the minimum and maximum values of those estimated ranges, we can calculate rough estimates of the total number of nesting females. With assumptions about sex ratios, we can even estimate the number of adult males too. (I will leave estimates of juvenile turtles to braver folks than I.)

The totals from this exercise show that, as of 2011, a maximum of 7.5 million adult females of all sea turtle species existed globally. Assuming a 3:1 ratio of females to males, fewer than 10 million adult sea turtles remained. For green turtles alone, there were perhaps 1.5 million females worldwide, and only 300,000 in the Caribbean. That's quite a bit different than the historical estimates before European exploitation.

Despite the dramatic declines in turtle abundance since Europeans arrived, turtles have been hanging on. In some places, their numbers have increased in recent years. Over the past several centuries and even in recent decades, humans have done a great job of reducing sea turtle numbers through consumption and other activities. Now it's up to today's and tomorrow's humans to do a great job at reversing those trends. •

	TOTAL ADULTS (ASSUMING 3:1 FEMALE TO MALE RATIO)		
SPECIES	MIDPOINT	LOWER BOUND	UPPER BOUND
Loggerhead	314,000	91,000	536,000
Green	1,002,000	245,000	1,759,000
Leatherback	426,000	133,000	1,289,000
Hawksbill	57,000	30,000	83,000
Kemp's ridley	21,000	3,000	25,000
Olive ridley	4,618,000	558,000	5,600,000
Flatback	23,000	7,000	69,000
Global total	6,461,000	1,067,000	9,361,000

Female abundance estimates were derived from the midpoints and upper and lower bounds of ranges of average annual abundance in Wallace et al. (2011) Global conservation priorities for marine turtles, PLoS ONE 6(9): e24510. doi:10.1371/journal.pone.0024510. Average remigration intervals by species were used to estimate total numbers of adult females, and an assumed 3:1 sex ratio allowed for estimation of total numbers of adult males. These abundance estimates were generated for illustrative purposes only and should be interpreted accordingly. **AT LEFT:** One way to determine sex in adult sea turtles is to look at their tails. Males' are long and extend past their carapace, as visible on the lone turtle (left) in this photo, whereas females' are much shorter. © Nicolas J. Pilcher

Acting Globally

SWOT Small Grants 2019

Since 2006, SWOT's small grants have helped field-based partners around the world to realize their research and conservation goals. To date, 93 grants have been awarded to 67 applicants in more than 45 countries and territories for work addressing three key themes: (1) networking and capacity building, (2) science, and (3) education and outreach.

The following are brief overviews of our 2019 grantees. Visit www.SeaTurtleStatus.org/grants for application instructions and a list of all past SWOT grantees.

CLOCKWISE FROM TOP LEFT: © Casa Congo, © Janie Reavis, © Haiti Ocean Project, © Turtle Foundation, © ProTECTOR, Inc.

Arizona State University (U.S.A.)

Bycatch is a global threat to sea turtles and other marine species, and many efforts have been dedicated to mitigating bycatch by industrial-scale fisheries. Less attention has been focused on small-scale fisheries, even though many small fisheries have high rates of bycatch. Janie Reavis and collaborators at Arizona State University are researching novel bycatch reduction technologies (BRTs) for small-scale fisheries. Their aim is to decrease bycatch rates without negatively affecting fisheries, which is especially important in developing areas. Janie will use a 2019 SWOT grant to test and develop the efficacy of new BRTs that use sensory cues to discourage turtles from interacting with fishing gear. Her results will be applicable to small-scale net fisheries in Baja California, Mexico, and potentially elsewhere.

Bluefields Bay Fishermen's Friendly Society (Jamaica)

The sea turtle monitoring program of the Bluefields Bay Fishermen's Friendly Society (BBFFS) was established in 2006 to reduce the poaching of nesting females and their eggs. The monitoring program includes nightly patrols of Bluefields' two main nesting beaches, tagging of nesting females, and education and outreach activities within the community. The wardens' nightly presence at the nesting beaches provides a deterrent to poachers while also allowing them to collect data on the nesting activities taking place. Collected data are shared with the National Environment and Planning Agency, Jamaica's environmental regulatory agency. The BBFFS will use a 2019 SWOT grant to continue its beach monitoring efforts and improve communication and data sharing with nearby organizations.

Casa Congo (Nicaragua)

Río Escalante–Chacocente Wildlife Refuge lies on the Pacific coast of Nicaragua and harbors one of two beaches in the country where thousands of olive ridley turtles come to lay their eggs in a phenomenon known as an arribada. The refuge also provides nesting habitat for three other species of sea turtles—green, hawksbill, and leatherback. Located within and around Chacocente are 17 rural communities that are economically dependent on the extraction of fish and turtle eggs, despite the government's efforts to halt poaching activities. Casa Congo facilitates community-based conservation in the area, running projects and programs alongside community members, researchers, interns, and volunteers. A 2019 SWOT grant will be used to construct and maintain a hatchery that not only will protect sea turtle nests but also will serve as an education tool for youth in the local communities.

Equilibrio Azul (Ecuador)

Puerto López beach on Ecuador's Pacific coast is one of the few index nesting beaches for the critically endangered east Pacific population of hawksbill sea turtles. In the past few years, this nesting habitat has been heavily affected by an increase in construction on and around the beach. With the weight of its 12 years of nesting data, Equilibrio Azul will use a 2019 SWOT grant to inform the local community and government about the importance of conserving and recuperating the beaches that provide vital nesting habitat for these critically endangered turtles. Ultimately, Equilibrio Azul aims to create a sea turtle conservation zone on approximately 800 meters (one-half mile) of developed beach.

Haiti Ocean Project (Haiti)

Haiti is possibly one of the biggest exploiters of sea turtles in the Caribbean region, yet little data exist on Haiti's artisanal fisheries. Basic ecological data on Haiti's sea turtle populations are also lacking. The Haiti Ocean Project is a marine conservation, education, and research organization located in southwest Haiti that educates youth, fishermen, and their communities about their marine environment. With a 2019 SWOT grant, Haiti Ocean Project will study the rates of directed take and bycatch of sea turtles in the artisanal fisheries of the Nippes and Grand'Anse regions and will assess the extent of local fishers' knowledge about sea turtles and fishery regulations. This study will help assess the scale of the threat that artisanal fisheries pose to Haitian sea turtle populations and will identify gaps in the knowledge of fishermen and the Haitian public that could be targeted by future education programs.

ProTECTOR Inc. (Thailand)

Although it is confirmed that green and hawksbill turtles nest in the Gulf of Thailand, there is little up-to-date information on the state of sea turtle nesting in the gulf, and currently no coordinated efforts by government or local communities have been undertaken to remedy this lack. ProTECTOR will use a 2019 SWOT grant to establish a Gulf of Thailand Nesting Recovery Network (GoTNRN), starting by holding capacity-building workshops in three communities in the Gulf of Thailand (Koh Talu, Thap Sakae, and Dom Sam Ram). At those workshops, participants will discuss shared goals, standard methods, government assistance, data reporting, funding development, and expansion of the network into other areas. Through its efforts, ProTECTOR hopes both to increase awareness of sea turtles in the region and to create future opportunities to gather new sea turtle data throughout Thailand.

RASTOMA (Cameroon, Gabon, and São Tomé and Príncipe)

Plastic pollution, as well as the degradation of feeding and reproductive habitats, are causes of sea turtle mortality worldwide. To mitigate this threat to the five species of sea turtles that inhabit the coastal waters of Central Africa (green, leatherback, olive ridley, hawksbill, and loggerhead), RASTOMA (Réseau des Acteurs de la Sauvegarde des Tortues Marines en Afrique Centrale) has adopted a "Beaches without Plastic" plan. The organization will use a 2019 SWOT grant to help reduce the impact of plastic on sea turtles by holding workshops and outreach campaigns in Cameroon, Gabon, and São Tomé and Príncipe. The workshops will focus on repurposing plastic waste into goods that can help communities generate income and raise awareness about plastic pollution.

Turtle Foundation (Indonesia)

After visiting a beach on the west coast of Pulau Sipura in the Mentawai Islands and discovering the remains of slaughtered leatherback turtles and poached nests, the Turtle Foundation decided to take action. Little is known about the northeast Indian Ocean subpopulation of leatherbacks, which is listed as Data Deficient by the IUCN Red List. With help from a 2019 SWOT grant, the Turtle Foundation aims to address this data gap using satellite tracking of female leatherbacks that nest on Pulau Sipura. By following the turtles' movements, the project aims to learn valuable information about migratory routes and about inter- and postnesting behavior that will be used to develop more efficient conservation strategies.

AZA-SAFE Grant Recipients

In 2019, SWOT partnered with the Association of Zoos and Aquariums (AZA) and its Sea Turtle SAFE (Save Animals from Extinction) program to make six additional grants available for projects related to the conservation of two of the top global priorities for sea turtle conservation—eastern Pacific leatherbacks and Kemp's ridleys—throughout their respective ranges. The projects on this spread were awarded 2019 SWOT grants thanks to the AZA-SAFE program.

ZIHUATANEJO, IXTAPA, AND LA BARRITA, GUERRERO, MEXICO

Campamento Tortuguero Ayotlcalli

Several sea turtle populations that nest along the Pacific coast of Mexico are declining because of human activity. In particular, the eastern Pacific leatherback is affected. The decline has motivated several communities to create sea turtle rescue and conservation camps that aim to protect these endangered animals. However, many of these projects fail because they lack government and financial support. Campamento Tortuguero Ayotlcalli will use a 2019 SWOT grant to develop a collaborative regional network and action plan that will include environmental education programs, training opportunities, and data collection protocols. Members of the network will be nonprofits, schools, local businesses, fishermen, local government agencies, and media. By sharing experiences, methods, and support, the project aims to create more sustainable conservation efforts in local communities along Mexico's Pacific coast.

BAHÍA SOLANO, CHOCÓ, COLOMBIA

Center for Environmental Management and Development (CIMAD)

To fill gaps in knowledge about the critically endangered eastern Pacific leatherback population, CIMAD has spearheaded research and community engagement efforts along the Pacific coasts of Panama and Colombia. Through the project, CIMAD aims to increase understanding of leatherback nesting locations, identify priority conservation areas, and attract local and global attention. CIMAD will use a 2019 SWOT grant to train community members to conduct nightly patrols and record sea turtle nesting activity, and it will use funds to financially support beach monitors. In addition, CIMAD will spread awareness about the project and connect with Colombian agencies and communities to increase awareness and support for their work.

REGIÓN DE ARICA Y PARINACOTA, CHILE

Instituto de Fomento Pesquero

Incidental capture in small-scale longline fishing gear is the main threat to the green, loggerhead, olive ridley, and leatherback turtles that inhabit northern Chile's coasts. Using sea turtles as flagship species, the Instituto de Fomento Pesquero will use a 2019 SWOT grant to conduct workshops, lectures, and events that will educate youth, fishermen, and communities of northern Chile and instill a deeper understanding and dedication to marine conservation. Specifically, fishermen will be educated about methods to minimize sea turtle bycatch and mortality, and local communities will be educated about sea turtle biology and about ways to protect sea turtles' critical habitats.

VALLE DEL CAUCA Y NARIÑO, COLOMBIA
JUSTSEA Foundation

Fisheries bycatch is considered the greatest threat to sea turtle populations globally. Although many efforts have sought to understand and minimize sea turtle bycatch, active participation of stakeholders in the process is lacking, especially in developing countries. To address this issue in Colombia, JUSTSEA began a project in 2016 to evaluate the nature, frequency, and impacts of fishing interactions with leatherback turtles. The project also will establish collaborative relationships with fishermen to promote data sharing and implementation of fishing practices that minimize sea turtle interactions and increase sea turtle survival after release. With a 2019 SWOT grant, JUSTSEA will lead workshops to raise awareness of leatherback turtle bycatch within the fishing community and will continue its collaborative fisheries observer program.

TEXAS, U.S.A.
Sea Turtle, Inc.

Sea Turtle, Inc., is a nonprofit sea turtle hospital in south Texas that rescues and rehabilitates sick and injured sea turtles for release back into the wild, educates the public, and assists with conservation efforts for marine turtles. Kemp's ridley conservation is a priority during nesting season, which coincides with peak tourist visitation on south Texas beaches that are open to vehicular access and are also home to the only nesting ground for this critically endangered species. Public awareness about the presence of sea turtle activity during the nesting season is critical to effectively protect nesting and hatching turtles. Using a 2019 SWOT grant, Sea Turtle, Inc., will place bilingual signs at vehicular beach access points to prevent sea turtle fatalities and increase nesting reports from beachgoers.

ISLA ARENA, CAMPECHE, MEXICO
Universidad Autónoma del Carmen

Isla Arena is a small fishing community on the Yucatán Peninsula whose beaches provide nesting habitat for hawksbill turtles and whose marine zone is a hotspot where green, hawksbill, Kemp's ridley, and loggerhead turtles all coincide during their lifecycles. Historically, local inhabitants of the island consumed turtle eggs and meat, and more recently they began to harvest eggs and capture adults to sell, illegally, to mainland communities. A local women-run nonprofit called Fileteras del Petén aims to combat turtle consumption through beach monitoring, environmental education, and outreach to promote more sustainable practices in this small community. The Universidad Autónoma del Carmen will use a 2019 SWOT grant to support Fileteras del Petén in organizing workshops and outreach activities and strengthening its sea turtle monitoring project.

SWOT Data Citations
WIDER CARIBBEAN

The data citations that follow correspond directly to the maps of Wider Caribbean sea turtle biogeography on pp. 24–27. To use these data for research or publication, you must obtain permission from the data providers.

NESTING DATA CITATIONS: WIDER CARIBBEAN

The map of sea turtle nesting biogeography in the Wider Caribbean Region (pp. 24–25) was produced in partnership with WIDECAST (Wider Caribbean Sea Turtle Conservation Network), and the data were sourced almost exclusively from WIDECAST's 2019 publication: Eckert, K. L., and A. E. Eckert. 2019. *An Atlas of Sea Turtle Nesting Habitat for the Wider Caribbean Region.* Rev. ed. WIDECAST Technical Report 19, Godfrey, IL.

Following is a list of all of the data providers to the WIDECAST Atlas and, therefore, to the nesting biogeography map on pp. 24–25, with names organized by territory. In addition to the data sourced from the WIDECAST Atlas, supplementary data were used from the SWOT network for four nesting sites with very high nesting abundance (in Costa Rica, Mexico, Trinidad and Tobago, and the United States) to better differentiate among those sites. Those four data citations are listed at the end of this section.

For detailed nesting data citations and metadata, please refer directly to the WIDECAST Atlas, available online at http://www.widecast.org/management/nesting-beach-atlas/.

ANGUILLA (UNITED KINGDOM)
Farah Mukhida, Anguilla National Trust
Randall Richardson, Department of Fisheries and Marine Resources

ANTIGUA AND BARBUDA
Cheryl Appleton, Ministry of Agriculture, Fisheries, and Barbuda Affairs
Mykl Clovis Fuller, Antigua Sea Turtle Project
Ian Horsford, Ministry of Agriculture, Fisheries, and Barbuda Affairs
Kate Levasseur, Jumby Bay Hawksbill Project
Tricia Lovell, Ministry of Agriculture, Fisheries, and Barbuda Affairs
Seth Stapleton, Jumby Bay Hawksbill Project

ARUBA
Edith van der Wal, Turtugaruba Foundation
Richard van der Wal, Turtugaruba Foundation
Sietske van der Wal, Aruba National Park Foundation

THE BAHAMAS
Lakeshia Anderson, The Bahamas National Trust
Indira Brown, Ministry of Agriculture and Marine Resources

BARBADOS
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Julia A. Horrocks, Barbados Sea Turtle Project, University of the West Indies

BELIZE
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Belize Audubon Society
Belize Fisheries Department
Gales Point Wildlife Sanctuary Management Committee
Hol Chan Marine Reserve
Southern Environmental Association
Toledo Institute for Development and Environment
University of Belize Environmental Research Institute

BERMUDA (UNITED KINGDOM)
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ADDITIONAL NESTING DATA CITATIONS

COSTA RICA

Data Sources: (1) Harrison, E. 2014. Sea turtle nesting at Tortuguero, Costa Rica. Personal communication. In 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. **(2)** García Varela, R., G. López Torrents, and E. Harrison. 2016. *Report on the 2015 Sea Turtle Program at Tortuguero, Costa Rica*. Unpublished report. San Pedro, Costa Rica: Sea Turtle Conservancy.
Nesting Beach: Tortuguero
Years: 2014–2015
Species and Counts: *Chelonia mydas*—greater than 100,000 crawls per year
SWOT Contact: Emma Harrison

MEXICO

Data Source: Gladys Porter Zoo Sea Turtle Conservation Program. 2013. Sea turtle nesting at Rancho Nuevo, Mexico. Personal communication. In 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.
Nesting Beach: Rancho Nuevo
Year: 2012
Species and Counts: *Lepidochelys kempii*—greater than 10,000 crawls per year
SWOT Contacts: Patrick Burchfield and Luis Jaime Peña

TRINIDAD AND TOBAGO

Data Source: The Northwest Atlantic Leatherback Working Group. 2019. *Dermochelys coriacea* (Northwest Atlantic Ocean subpopulation). *The IUCN Red List of Threatened Species 2019*. e.T46967827A83327767.
Nesting Beach: Grand Riviere
Years: 2009–2017
Species and Counts: *Dermochelys coriacea*—greater than 10,000 crawls per year

UNITED STATES

Data Source: Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute. 2019. https://myfwc.com/research/wildlife/sea-turtles/nesting/monitoring/. Accessed October 2019.
Nesting Beaches: Brevard County, Martin County, Palm County
Year: 2018
Species and Counts: *Caretta caretta*—greater than 10,000 crawls per year at each location

TELEMETRY DATA CITATIONS: WIDER CARIBBEAN

The following data records refer to satellite telemetry datasets from tags that were deployed on sea turtles in the Wider Caribbean Region and were combined to create the map on pp. 26–27. They are organized by the country of deployment. For information regarding data processing and filtering, see the map introduction on p. 23. 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: **(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. **(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.

ANGUILLA

DATA RECORD 1

Project Title: Anguilla Marine Turtle Tracking
Project Partners: Anguilla Department of Fisheries and Marine Resources and Anguilla National Trust, funded by the European Union Voluntary Scheme for Biodiversity and Ecosystem Services in Territories of Europe Overseas
Metadata: 7 adult and 1 juvenile *Eretmochelys imbricata*; 14 juvenile *Chelonia mydas*
Data Source: Soanes, L. 2019. Anguilla marine turtle tracking. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contact: Louise Soanes

BELIZE

DATA RECORD 2 | SWOT ID: 1284

Project Title: Hawksbill Turtle Tracking at Lighthouse Reef Atoll, Western Caribbean—MarAlliance
Metadata: 1 adult female, 1 female subadult, and 2 juvenile *Eretmochelys imbricata*
Data Sources: **(1)** Graham, R. 2019. Hawksbill turtle tracking at Lighthouse Reef Atoll, Western Caribbean—MarAlliance. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu /dataset/1284). **(2)** STAT. (3) OBIS-SEAMAP.
SWOT Contact: Rachel Graham

BONAIRE

DATA RECORD 3

Project Title: Bonaire Turtles
Metadata: 5 female nesting *Caretta caretta*; 5 *Chelonia mydas*; 13 *Eretmochelys imbricata*
Data Sources: **(1)** Nava, M. I., and Sea Turtle Conservation Bonaire. 2019. Tracking marine turtles off of Bonaire. 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

CAYMAN ISLANDS

DATA RECORD 4 | SWOT ID: 349

Project Title: Cayman Islands 2003: Loggerhead and Green Turtles
Project Partner: Marine Turtle Research Group, Cayman Islands Department of Environment
Metadata: 1 adult *Caretta caretta*; 2 *Chelonia mydas*
Data Sources: **(1)** Blumenthal, J. 2018. Cayman Islands 2003: Loggerhead and 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 5 | SWOT ID: 349

Project Title: Cayman Islands 2004: Loggerhead and Green Turtles
Project Partner: Marine Turtle Research Group, Cayman Islands Department of Environment
Metadata: 2 adult *Caretta caretta*; 3 *Chelonia mydas*
Data Sources: **(1)** Blumenthal, J. 2018. Cayman Islands 2004: Loggerhead and 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 6 | SWOT ID 929

Project Title: Cayman Islands 2005: Green Turtles
Project Partner: Marine Turtle Research Group, Cayman Islands Department of Environment
Metadata: 3 adult female *Chelonia mydas*
Data Sources: **(1)** Blumenthal J. 2018. Cayman Islands 2005: Green Turtles. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu /dataset/929) and originated from Satellite Tracking and Analysis Tool (STAT; http://www .seaturtle.org/tracking/index.shtml?project_ id=92). **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Janice Blumenthal

DATA RECORD 7 | SWOT ID: 930

Project Title: Cayman Islands 2006: Green Turtles
Project Partner: Marine Turtle Research Group, Cayman Islands Department of Environment
Metadata: 1 adult female *Chelonia mydas*
Data Sources: **(1)** Blumenthal J. 2018. Cayman Islands 2006: Green Turtle. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu /dataset/930) and originated from Satellite Tracking and Analysis Tool (STAT; http://www .seaturtle.org/tracking/index.shtml?project_ id=175). **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Janice Blumenthal

COLOMBIA

DATA RECORD 8 | 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), and Mundo Marino Aquarium, Museo del Mar Foundation
Metadata: 1 neonate, 1 juvenile, and 1 adult *Caretta caretta*; 1 adult, 1 subadult, and 3 juvenile *Eretmochelys imbricata*
Data 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

DATA RECORD 9 | SWOT ID: 1312

Project Title: Juveniles de la Guajira
Project Partners: College of Arts and Sciences and Department of Biology, University of Miami
Metadata: 1 juvenile *Chelonia mydas*
Data Sources: **(1)** Vásquez C. 2016. Juveniles de la Guajira. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu /dataset/1312) and originated from Satellite Tracking and Analysis Tool (STAT; http://www .seaturtle.org/tracking/index.shtml?project_ id=1132). **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Catalina Vásquez

COSTA RICA

DATA RECORD 10

Project Title: Costa Rica Leatherback Tracking between 2004 and 2015
Metadata: 1 adult female *Dermochelys coriacea*
Data Source: Evans, D. 2020. Sea Turtle Conservancy leatherback tracking in Costa Rica: Personal Communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contact: Daniel Evans

CUBA

DATA RECORD 11

Project Title: Cuban Hawksbills
Metadata: 1 adult male and 20 adult female *Eretmochelys imbricata*
Data Source: Moncada, F., L. Hawks, B. Godley, S. Manolis, Y. Medina, G. Nodarse, and G. Webb. 2012. Patterns of dispersal of hawksbill turtles from the Cuban shelf inform scale of conservation and management. *Biological Conservation* 148: 191–199.
SWOT Contact: Félix Moncada

DOMINICA

DATA RECORD 12 | SWOT ID: 890

Project Title: Sea Turtles of Dominica
Project Partners: Dominica Sea Turtle Conservation Organization, International Fund for Animal Welfare, and Disney's Friends for Change Project Green
Metadata: 7 adult *Dermochelys coriacea*; 2 juvenile *Eretmochelys imbricata*
Data Sources: **(1)** Levenson, J. 2018. Sea Turtles of Dominica. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu /dataset/890) and originated from Satellite Tracking and Analysis Tool (STAT; http://www .seaturtle.org/tracking/index.shtml?project_ id=773). **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Jacob Levenson

DOMINICAN REPUBLIC

DATA RECORD 13

Project Title: Dominican Republic Hawksbills
Metadata: 9 nesting female *Eretmochelys imbricata*
Data Sources: **(1)** Hawkes, L. A., J. Tomás, O. Revuelta, Y. M. León, J. M. Blumenthal, A. C. Broderick, M. Fish, J. A. Raga, M. J. Witt, and B. J. Godley. 2012. Migratory patterns in hawksbill turtles described by satellite tracking. *Marine Ecology Progress Series* 461: 223–232. **(2)** Revuelta, O., L. A. Hawkes, Y. M. León, B. J. Godley, J. A. Raga, and J. Tomás. 2015. Evaluating the importance of Marine Protected Areas for the conservation of hawksbill turtles (*Eretmochelys imbricata*) nesting in the Dominican Republic. *Endangered Species Research* 27: 169–180.
SWOT Contact: Lucy Hawkes

FRENCH GUIANA (FRANCE)

DATA RECORD 14

Project Title: French Guiana Marine Turtle Tracking
Project Partner: CNRS
Metadata: 10 adult *Chelonia mydas*; 20 adult Lepidochelys olivacea; 19 adult *Dermochelys coriacea*
Data Sources: **(1)** Chevallier, D. 2020. Satellite tracking of marine turtles in French Guiana. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020). **(2)** Chambault, P., B. de Thoisy, M. Huguin, J. Martin, M. Bonola, D. Etienne, J. Gresser, G. Hiélard, J. Mailles, F. Védie, C. Barnerias, E. Sutter, B. Guillemot, É. Dumont-Dayot, S. Regis, N. Lecerf, F. Lefebvre, C. Frouin, N. Aubert, C. Guimera, R. Bordes, L. Thieulle, M. Duru, M. Bouaziz, A. Pinson, F. Flora, P. Queneherve, T. Woignier, J. P. Allenou, N. Cimiterra, A. Benhalilou, C. Murgale, T. Maillet, L. Rangon, N. Chanteux, B. Chanteur, C. Béranger, Y. Le Maho, O. Petit, and D. Chevallier. 2018. Connecting paths between juvenile and adult habitats in the Atlantic green turtle using genetics and satellite tracking. *Ecological Evolution* 8 (24): 1–13. https://doi.org/10.1002/ece3.4708.
SWOT Contacts: Damien Chevallier and Phillippine Chambault

GUADELOUPE (FRANCE)

DATA RECORD 15 | SWOT ID: 1022

Project Title: SEATAG–Guadeloupe and Saint-Martin, French West Indies
Project Partners: French State, Guadeloupe Region, European Union, and private sponsors
Metadata: 4 adult female and 5 juvenile *Chelonia mydas*; tags deployed in Guadeloupe
Data Sources: **(1)** Delcroix, E. 2018. SEATAG–Guadeloupe and Saint-Martin, French West Indies. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1022) and originated from Satellite Tracking and Analysis Tool (STAT; http://www.seaturtle.org /tracking/index.shtml?project_id=942). **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Eric Delcroix

MARTINIQUE (FRANCE)

DATA RECORD 16

Project Title: Martinique Marine Turtle Tracking
Metadata: 2 adult *Dermochelys coriacea*
Data Source: Chevallier, D. 2020. Satellite tracking of marine turtles in Martinique. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contacts: Damien Chevallier and Phillippine Chambault

MEXICO

DATA RECORD 17 | SWOT ID: 1197

Project Title: Movimiento Migratorio de la Tortuga Carey, Islas del Parque Nacional Sistema Arrecifal Veracruzano; Acuario de Veracruz A.C.
Metadata: 2 adult female *Eretmochelys imbricata*
Data Sources: **(1)** Mirón, R. 2016. Movimiento migratorio de la tortuga carey, Islas del Parque Nacional Sistema. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu /dataset/1197) and originated from Satellite Tracking and Analysis Tool (STAT; http://www .seaturtle.org/tracking/index.shtml?project_ id=1023). **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Raúl Mirón

DATA RECORD 18

Project Title: Yucatan Marine Turtle Tracking
Metadata: 12 adult female *Eretmochelys imbricata*; 6 adult female *Chelonia mydas*
Data Source: Cuevas, E. 2020. Hawksbill and green turtle tracking off of the Yucatan. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contacts: Eduardo Cuevas, Abigail Uribe-Martínez, and Melania C. López-Castro

PANAMA

DATA RECORD 19

Project Title: Panama Leatherback Tracking
Metadata: 7 adult female *Dermochelys coriacea*; tags deployed between 2004 and 2015
Data Source: Evans, D. 2020. Sea Turtle Conservancy tracking of leatherbacks in Panama. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contact: Daniel Evans

PUERTO RICO (UNITED STATES)

DATA RECORD 20

Project Title: Puerto Rico Leatherback Tracking
Metadata: 1 adult female *Dermochelys coriacea*; tags deployed between 2004 and 2015
Data Source: Evans, D. 2020. Leatherback satellite tracking in Puerto Rico. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contact: Daniel Evans

SAINT MARTIN (FRANCE)

DATA RECORD 22 | SWOT ID: 1022

Project Title: SEATAG—Guadeloupe and Saint-Martin, French West Indies
Project Partners: French State, Guadeloupe Region, European Union, and private sponsors
Metadata: 2 juvenile *Chelonia mydas*; tags deployed in Saint Martin
Data Sources: (1) Delcroix, E. 2018. SEATAG–Guadeloupe and Saint-Martin, French West Indies. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1022) and originated from Satellite Tracking and Analysis Tool (STAT; http://www.seaturtle.org/tracking/index.shtml?project_id=942). **(2)** STAT. **(3)** OBIS-SEAMAP.
SWOT Contact: Eric Delcroix

SINT EUSTATIUS (THE NETHERLANDS)

DATA RECORD 21

Project Title: Dutch Antilles Marine Tracking
Metadata: 3 adult female *Chelonia mydas*; 2 adult female *Eretmochelys imbricata*
Data Source: Esteban, N., R. van Dam, E. Harrison, A. Herrera, and J. Berkel. 2015. Green and hawksbill turtles in the Lesser Antilles demonstrate behavioral plasticity in inter-nesting behavior and post-nesting migration. *Marine Biology* 162: 1153–1163.
SWOT Contact: Nicole Esteban

TRINIDAD

DATA RECORD 23

Project Title: Trinidad Leatherbacks
Metadata: 8 nesting female *Dermochelys coriacea*
Data Source: Eckert, S. 2020. Satellite tracking of adult leatherback turtles off of Trinidad. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contact: Scott Eckert

UNITED STATES

DATA RECORD 24

Project Title: Lost Year Neonates
Metadata: 17 juvenile *Caretta caretta*; tags deployed at sea
Data 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 25

Project Title: Mote Marine Lab Loggerheads
Metadata: 127 *Caretta caretta*; tags deployed on nesting females
Data Source: Tucker, T., and K. Mazzarella. 2018. Mote Marine Lab loggerhead tracking. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XIV (2019).
SWOT Contacts: Tony Tucker and Kristen Mazzarella

DATA RECORD 26 | SWOT ID: 1342

Project Title: Florida Loggerhead Migrations
Project Partner: National Marine Fisheries Service Office of Protected Resources
Metadata: 38 adult *Caretta caretta*; tags deployed between 1998 and 2000
Data 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 27 | SWOT ID: 960

Project Title: Movement Patterns of Kemp's Ridley Sea Turtles in the Northwestern Gulf of Mexico, 2004–2007
Project Partner: Sea Turtle and Fisheries Ecology Research Laboratory, Department of Marine Biology, Texas A&M University at Galveston
Metadata: 7 adult female and 15 juvenile *Lepidochelys kempii*
Data Sources: (1) Seney, E. 2013. Movement patterns of Kemp's ridley sea turtles in the northwestern Gulf of Mexico, 2004–2007. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/960). **(2)** OBIS-SEAMAP.
SWOT Contact: Erin Seney

DATA RECORD 28 | SWOT ID: 1280

Project Title: Institute for Marine Mammal Studies Kemp's Ridley Tracks
Metadata: 51 juvenile, 16 subadult, and 1 adult *Lepidochelys kempii*; 2 juvenile *Caretta caretta*; 2 juvenile *Chelonia mydas*
Data Sources: (1) Eric Pulis. 2018. IMMS Ridley datasets 8 and 9. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu) and originated from Satellite Tracking and Analysis Tool (STAT; http://www.seaturtle.org/tracking/index.shtml?project_id=1280). **(2)** Coleman, A. 2017. IMMS Ridley datasets 1–7. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1083) and originated from Satellite Tracking and Analysis Tool (STAT; http://www.seaturtle.org/tracking/index.shtml?project_id=678). **(3)** STAT. **(4)** OBIS-SEAMAP.
SWOT Contacts: Andy Coleman and Eric Pullis

DATA RECORD 29 | SWOT ID: 1142

Project Title: Northeast Florida Green Turtle Tracking Project
Project Partners: Guana Tolomato Matanzas National Estuarine Research Reserve, Friends of the GTM Reserve, Keepers of the Coast, and Eastman Environmental.
Metadata: 3 juvenile *Chelonia mydas*
Data Sources: (1) Eastman S. 2017. Northeast Florida Green Turtle Tracking Project. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1142) and originated from Satellite Tracking and Analysis Tool (STAT; http://www.seaturtle.org/tracking/index.shtml?project_id=620). **(2)** OBIS-SEAMAP.
SWOT Contact: Erin Seney

DATA RECORD 30

Project Title: Cape Canaveral Sea Turtle Tagging
Metadata: 32 male *Caretta caretta*; 3 *Lepidochelys kempii*
Data Sources: (1) Arendt, M. D., A. L. Segars, J. I. Byrd, J. Boynton, J. D. Whitaker, L. Parker, D. W. Owens, G. Blanvillain, J. M. Quattro, and M. A. Roberts. 2012a. Distributional patterns of adult male loggerhead (*Caretta caretta*) sea turtles in the vicinity of Cape Canaveral, Florida, USA, during and after a major annual breeding aggregation. *Marine Biology* 159 (1): 101–112. **(2)** Arendt, M.D., A. L. Segars, J. I. Byrd, J. Boynton, J. Schwenter, J. D. Whitaker, and L. Parker. 2012b. Migration, distribution, and dive behavior of adult male loggerhead sea turtles (*Caretta caretta*) following dispersal from a major breeding aggregation in the North Western Atlantic. *Marine Biology* 159 (1):113–125.
SWOT Contact: Mike Arendt

DATA RECORD 31

Project Title: Archie Carr Green Turtles
Metadata: 19 male and 8 female adult *Chelonia mydas*
Data Sources: Bagley, D. 2019. Tracking of male and female green turtles. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contact: Dean Bagley

DATA RECORD 32

Project Title: Archie Carr Internesting Loggerheads
Metadata: 14 adult female *Caretta caretta*
Data Sources: (1) Ceriani, S. 2019. Tracking internesting loggerhead turtles. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020). **(2)** Evans, D. R., R. R. Carthy, and S. A. Ceriani. 2019. Migration routes, foraging behavior, and site fidelity of loggerhead sea turtles (*Caretta caretta*) satellite tracked from a globally important rookery. *Marine Biology* 166: 134.
SWOT Contact: Simona Ceriani

DATA RECORD 33 | SWOT ID: 658

Project Title: Loggerhead Marinelife Center Tracking
Metadata: 7 adult, 3 juvenile, and 6 subadult *Caretta caretta*
Data Sources: (1) Manire, C. 2019. Loggerheads rehabilitated at Loggerhead Marinelife Center. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/658). **(2)** OBIS-SEAMAP.
SWOT Contacts: Sarah Hirsch and Charles Manire

DATA RECORD 34

Project Title: Gulf of Mexico Kemp's and Green Turtles
Metadata: 9 *Lepidochelys kempii*; 15 *Chelonia mydas*
Data Source: Metz, T. 2019. Tracking Kemp's and green turtles in the Gulf of Mexico. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contact: Tasha Metz

DATA RECORD 35

Project Title: Mote Additional Loggerheads
Metadata: 7 adult male *Caretta caretta*
Data Sources: (1) Mazzarella, K., R. Hardy, and D. Evans. Satellite tagged sea turtle movements associated with red tide. Poster presentation at the Annual Symposium on Sea Turtle Conservation and Biology, February 2019. **(2)** Mazzarella, K. Unpublished data from the Mote Marine Lab. http://www.seaturtle.org/tracking/index.shtml?project_id=1325. (3) STAT.
SWOT Contact: Kristen Mazzarella

DATA RECORD 36

Project Title: Green Turtles from Southwest Florida
Metadata: 10 adult female *Chelonia mydas*
Data Source: Sloan, K. 2020. Tracking green turtles from southwest Florida. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020).
SWOT Contact: Kelly Sloan

GLOBAL LOGGERHEAD SATELLITE TELEMETRY

The following data records refer to satellite telemetry datasets from tags that were deployed on loggerhead turtles worldwide and were combined to create the map on pp. 32–33. The data are organized first by ocean basin and then by country of deployment. For information regarding data processing and filtering, see the note on the map on p. 32. 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: **(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. **(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.

ATLANTIC OCEAN

ARGENTINA

DATA RECORD 1

Metadata: 6 *Caretta caretta*; tags deployed in Argentina
Data 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: Victoria González Carman

BONAIRE

DATA RECORD 2

Metadata: 5 female *Caretta caretta*; tags deployed on nesting turtles
Data Sources: (1) Nava, M. I., and Sea Turtle Conservation Bonaire. 2019. Tracking marine turtles off of Bonaire. 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

BRAZIL

DATA RECORD 3

Metadata: 19 juvenile *Caretta caretta*; tags deployed at sea
Data 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 4

Metadata: 10 nesting *Caretta caretta*
Data Source: Marcovaldi, M. Â., G. G. Lopez, L. S. Soares, E. S. H. M. Lima, J. C. A. Thomé, 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 5

Metadata: 13 *Caretta caretta*; tags deployed in Brazil
Data 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 6 | SWOT ID: 951

Project Title: Brazil Trawl-Caught Turtles
Project Partners: Fisheries Bycatch Research Group; Danielle Monteiro, Universidade Federal do Rio Grande (FURG); and Projeto TAMAR
Metadata: 3 adult and 5 juvenile *Caretta caretta* tagged after being caught in trawl fisheries and released on the continental shelf of southern Brazil in 2013 and 2014
Data 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 7 | SWOT ID: 1148

Project Title: Neonates Tagged Off Brazil
Project Partners: Fisheries Bycatch Research Group; Yonat Swimmer, Projeto TAMAR; and NOAA, University of Central Florida
Metadata: 4 juvenile *Caretta caretta*; tags deployed in 2013
Data 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

DATA RECORD 8 | SWOT ID: 984

Project Title: Study of the Biology of Sea Turtles in Brazil through Satellite Telemetry
Project Partner: Projeto TAMAR-IBAMA
Metadata: 15 adult *Eretmochelys imbricata*; 5 adult *Dermochelys coriacea*; 10 adult *Caretta caretta*; 10 adult Lepidochelys olivacea; tags deployed in Brazil in 2005 and 2006
Data Sources: (1) Lopez, G. 2018. Study of the Biology of Sea Turtles in Brazil through Satellite Telemetry. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/984) on February 10, 2020, and originated from Satellite Tracking and Analysis Tool (STAT; http://www.seaturtle.org/tracking/index.shtml?project_id=63). **(2)** STAT. **(3)** SWOT Online Database.
SWOT Contact: Gustave Lopez

DATA RECORD 9

Project Title: Study of Habitat Use by Loggerhead Turtles in Southern Brazil
Project Partner: Danielle Monteiro, Projeto TAMAR—NEMA/FURG
Metadata: 16 *Caretta caretta*; tags deployed in southern Brazil
Data Source: Monteiro, D. 2016. Satellite tracking of loggerhead turtles in southern Brazil. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).

CABO VERDE

DATA RECORD 10 | SWOT ID: 346

Project Title: Cabo Verde (Proyecto Aegina): Males and Females
Project Partners: Instituto Canario de Ciencias Marinas (ICCM), Gobierno de Canarias; Instituto Nacional de Desenvolvimento das Pescas (INDP); Direcção Geral do Ambiente; and Ministerio de Ambiente, Agricultura e Pescas
Metadata: 3 adult *Caretta caretta*
Data Sources: (1) Cruz, N. 2018. Cabo Verde (Proyecto Aegina): Males and females. 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 11 | SWOT ID: 1442

Project Title: Cabo Verde: LIFE *Caretta caretta*
Project Partner: LIFE *Caretta caretta*
Metadata: 4 adult *Caretta caretta*; tags deployed in 1999
Data 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 12

Metadata: 11 *Caretta caretta*; tags deployed at sea
Data 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 (SPAIN)

DATA RECORD 13 | SWOT ID: 496

Project Title: Canary Islands: OAG
Project Partners: Observatorio Ambiental Granadilla; Sociedad de Estudio de Cetáceos en el Archipiélago Canario; Centro de Gestión de Biodiversidad, Departamento de Biología, Universidad de Las Palmas de Gran Canaria; and Centro de Recuperación de Fauna Silvestre, Cabildo Insular de Gran Canaria
Metadata: 18 juvenile and 1 subadult *Caretta caretta*; tags deployed between 2008 and 2010
Data 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 14

Project Title: Juvenile loggerheads (1999–2000) tagged in the Canary Islands
Project Partners: Universidad de Las Palmas de Gran Canaria and Sociedad Herpetológica Española
Metadata: 5 juvenile *Caretta caretta*; tags deployed in the Canary Islands
Data Source: Universidad de Las Palmas de Gran Canaria and Sociedad Herpetológica Española. 2017. Program number 01602: Proyecto Life B4-3200/97/247 de apoyo a la conservación del delfín mular (*Tursiops truncatus*) y la tortuga común (*Caretta caretta*) en Canarias. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XII (2017).
SWOT Contact: Nuria Varo Cruz

DATA RECORD 15 | SWOT ID: 347

Project Title: Islas Canarias (Proyecto Aegina): Juvenile Loggerheads
Project Partners: Instituto Canario de Ciencias Marinas, Gobierno de Canarias; Instituto Nacional de Desenvolvimento das Pescas; and Direcção Geral do Ambiente, Ministerio de Ambiente, Agricultura e Pescas
Metadata: 11 juvenile *Caretta caretta*; tags deployed in 2006
Data 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 Varo Cruz

DATA RECORD 16 | SWOT ID: 1444

Project Title: Canary Islands
Project Partner: LIFE *Caretta caretta*
Metadata: 9 juvenile *Caretta caretta*; tags deployed in Canary Islands
Data Sources: (1) Cruz, N. 2016. Canary Islands. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1444) on February 12, 2017, originated from STAT (http://www.seaturtle.org/tracking/index.shtml?project_id=886). **(2)** STAT. **(3)** SWOT Online Database.
SWOT Contact: Nuria Varo Cruz

DATA RECORD 17 | 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) and 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
Data 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 Varo Cruz

CAYMAN ISLANDS

DATA RECORD 18 | SWOT ID: 349

Project Title: Cayman Islands 2003: Loggerhead and Green Turtles
Project Partner: Marine Turtle Research Group, Cayman Islands Department of Environment
Metadata: 1 adult *Caretta caretta*; tag deployed July 2003
Data Sources: (1) Blumenthal, J. 2018. Cayman Islands 2003: Loggerhead and 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 19 | SWOT ID: 350

Project Title: Cayman Islands 2004: Loggerhead and Green Turtles
Project Partner: Marine Turtle Research Group, Cayman Islands Department of Environment
Metadata: 2 adult *Caretta caretta*; tags deployed in 2005 and 2006
Data Sources: (1) Blumenthal, J. 2018. Cayman Islands 2004: Loggerhead and 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 20 | 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), and 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
Data 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 21 | SWOT ID: 1146

Project Title: Spain Tags Merged
Project Partners: Fisheries Bycatch Research Group, NOAA, and Kai Submon, University of North Carolina, Wilmington
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 22 | SWOT ID: 1401

Project Title: Conservación y Preservación de Tortugas Marinas
Project Partners: Fundación para la Conservación y Recuperación de Animales Marinos and 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, United States
Data Sources: (1) Fundación para la Conservación y Recuperación de Animales Marinos. 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

DATA RECORD 23

Project Title: Cape Canaveral Male Loggerheads
Metadata: 32 male *Caretta caretta*
Data Sources: (1) Arendt, M. D., A. L. Segars, J. I. Byrd, J. Boynton, J. D. Whitaker, L. Parker, D. W. Owens, G. Blanvillain, J. M. Quattro, and M.A. Roberts. 2012. Distributional patterns of adult male loggerhead (*Caretta caretta*) sea turtles in the vicinity of Cape Canaveral, Florida, USA, during and after a major annual breeding aggregation. *Marine Biology* 159 (1): 101–112. **(2)** Arendt, M. D., A. L. Segars, J. I. Byrd, J. Boynton, J. Schwenter, J. D. Whitaker, and L. Parker. 2012. Migration, distribution, and dive behavior of adult male loggerhead sea turtles (*Caretta caretta*) following dispersal from a major breeding aggregation in the North Western Atlantic. *Marine Biology* 159 (1):113–125.
SWOT Contact: Mike Arendt

DATA RECORD 24

Metadata: 3 *Caretta caretta*
Data 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 Contacts: Matthew Godfrey and Karen Beasley

DATA RECORD 25 | SWOT ID: 996

Project Title: North Carolina Rehabilitated Sea Turtle Monitoring Project
Project Partners: Karen Beasley, Sea Turtle Rescue and Rehabilitation Center, and North Carolina State University
Metadata: 2 subadult *Caretta caretta*; tags deployed in 2009 and 2013 on rehabilitated individuals
Data 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 26

Metadata: 17 juvenile *Caretta caretta*; tags deployed at sea
Data 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 27

Project Partners: College of William and Mary and Virginia Institute of Marine Science
Metadata: 21 juvenile and 10 adult *Caretta caretta*
Data 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 28

Metadata: 127 *Caretta caretta*; tags deployed on nesting females in Florida
Data 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 29 | SWOT ID: 410

Project Title: Virginia Aquarium Stranding Response Program
Project Partners: Virginia Aquarium Stranding Response Program, Virginia Aquarium and Marine Science Center, and Seaturtle.org
Metadata: 17 juvenile, 3 subadult, and 1 adult *Caretta caretta*; tags deployed between 2007 and 2016 on stranded turtles
Data 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 30 | SWOT ID: 978

Project Title: Virginia Aquarium Sea Turtle Research
Project Partner: Virginia Aquarium and Marine Science Center Foundation
Metadata: 1 adult, 7 subadult, and 2 unknown-life-stage *Caretta caretta*; tags deployed on wild-caught or bycaught individuals in 2013 and 2015
Data 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 31 | SWOT ID: 1018

Project Title: Virginia Aquarium and U.S. Navy Sea Turtle Research Project
Project Partners: Virginia Aquarium Research and Conservation Department, and 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
Data 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 32 | SWOT ID: 655

Project Title: North Carolina Long-Term Sea Turtle Monitoring Project

Project Partners: Seaturtle.org, the North Carolina Wildlife Resources Commission, and Duke University Marine Laboratory
Metadata: 8 adult *Caretta caretta*; tags deployed in 2010, 2012, and 2013
Data 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 33 | SWOT ID: 1342

Project Title: Florida Loggerhead Migrations
Project Partner: National Marine Fisheries Service Office of Protected Resources
Metadata: 38 adult *Caretta caretta*; tags deployed between 1998 and 2000
Data 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 34 | SWOT ID: 1490

Project Title: Juvenile Loggerhead Use of the Gulf Stream off Cape Hatteras, North Carolina
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, and University of Central Florida
Metadata: 3 juvenile *Caretta caretta*; headstarted turtles 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
Data Sources: (1) Dubbs, L. 2017. Juvenile loggerhead use of the Gulf Stream off Cape Hatteras, North Carolina. 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

DATA RECORD 35

Project Title: Mote Marine Lab Males
Metadata: 7 adult male *Caretta caretta*
Data Sources: (1) Mazzarella, K., R. Hardy, and D. Evans. 2019. Satellite tagged sea turtle movements associated with red dide. Poster presentation at the Annual Symposium on Sea Turtle Conservation and Biology, February 2019. **(2)** Mazzarella, K. 2019. Unpublished data from the Mote Marine Lab. http://www.seaturtle.org/tracking/index.shtml?project_id=1325.
SWOT Contact: Kristen Mazzarella

DATA RECORD 36

Project Title: Archie Carr Internesting Loggerheads
Metadata: 14 adult female *Caretta caretta*
Data Sources: (1) Ceriani, S. 2019. Tracking internesting loggerhead turtles. Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XV (2020). **(2)** Evans, D. R., R. R. Carthy, and S. A. Ceriani. 2019. Migration routes, foraging behavior, and site fidelity of loggerhead sea turtles (*Caretta caretta*) satellite tracked from a globally important rookery. *Marine Biology* 166: 134.
SWOT Contact: Simona Ceriani

DATA RECORD 37

Project Title: Loggerhead Marinelife Center Tracking
Metadata: 7 adult, 3 juvenile, and 6 subadult *Caretta caretta*
Data Sources: (1) Manire, C. 2019. Loggerheads rehabilitated at Loggerhead Marinelife Center. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/658). **(2)** OBIS-SEAMAP.
SWOT Contacts: Sarah Hirsch and Charles Manire

INDIAN OCEAN

AUSTRALIA

DATA RECORD 38

Project Title: Western Australia Loggerheads
Metadata: 31 *Caretta caretta*
Data Sources: (1) Waayers D., T. Tucker, S. Whiting, R. Groom, M. Vanderklift, R. Pillans, J. Rossendell, K. Pendoley, X. Hoenner, M. Thums, K. Dethmers, C. J. Limpus, A. Wirsig, C. McMahon, A. Strydom, P. Whittock, K. Howlett, D. Oades, G. McFarlane, T. Duke, M. Guinea, A. Whiting, M. Speirs, J. King, K. Hattingh, M. Heithaus, R. Mau, and D. Holley. 2019. Satellite tracking of marine turtles in south-eastern Indian Ocean: A gap analysis of deployments spanning 1990–2016. *Indian Ocean Turtle Newsletter* 29: 23–37. **(2)** Mau, R., B. Halkyard, C. Smallwood, and J. Downs. 2013. Critical habitats and migratory routes of tagged loggerhead turtles (*Caretta caretta*) after nesting at Ningaloo Reef, Western Australia. In *Proceedings of the First Western Australian Marine Turtle Symposium* 1: 14. **(3)** Tucker, T., S. Fossette, S. Whiting, D. Rob, and P. Barnes. 2019. *Spatial and Temporal Use of Inter-nesting Habitat by Sea Turtles along the Muiron Islands and Ningaloo Coast.* Woodside Energy Report.
SWOT Contact: Tony Tucker

MOZAMBIQUE

DATA RECORD 39 | SWOT ID: 1118

Project Title: AICM Satellite-Tracked Loggerhead Sea Turtles from Mozambique, 2012, under the Southwest Indian Ocean Fisheries Project (SWIOPF)
Project Partners: Associação para Investigação Costeira e Marinha, Ifremer, and Kélonia
Metadata: 3 adult female *Caretta caretta*; tags deployed in Mozambique
Data Sources: (1) Pereira, M. A. M., E. J. S. Videira, P. M. B. Gonçalves, and R. S. Fernandes. 2014. Post-nesting migration of loggerhead turtles (*Caretta caretta*) from Southern Mozambique. *African Sea Turtle Newsletter* 1: 48–51. **(2)** Videira, E., M. Dalleau, J. Bourjea, and M. Pereira. 2015. AICM satellite-tracked loggerhead sea turtles from Mozambique, 2012, under SWIOFP. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1118) on February 12, 2017. **(3)** SWOT Online Database.
SWOT Contacts: Eduardo Videira, Mayeul Dalleau, Jérôme Bourjea, and Marcos Pereira

OMAN

DATA RECORD 40

Project Title: Masirah Island Nesting Females
Metadata: 10 female nesting *Caretta caretta*
Data Sources: (1) Rees, A. F., S. Al Saady, A. C. Broderick, M. S. Coyne, N. Papathanasopoulou, and B. J. Godley. 2010. Behavioral polymorphism in one of the world's largest populations of loggerhead sea turtles, *Caretta caretta. Marine Ecology Progress Series* 418: 201–212. **(2)** Rees, A. F., A. Al-Kiyumi, A. C. Broderick, N. Papathanasopoulou, and B. J. Godley. 2012. Each to their own: Interspecific differences in migration of Masirah Island turtles. Chelonian Conservation Biology 11 (2): 243–248.
SWOT Contact: ALan Rees

RÉUNION ISLAND (FRANCE)

DATA RECORD 41

Project Title: Movements of Late Juvenile Loggerhead Sea Turtles from Réunion Island (COCA LOCA Project)
Project Partners: Kélonia and Ifremer
Metadata: 22 adult *Caretta caretta*; tags deployed in La Réunion (France)
Data Source: Dalleau, M., L. Hoarau, M. Lalire, P. Gaspar, C. Tardy, S. Jaquemet, J. Bossert, S. Ciccione, and J. Bourjea. 2016. *COCA LOCA: Connectivity of Loggerhead Turtle (Caretta caretta) in Western Indian Ocean: Implementation of Local and Regional Management.* Final Report, Centre d'Étude et de Découverte des Tortues Marines.
SWOT Contacts: Mayeul Dalleau and Jérôme Bourjea

DATA RECORD 42 | SWOT ID: 1014

Project Title: Ifremer/Kélonia Satellite-Tracked Late Juvenile Loggerhead Sea Turtles from Reunion Island, 2008–2012
Project Partners: Ifremer, CLS, and Kélonia
Metadata: 17 juvenile *Caretta caretta*; tags deployed in La Réunion (France)
Data Source: Dalleau, M., B. Simon, J. Sudre, S. Ciccione, and J. Bourjea. 2014. The spatial ecology of juvenile loggerhead turtles (*Caretta caretta*) in the Indian Ocean sheds light on the "lost years" mystery. *Marine Biology* 161 (8): 1835–1849.
SWOT Contacts: Mayeul Dalleau and Jérôme Bourjea

SOUTH AFRICA

Data Record 43

Project Title: POST-NESTING LEATHERBACK AND LOGGERHEAD TURTLES IN SOUTH AFRICA
Metadata: 20 adult female *Caretta caretta*; tags deployed in South Africa
Data Sources: (1) Harris, L.R., R. Nel, H. Oosthuizen, M. Meÿer, D. Kotze, D. Anders, S. McCue, and S. Bachoo. 2017. Managing conflicts between economic activities and threatened migratory marine species toward creating a multiobjective blue economy. Conservation Biology 32 (2): 411–423. **(2)** Harris, L. R., R. Nel, H. Oosthuizen, M. Meÿer, D. Kotze, D. Anders, S. McCue, and S. Bachoo. 2015. Paper-efficient multi-species conservation and management are not always field-effective: The status and future of West Indian Ocean leatherbacks. *Biological Conservation* 191: 383–390.
SWOT Contacts: Ronel Nel and Linda Harris

PACIFIC OCEAN

JAPAN

DATA RECORD 44

Metadata: 4 adult female *Caretta caretta*; 5 tags deployed in Japan, but only 4 transmitted
Data Source: Hatase, H., N. Takai, Y. Matsuzawa, W. Sakamoto, K. Omuta, K. Goto, N. Arai, and T. Fujiwara. 2002. Size-related differences in feeding habitat use of adult female loggerhead turtles *Caretta caretta* around Japan determined by stable isotope analyses and satellite telemetry. *Marine Ecology Progress Series* 233: 273–281.
SWOT Contact: Hideo Hatase

DATA RECORD 45 | SWOT ID: 1546

Project Title: Post-nesting Migration of Loggerhead Turtles around Japan 2005
Project Partners: Atmosphere and Ocean Research Institute, University of Tokyo, and Yakushima Sea Turtle Research Group
Metadata: 2 adult female *Caretta caretta*; tags deployed in Japan in 2005
Data Sources: (1) Hatase, H., K. Omuta, and K. Tsukamoto. 2007. Bottom or midwater: Alternative foraging behaviours in adult female loggerhead sea turtles. *Journal of Zoology* 273: 46–55. **(2)** Hatase H. 2017. Post-nesting migration of loggerhead turtles around Japan 2005. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1546) on October 10, 2017. **(3)** STAT. **(4)** OBIS-SEAMAP. **(5)** SWOT Online Database.
SWOT Contact: Hideo Hatase

DATA RECORD 46

Project Partners: Data were combined from various studies carried out by the NOAA Pacific Islands Fisheries Science Center (PIFSC) in collaboration with many partners. See cited literature for project partners and other details.
Metadata: 178 *Caretta caretta*; tags deployed in Japan on animals captive reared by the Port of Nagoya Public Aquarium and on animals caught incidentally in fisheries
Data Sources: (1) Polovina, J. J., I. Uchida, G. H. Balazs, E. A. Howell, D. M. Parker, and P. H. Dutton. 2006. The Kuroshio Extension bifurcation region: A pelagic hotpot for juvenile loggerhead sea turtles. *Deep Sea Research Part II: Topical Studies in Oceanography* 53 (3–4): 326–339. **(2)** Kobayashi, D. R., J. J. Polovina, D. M. Parker, N. Kamezaki, I.-J. Cheng, I. Uchida, P. H. Dutton, and G. H. Balazs. 2008. Pelagic habitat characterization of loggerhead sea turtles, *Caretta caretta*, in the North Pacific Ocean (1997–2006): Insights from satellite tag tracking and remotely sensed data. *Journal of Experimental Marine Biology and Ecology* 356 (1–2): 96–114. **(3)** Abecassis, M., I. Senina, P. Lehodey, P. Gaspar, D. M. Parker, G. H. Balazs, and J. Polovina. 2013. A model of loggerhead sea turtle (*Caretta caretta*) habitat and movement in the oceanic North Pacific. *PLoS ONE* 8 (9): e73274. **(4)** Parker, D. M., G. H. Balazs, M. R. Rice, and S. M. Tomkeiwicz. 2014. Variability in reception duration of dual satellite tags on sea turtles tracked in the Pacific Ocean. *Micronesica* 2014-03: 1–8. **(5)** Saito, T., M. Kurita, H. Okamoto, I. Uchida, D. M. Parker, and G. H. Balazs. 2015. Tracking male loggerhead turtle migrations around southwestern Japan using satellite telemetry. *Chelonian Conservation and Biology* 14 (1):82–87. **(6)** Briscoe, D. K., D. M. Parker, G. H. Balazs, M. Kurita, T. Saito, H. Okamoto, M. R. Rice, J. J. Polovina, and L. B. Crowder. 2016. Active dispersal in loggerhead sea turtles (*Caretta caretta*) during the "lost years." *Proceedings of the Royal Society B* 283: 20160690. **(7)** Briscoe, D. K., D. M. Parker, S. Bograd, E. Hazen, K. Scales, G. H. Balazs, M. Kurita, T. Saito, H. Okamoto, M. R. Rice, J. J. Polovina, and L. B. Crowder. 2016. Multi-year tracking reveals extensive pelagic phase of juvenile loggerhead sea turtles in the North Pacific. *Movement Ecology* 4: 23.
SWOT Contact: T. Todd Jones

MEXICO

DATA RECORD 47 | SWOT ID: 1265

Project Title: Loggerhead Turtle Movements in the Southern California Bight
Project Partners: NOAA–National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center, NMFS West Coast Regional Office, and Aquarium of the Pacific
Metadata: 3 *Caretta caretta*; tags deployed in Southern California
Data Sources: (1) NOAA Southwest Fisheries Science Center. 2018. Satellite tracking of three loggerhead turtles in Mexico. Personal communication. In *SWOT Report—The State of the World's Sea Turtles*, vol. XIII (2018). **(2)** Seminoff, J., and T. Eguchi. 2016. Loggerhead turtle movements in the Southern California Bight. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1265) on October 2, 2017. **(3)** OBIS-SEAMAP. **(4)** SWOT Online Database. **(5)** STAT.
SWOT Contact: Jeffrey Seminoff

DATA RECORD 48

Metadata: 12 *Caretta caretta*; tags deployed in Baja California Sur, Mexico, from 1996 to 2005
Data Source: Peckham, S. H., D. Maldonado Diaz, A. Walli, G. Ruiz, L. B. Crowder, and W. J. Nicholes. 2007. Small-scale fisheries bycatch jeopardizes endangered Pacific loggerhead turtles. *PLoS ONE* 2 (10): e1041.
SWOT Contact: Hoyt Peckham

DATA RECORD 49

Project Title: Adelita
Metadata: 1 *Caretta caretta*; tag deployed in Baja California, Mexico. (This turtle, known as "Adelita," was the first loggerhead to be tracked crossing the Pacific Ocean. The tag was deployed on July 19, 1994, on the central Pacific coast of the Baja California Peninsula and was recovered, on the turtle, dead in a set net, by a fisherman off the coast of Kyushu, Japan, 478 days later on November 9, 1995, after traveling 10,600 kilometers.)
Data Sources: (1) Nichols, W. J., A. Resendiz, J. A. Seminoff, and B. Resendiz. 2000. Transpacific migration of a loggerhead turtle monitored by satellite telemetry. *Bulletin of Marine Science* 67: 937–947. **(2)** Resendiz, A., B. Resendiz, W. J. Nichols, J. A. Seminoff, and N. Kamezaki. 1998. First confirmed east-west transpacific movement of a loggerhead sea turtle, *Caretta caretta*, released in Baja California, Mexico. *Pacific Science* 52 (2): 151–153
SWOT Contact: Wallace J. Nichols

DATA RECORD 50 | SWOT ID: 126

Project Title: Pacific Turtle Tracks: Turtle-Safe Seas Project
Project Partner: Blue Ocean Institute
Metadata: 1 *Caretta caretta*; tag deployed in Baja California, Mexico
Data Sources: (1) Nichols, W. J. 2014. Pacific Turtle Tracks: Turtle-Safe Seas Project. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/126) on February 17, 2017. **(2)** OBIS-SEAMAP. **(3)** SWOT Online Database.
SWOT Contact: Wallace J. Nichols

DATA RECORD 51

Project Title: Pacific Turtle Tracks: Grupo Tortuguero
Project Partner: Grupo Tortuguero
Metadata: 12 *Caretta caretta*; tags deployed in Mexico from 1996 to 2001
Data Sources: (1) Nichols, W. J. 2016. Pacific Turtle Tracks: Grupo Tortuguero. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/317) on July 7, 2016. **(2)** OBIS-SEAMAP. **(3)** STAT.
SWOT Contact: Wallace J. Nichols

DATA RECORD 52 | SWOT ID: 1176

Project Title: Tortugas Marinas del Golfo de California
Project Partners: Instituto Politécnico Nacional, CIIDIR Sinaloa, Red Tortuguera A.C., Grupo Tortuguero de las Californias A.C., Smithsonian Mason School of Conservation, Instituto de Ciencias del Mar y Limnología–UNAM, and the local fishing communities of La Reforma and Angostura
Metadata: 6 *Caretta caretta* adults and subadults; tags deployed in the Gulf of California, Mexico
Data Sources: (1) Zavala, A. 2016. Tortugas Marinas del Golfo de California. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1176) on July 7, 2016. **(2)** OBIS-SEAMAP. **(3)** STAT. (4) SWOT Database Online.
SWOT Contact: Alan Zavala

DATA RECORD 53

Metadata: 12 loggerheads; tags deployed in Baja California Sur, Mexico

Data Source: Animal Telemetry Network. 2018. 12 loggerhead turtle tracks in Baja California Sur, Mexico. http://oceanview.pfeg.noaa.gov/ATN/.
SWOT Contact: Scott Eckert

NEW CALEDONIA (FRANCE)

DATA RECORD 54

Project Partners: NOAA Pacific Islands Fisheries Science Center and Aquarium des Lagons, Noumea, New Caledonia
Metadata: 52 juvenile *Caretta caretta*; tags deployed in 2008 and 2012 on animals that were captive reared by the Aquarium des Lagons in Noumea, New Caledonia
Data Sources: **(1)** Kobayashi, D. R., R. Farman, J. J. Polovina, D. M. Parker, M. R. Rice, and G. H. Balazs. 2014. "Going with the flow" or not: Evidence of positive rheotaxis in oceanic juvenile loggerhead turtles (*Caretta caretta*) in the South Pacific Ocean using satellite tags and ocean circulation data. *PLoS ONE* 9 (8): e103701. **(2)** Christiansen, F., N. F. Putman, R. Farman, D. M. Parker, M. R. Rice, J. J. Polovina, G. H. Balazs, and G. C. Hays. 2016. Spatial variation in directional swimming enables juvenile sea turtles to reach and remain in productive waters. *Marine Ecology Progress Series* 557: 247–259.
SWOT Contact: T. Todd Jones

PERU

DATA RECORD 55 | SWOT ID: 931

Project Title: Peru Cabezonas
Project Partners: Jeffrey Mangel, ProDelphinus, NOAA Southwest Fisheries Science Center, Peter Dutton, Jeff Seminoff, and Denise Parker
Metadata: 15 subadult *Caretta caretta*; tags deployed in Ilo and Pucusana, Peru, from 2003 to 2007, on turtles bycaught in line fisheries; only 14 tags transmitted effectively
Data Sources: **(1)** Mangel, J. C., J. Alfaro-Shigueto, M. J. Witt, P. H. Dutton, J. A. Seminoff and B. J. Godley. 2011. Post-capture movements of loggerhead turtles in the southeastern Pacific Ocean assessed by satellite tracking. *Marine Ecology Progress Series* 433: 261–272. **(2)** STAT. **(3)** SWOT Online Database.
SWOT Contact: Jeffrey Mangel

TAIWAN

DATA RECORD 56

Project Title: Loggerhead Turtle Movement off the Coast of Taiwan
Project Partners: Data are from the NOAA Pacific Islands Fisheries Science Center in collaboration with many partners. See cited literature for project partners and other details.
Metadata: 34 *Caretta caretta*; tags deployed on turtles caught as bycatch in the Taiwanese coastal poundnet fishery from 2002 to 2008
Data Sources: **(1)** Kobayashi, D. R., J. J. Polovina, D. M. Parker, N. Kamezaki, I.-J. Cheng, I. Uchida, P. H. Dutton, and G. H. Balazs. 2008. Pelagic habitat characterization of loggerhead sea turtles, *Caretta caretta*, in the North Pacific Ocean (1997–2006): Insights from satellite tag tracking and remotely sensed data. *Journal of Experimental Marine Biology and Ecology* 356: 96–114. **(2)** Kobayashi, D. R., I.-J. Cheng, D. M. Parker, J. J. Polovina, N. Kamezaki, and G. H. Balazs. 2011. Loggerhead turtle (*Caretta caretta*) movement off the coast of Taiwan: Characterization of a hotspot in the East China Sea and investigation of mesoscale eddies. ICES *Journal of Marine Science* 68 (4): 707–718. **(3)** Parker, D., G. H. Balazs, and J. J. Polovina. 2015. Loggerhead turtle movement off the coast of Taiwan. Data downloaded from OBIS-SEAMAP (http://seamap.env.duke.edu/dataset/1304) on February 23, 2017. **(4)** OBIS-SEAMAP.
SWOT Contacts: Denise Parker, George Balazs, Jeffrey Polovina, and T. Todd Jones

INTERNATIONAL

DATA RECORD 57

Project Partners: Data were combined from various studies carried out by the NOAA Pacific Islands Fisheries Science Center in collaboration with many partners. See cited literature for project partners and other details.
Metadata: 28 *Caretta caretta*; tags deployed at various locations in the Central North Pacific Ocean on turtles caught incidentally in commercial longline fisheries
Data Sources: **(1)** Polovina, J. J., D. R. Kobayashi, D. M. Ellis, M. P. Seki, and G. H. Balazs. 2000. Turtles on the edge: Movement of loggerhead turtles (*Caretta caretta*) along oceanic fronts in the central North Pacific, 1997–1998. *Fisheries Oceanography* 9 (1): 71–82. **(2)** Polovina, J. J., E. Howell, D. M. Parker, and G. H. Balazs. 2003. Dive-depth distribution of loggerhead (*Caretta caretta*) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific: Might deep longline sets catch fewer turtles? *Fisheries Bulletin* 101 (1): 189–193. **(3)** Chaloupka, M., D. M. Parker, and G. H. Balazs. 2004. Modelling post-release mortality of loggerhead sea turtles exposed to the Hawaii-based pelagic longline fishery. *Marine Ecology Progress Series* 280: 285–293. **(4)** Polovina, J. J., G. H. Balazs, E. A. Howell, D. M. Parker, M. P. Seki, and P. H. Dutton. 2004. Forage and migration habitat of loggerhead (*Caretta caretta*) and olive ridley (Lepidochelys olivacea) sea turtles in the central North Pacific Ocean. *Fisheries Oceanography* 13 (1): 36–51. **(5)** Polovina, J. J., I. Uchida, G. H. Balazs, E. A. Howell, D. M. Parker, D., and P. H. Dutton. 2006. The Kuroshio Extension bifurcation region: A pelagic hotspot for juvenile loggerhead sea turtles. *Deep Sea Research Part II: Topical Studies in Oceanography* 53 (3–4): 326–339. **(6)** Kobayashi, D. R., J. J. Polovina, D. M. Parker, N. Kamezaki, I.-J. Cheng, I. Uchida, P. H. Dutton, and G. H. Balazs. 2008. Pelagic habitat characterization of loggerhead sea turtles, *Caretta caretta*, in the North Pacific Ocean (1997–2006): Insights from satellite tag tracking and remotely sensed data. *Journal of Experimental Marine Biology and Ecology* 356: 96–114. **(7)** Howell, E. A., P. H. Dutton, J. J. Polovina, H. Bailey, D. M. Parker, and G. H. Balazs. 2010. Oceanographic influences on the dive behavior of juvenile loggerhead turtles (*Caretta caretta*) in the North Pacific Ocean. *Marine Biology* 157: 1011–1026. **(8)** Abecassis, M., I. Senina, P. Lehodey, P. Gaspar, D. M. Parker, G. H. Balazs, and J. J. Polovina. 2013. A model of loggerhead sea turtle (*Caretta caretta*) habitat and movement in the oceanic North Pacific. *PLoS ONE* 8 (9): e73274. **(9)** Parker, D. M., G. H. Balazs, M. R. Rice, and S. M. Tomkeiwicz. 2014. Variability in Reception Duration of Dual Satellite Tags on Sea Turtles Tracked in the Pacific Ocean. Micronesica 2014–03: 1–8. **(10)** Briscoe, D. K., D. M. Parker, S. Bograd, E. Hazen, K. Scales, G. H. Balazs, M. Kurita, T. Saito, H. Okamoto, M. R. Rice, J. J. Polovina, and L. B. Crowder. 2016. Multi-year tracking reveals extensive pelagic phase of juvenile loggerhead sea turtles in the North Pacific. *Movement Ecology* 4:23.
SWOT Contact: T. Todd Jones

MEDITERRANEAN SEA

ALBANIA

DATA RECORD 58 | 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

CYPRUS

DATA RECORD 59 | 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 60 | 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 61 | 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 62 | 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 63

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 64 | 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 65 | 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 66 | 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

GREECE

DATA RECORD 67 | 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 68 | 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 69 | 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 70 | 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 71 | 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 72

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

ISRAEL

DATA RECORD 73 | 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.

ITALY

DATA RECORD 74 | 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 75 | 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 76 | 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 77 | 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 78 | 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 79 | 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 80

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., E. 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 81

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 82

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 83

Metadata: 1 adult *Caretta caretta*. Tag deployed on a rehabilitated individual.
Data Sources: (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.

DATA RECORD 84

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 85

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 86

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 87

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

SPAIN

DATA RECORD 88

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 89 | 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 90 | 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 91 | 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 92 | 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 93 | 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

TUNISIA

DATA RECORD 94

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 95

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

TURKEY

DATA RECORD 96

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

INTERNATIONAL

DATA RECORD 97

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 98 | 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 99

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.

IN MEMORIAM

TIM DYKMAN (1946–2019)

Tim Dykman was an idol and an inspiration to the people that knew and loved him, and he catalyzed the conservation careers of many people around the globe, from Mexico to Panama, Mozambique, and beyond. He led by example, and his creativity, inclusivity, and above all hope galvanized conservation movements around the world that included ocean revolutionaries, indigenous leaders, field biologists, fishermen, and poets and artists. As the director of Ocean Revolution, he worked directly with the Bitonga people of Inhambane, Mozambique. In consort with Mozambique's Ministry of Fisheries and Marine Police, he played a pivotal role in creating a network of nine community-managed, nonhunting protected areas, the first of their kind in that country. Tim's absence will be felt by many people and ecosystems the world over, but his legacy lives on in the many people continuing to live by his example.

PHOTO: © Wallace J. Nichols

B. B. SOLARIN (1949–2019)

Dr. Bashir Bolu Solarin was a respected wildlife researcher and marine conservation advocate in Nigeria. B. B. worked 38 years (1978–2016) with the Nigerian Institute for Oceanography and Marine Research (NIOMAR) in Lagos, where he rose to the position of director and head of fisheries resources. He was devoted to developing and promoting bycatch reduction technologies to reduce impacts on megafauna, especially sea turtles, while increasing the efficiency of fishing. He published impactful research, and was a member of numerous societies, committees, and organizations through which he advocated for sustainable fishing practices and marine conservation. B. B. will be greatly missed by his family, his country, and the global marine conservation community.

PHOTO: © Tony Nalovic

SUE TAEI (1962–2020)

Sue Taei launched her prolific career in 1994 as biodiversity adviser to the Secretariat of the Pacific Regional Environment Programme (SPREP), where she and her teams made great advances for ocean conservation. Later, as senior director for the Pacific Islands Program for Conservation International (CI), Sue led the design and oversight of many community-based, multiuse marine protected areas (MPAs). Sue's voice reached key decision makers, governments, donors, and local communities, and she personally led conservation initiatives at the regional, national, and international levels, most notably the Phoenix Islands Protected Area (PIPA). Sue penned the dossier that led to the creation of PIPA, one of the world's largest (and deepest) MPAs and a World Heritage Site. Sue was CI's lead with the Pacific Island Leaders' Pacific Oceanscape initiative, which was adopted in 2010, was endorsed by 22 island nations, and spans 38 million square kilometers. Sue will be remembered for her passion for the ocean, and she leaves us with a legacy of achievements that will continue to guide Pacific Ocean conservation.

PHOTO: © Conservation International

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