SWOT report

Volume XI

The State of the World's Sea Turtles

SPECIAL FEATURE
South America

ALSO INSIDE:
TURTLES AND PLASTICS
LEATHERBACK STATUS
NICARAGUAN TURTLES
AND MORE ...

A hawksbill forages in the Indian Ocean off the coast of Mayotte. © JORDI CHIAS / NATUREPL.COM
FRONT COVER: A hatchling leatherback makes its way to sea on the sediment-laden shores of French Guiana. © MANON MOULIS AND MERIL DAREES / MnMWoW.com

Editor's Note

Addressing Old Challenges with New Tools

Back in the days when "cut and paste" actually meant using scissors and glue (1983), an effort called the Western Atlantic Turtle Symposium (WATS) brought together hundreds of people to compile and review data and to collectively brainstorm measures to protect sea turtles in the 38-country-wide Caribbean region. Hindered as it was by the absence of computers, spreadsheets, e-mail, and GPS (global positioning system), WATS nonetheless created a groundswell of interest and of broad-scale regional commitment to sea turtle conservation.

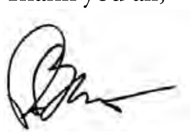
Being the symposium coordinator for WATS was my first real conservation job (my paychecks were signed by Archie Carr), and it eventually took me to South America to write the Colombia National Report for WATS-2. While walking Colombia's Caribbean coast as part of my assignment, I met desperately poor fishermen who were struggling to feed their families. I repeatedly heard the saying, "*Tortuga vista es tortuga muerta*" (a turtle we see is a turtle we kill). Indeed, the first words that landed on my ears in one town were those of a street hawker bellowing, "*Arroz con tortuga!*" (rice with turtle). This was the heyday of Colombia's hawksbill shell trade, a time when people did not think twice about sea turtle stew on a restaurant menu and when the number of conservationists focusing on sea turtles was few. As you will learn in this volume, things have changed in South America.

WATS ultimately lost steam, but its essence remains intact. In fact, it built a network, changed the lives of conservationists, and compiled baseline data. The State of the World's Sea Turtle (SWOT) Program now works to achieve similar goals but at a scale and with tools that no one in the 1980s could have imagined. With the International Sea Turtle Society preparing to host its 36th Annual Symposium in Lima, Peru—the first in South America—this *SWOT Report* includes a special feature about that important region (pp. 14–27). It also showcases our first continent-wide maps of nesting biogeography and satellite telemetry, using data contributed by the SWOT team network.

As we continue to expand SWOT's global database of sea turtle biogeography, we also recognize the importance of grounding our efforts in local realities. Those are the places where conservation rubber meets the road. In this volume, we explore broad threats such as plastic pollution, ghost nets, and cold stunning. We also draw attention to special places such as Greece, Guinea-Bissau, Nicaragua, and São Tome and Príncipe, from which our partners share engaging stories of their challenges and successes.

Our series of regional-scale overviews began with Costa Rica in *SWOT Report,* vol. X, and builds here to include the entirety of South America. As we set our sights to the future, we plan to broaden our network even further so we can address every region in which sea turtles occur.

Thank you all,



Roderic B. Mast

AT LEFT: A green turtle grazes on seagrass pastures in Hol Chan Marine Reserve, Belize.
© PETE OXFORD

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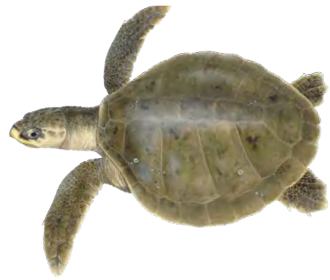
State of the World's Sea Turtles
Oceanic Society
P.O. Box 844
Ross, CA 94957
+1-415-256-9604

office@oceanicsociety.org
www.SeaTurtleStatus.org

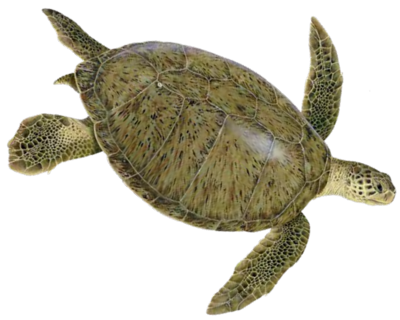
meet the turtles

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

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

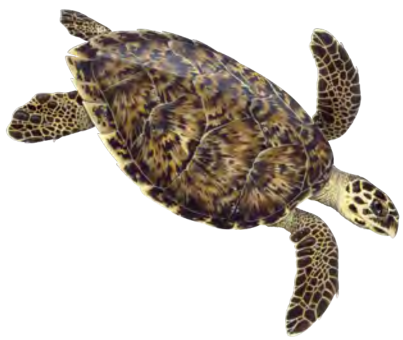


Kemp's ridley (*Lepidochelys kempii*)
IUCN Red List status: Critically Endangered



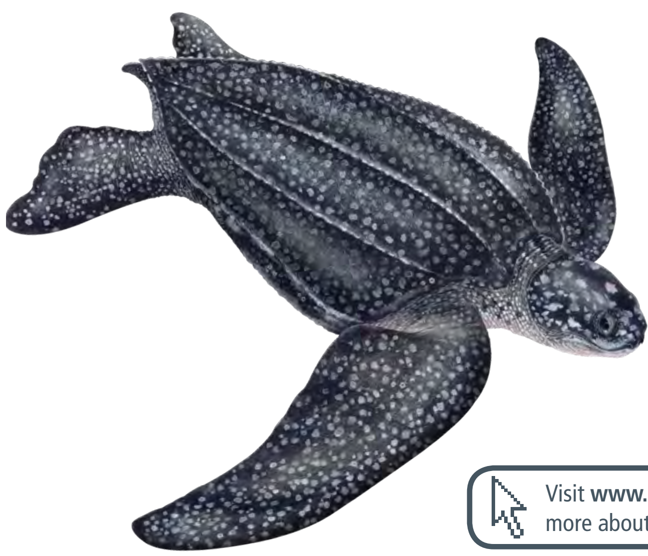
Green (*Chelonia mydas*)
IUCN Red List status: Endangered

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



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

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



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

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

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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. © CHRISTOPHER DOHERTY PHOTOGRAPHY Illustrations, at left: © DAWN WITHERINGTON

Turtles and Plastic

THE CASE FOR MORE ACTION

By EMILY DUNCAN

Pollution has been identified as a major, global-scale threat to sea turtles for decades, and the oceans are now experiencing a relatively novel and dangerous type of pollutant: highly persistent plastic. Over the past 65 years, the global annual production of plastic has grown from 1.5 million to 299.0 million metric tons. Of this, it is estimated that between 4 million and 12 million metric tons enter the oceans every year. The abundance and distribution of plastic pollution at sea are increasing, both in the form of large pieces of plastic, known as macroplastics, and as pieces of plastic smaller than five millimeters in diameter (less than a quarter inch), known as microplastics. Microplastics originate as fibers shed from clothing when it is washed; as microbeads used in cosmetic products; and as pieces of larger plastic items that break down into ever-smaller pieces as a result of wave action, exposure to ultraviolet light, and physical abrasion.

Plastics threaten many forms of marine wildlife through ingestion, entanglement, and the degradation of habitats and ecosystems. Sea turtles are of particular concern because their complex life histories, highly mobile behaviors, and use of numerous marine habitats expose them to harm from plastic pollutants through many different pathways.

INGESTION

Ingestion of plastic by sea turtles is an ever-growing problem and is now a global phenomenon that affects all seven species. It is unknown whether ingestion is accidental (the plastics are mixed with prey items) or selective (the plastic items are specifically targeted by turtles). Because turtles are primarily visual feeders, the colors and shapes of ocean plastics are likely to be important factors in determining the probability of ingestion. Ingestion rates are also likely to differ dramatically among life stages and species. Six of the world's seven sea turtle species undergo a period of pelagic drifting with currents that transport hatchlings to highly productive foraging hotspots. These are the same oceanic processes that also concentrate floating anthropogenic debris, thus creating a spatial overlap of plastics and young turtles that could be acting as an ecological trap.

As they grow, many species begin to develop more specialized diets. Carnivorous species such as the loggerhead, Kemp's ridley, olive ridley, and flatback risk indirectly ingesting microplastics by consuming contaminated prey items. Other species risk ingesting plastics that resemble their prey. For example, clear, soft plastics resemble the natural structure and behavior of sea grasses and gelatinous prey, which are important food sources for green turtles and leatherback turtles, respectively. Plastic ingestion can be lethal, causing blockages, internal injuries, and lacerations. Adverse sublethal effects can also take place, such as dietary dilution in which the stomach is filled with nonfood items that can lead to starvation, malnutrition, and impaired immunity.

The large surface area to volume ratio of microplastics also has the potential to attract hydrophobic contaminants—such as polychlorinated biphenyls, known as PCBs—that can be released into the animal's tissues when ingested. The sheer scale and diversity of possible effects of plastic ingestion on marine turtles make this topic one that is in urgent need of further research.

ENTANGLEMENT

Beyond ingestion, entanglement in marine debris can cause severe injuries such as abrasions and loss of limbs, and it also can cause turtles to drown or can reduce their ability to move and avoid predators. There have been many reports of turtles becoming entangled in marine debris originating from packaging as well as in lost fishing gear (ghost nets). Those forms of plastic pollution may persist in the environment for many years, during which they will affect unknown numbers of animals. Eventually the debris becomes biofouled—that is, covered in microorganisms, plants, or animals—which attracts ocean grazers and predators such as sea turtles, which can become entangled.

Large knowledge gaps exist about the severity of this threat, and the sources of entangling plastic pollutants are difficult to trace because of their widespread distribution and movements within ocean currents. Many individual cases of debris entanglement are probably not published. Therefore, rates of entanglement—especially those involving land-based sources, as opposed to ghost fishing gear—are possibly greatly underestimated.

HABITAT DEGRADATION

The presence of plastic in marine environments may lead to the degradation of key habitats used by sea turtles. Nesting beaches, for instance, are frequently sinks for marine debris. As a result, nesting females may have difficulty ascending to lay their eggs, or debris could act as obstacles for emerging hatchlings. Moreover, the physical properties of nesting beaches, particularly the permeability and temperature of sediments, are known to be altered by the presence of plastic fragments. Such alterations could ultimately have implications for sex ratios, which are influenced by nest conditions, and for nest success rates when pollution is severe.

Sea turtles use a variety of aquatic habitats, both near the coast and in the open ocean, that may be adversely affected by the presence of plastics. For example, plastic pollution could reduce the health of coral reefs by causing suffocation, abrasion of polyp tissue, shading from light, and sediment accumulation. The aggregation of both macroplastics and microplastics on oceanic fronts has the potential to decrease the quality of such vital habitats by altering the abundance of available food.

AT LEFT: Microplastic particles are found on a coastal cleanup in the Ha'apai Islands, Tonga. Plastic is now found throughout the world's oceans and in beach sands everywhere.
© SANDY BRITAIN, SUSTAINABLE COASTLINES / MARINE PHOTOBANK

5 THINGS YOU CAN DO TO REDUCE OCEAN PLASTIC POLLUTION

1	**REFUSE, REUSE, RECYCLE**—Know that change starts with you. Reduce the amount of plastic that ends up in the ocean by refusing single-use plastics, reusing other plastic items, and recycling plastics that cannot be reused.
2	**CLEAN UP**—Help remove plastics from the ocean, and prevent them from getting there in the first place by participating in or organizing a cleanup of your local beach or waterway.
3	**SUPPORT BANS**—Many municipalities around the world have enacted bans on single-use plastic bags, takeout containers, and bottles. You can support the adoption of such policies in your community.
4	**SPREAD THE WORD**—Tell your friends and family about how they can be part of the solution, or host a viewing party for one of the many documentaries about plastic pollution.
5	**STAY INFORMED**—Learn more about ocean plastic pollution through *SWOT Report*, news stories, documentary films, and scientific articles (similar to the one that this article was based on and that was published in *ICES Journal of Marine Science* in 2015; see http://dx.doi.org/10.1093/icesjms/fsv165).

URGENT ACTION NEEDED

Research is urgently needed to better understand plastic pollution and its many effects on marine turtles. I and other authors published a comprehensive review of the published literature about the impact of ocean plastic pollution on sea turtles in *ICES Journal of Marine Sciences* in 2015 (see reference in box above). The review highlights the research needs in a number of disciplines, ranging from ecology to pathology. A number of worthy lines of investigation could aid in understanding the magnitude of the problem and could serve as building blocks for pursuing solutions.

To fully comprehend ingestion and entanglement risk, for instance, researchers must collect data over a variety of geographic, species, and life-stage scales, which would culminate in a global-scale metadatabase. Those data could be further complemented by (a) research to classify the sizes and types of plastics ingested by turtles to reveal patterns of selectivity, (b) oceanographic modeling to highlight hotspots of vulnerability, and (c) investigations into the presence and possible trophic transfer of microplastic particles and contaminant burdens within food webs. Key turtle habitats should also be studied, including quantifying plastic distributions and densities on nesting beaches and conducting experimental research into the effects on sex ratios and nest success.

While we work to advance our understanding of this important threat to turtles and their ocean habitats, we must also do whatever we can as individuals to reduce ocean plastic pollution by influencing the actions of governments, businesses, and other individuals. Change starts with each of us remembering to act in our day-to-day lives by refusing, reducing, reusing, and recycling plastics and by ensuring that our elected officials and the businesses we support through our purchases get the message to do the same. ■

HOW IN-WATER
GENERATE VALU

TURTLE OBSERVATIONS
ABLE NEW INSIGHTS

By KOSTAS PAPAFITSOROS and GAIL SCHOFIELD

There are few places in the world where people can swim with turtles in calm, clear coastal waters. In many places, the sea is too turbid or dangerous, with waves, strong currents, or dangerous animals such as sharks and crocodiles. However, coming face to face with a living fossil underwater is a unique experience, and prolonged in-water sea turtle observation can teach us new and unexpected things about turtles that will help us to conserve them and their ocean habitats.

Laganas Bay, on the Greek island of Zakynthos, is one of the most northerly reproductive sites on Earth for sea turtles and is home to one of the most important nesting sites for loggerheads in the Mediterranean (see *SWOT Report*, vol. X, p. 25). Migratory male and female loggerheads enter Laganas Bay starting in March of each year. Mating peaks in April, males depart by the end of May, and females leave primarily between July and August after laying several clutches of eggs on nearby beaches. What makes this site ideal for in-water behavioral observations is that females aggregate close to shore to occupy warmer waters while they develop their eggs before nesting. Furthermore, several year-round resident turtles occupy the bay, so one can see turtles at almost any time of year.

Since 2000, we have been gathering in-water photographic and video observations of many individual sea turtles at this site through snorkeling surveys. Because we see the same male and female turtles year after year, we have learned that every single turtle is unique, not just in the shape and arrangement of its facial scutes, but also in its individual behavior and response to humans.

Through photographic identification of facial scutes, we have distinguished more than 500 individuals over the past 15 years of surveys. We have observed that most migratory males return every year, and most females return every two years, with a few females returning annually or in three-year cycles. The knowledge gained from our in-water surveys augments and contrasts with beach-based tagging programs because we obtain information not only about females, but also about male, subadult, and juvenile loggerheads. We even saw one juvenile green turtle, a member of a species that generally is not thought to occur in Laganas Bay. (It may have been visiting from the nearby Greek mainland, the Peloponnese, where greens are known to forage.)

For some individuals, our records date back the full 15 years, such as a resident male we named Sotiris, who takes advantage of fishermen's scraps at the local port. The locals claim he has been around even longer, although at least 10 resident males live in this part of the bay with whom he could be confused. We have observed several females who have been around for at least 15 years, one example being a female with a highly recognizable underbite. The long-term records demonstrate the importance of photo ID as a noninvasive mark-recapture method, which has many advantages over traditional flipper tags. The high loss rates of tags often prevent researchers from compiling complete life histories. Our records also provide insights about the frequency of injury to turtles, changes in barnacle loads across years,

and an array of other in-water behavioral traits that could never be seen from traditional nesting-beach tagging alone.

Through our work, we have documented a number of solitary and interactive behaviors of both male and female turtles, including male-male fights over females, male search efforts for mates, courtship, mating and mate-avoidance behaviors, and attacks by satellite males on mating males. Females are generally solitary during the breeding season, when they rest in the warm nearshore waters before and during the early nesting period. Warm water sites are rare at the start of the season until late June, when sea temperature exceeds 25 °C, which is optimal for egg development before laying. During this time, females compete for access to such sites, and fighting is a common occurrence between females that enter each other's visual range.

However, we have seen up to three females using the same fish-cleaning station at once. Such tolerance may indicate the importance of the cleaning behavior in preventing a buildup of epibionts such as barnacles and algae, which can hinder the animals' movements, cause disease, or have other negative effects. One particular female remained at the same cleaning station for more than six days but was not cleaned by cleaner fish, maybe because she was not in the correct pose or possibly because the fish had consumed all edible items from her body surface. We have not yet documented a male at a fish-cleaning station, although both males and females bear evidence of self-cleaning activity: scratches on their carapaces from rubbing against rocks and anchors.

The year-round residents, primarily males, tend to react more strongly to the presence of other turtles. For example, at one location where we have observed residents foraging, fights often ensue, with resident males aggressively biting the body, neck, and tail of other turtles entering the foraging area until the visitors retreat.

… we have learned that every single turtle is unique, not just in the shape and arrangement of its facial scutes, but also in its individual behavior and response to humans …

Furthermore, we have gained insights into how turtles respond to human presence. Overall, it is much harder for snorkelers to approach turtles in the morning, when sea temperatures are cooler (below 25 °C) or when underwater visibility is poor. Some individual turtles, however, will always swim away when approached, regardless of conditions, whereas others will remain, appearing to be undisturbed. During April and May, reproductively active males who are searching for females will either swim away quickly or make aggressive advances, appearing to view snorkelers as potential competitors. Furthermore, turtles are more likely to swim away if approached from different sides by more than one person. The turtles' preference to keep the person in view makes photographing both sides of a turtle's head frustrating.

Understanding the ecology and behavior of turtles in Laganas Bay has helped local stakeholders to develop and monitor strategies and practices that will minimize the impact of tourism activities. Most visitors view the bay's sea turtles from turtle-spotting boats that operate during the nesting season. About 20 such boats operate in Laganas Bay, and most follow the code of conduct prescribed by the National Marine Park of Zakynthos, which includes the bay.

Volunteers from the Greek nongovernmental organization Archelon are on board to provide educational information. During the nesting season, enough turtles can be seen in the bay to satisfy tourist demand, but outside the nesting season (from mid-August until tourism stops in mid-October), the fewer resident (mostly male) turtles are intensively pursued by spotters. While we have found that the population-level effect of such tourism is minimal, we are currently investigating the potential effects on individuals, particularly late-season breeding females. Such females require sufficient energy reserves to return to distant foraging grounds (around 1,000 kilometers away, or about 620 miles) after completing nesting.

It is not always possible for researchers to directly observe turtles as we have been fortunate to do while snorkeling in Laganas Bay's clear waters. However, technology is providing new ways of observing individuals, such as by attaching animal-borne cameras or by setting camera or video traps at fixed locations. In whatever way the data are gathered, in-water surveys provide a unique glimpse into how both male and female turtles from all age classes behave in relation to each other, to their habitats, and to their human and nonhuman (camera) observers. To protect sea turtles and their habitats wisely, we must improve our understanding of these magnificent animals. Ultimately, we still have much to learn, and one of the best ways to start to discover their mysteries is simply to dive in. ■

AT LEFT: In-water observation allows researchers to observe sea turtles' social interactions. © SEA TURTLE PHOTOGRAPHY / KOSTAS PAPAFITSOROS; Researcher Kostas Papafitsoros photographs a feeding loggerhead in Laganas Bay, Zakynthos, Greece. © GAIL SCHOFIELD PREVIOUS SPREAD: A loggerhead turtle forages for mollusks during behavioral observations in Laganas Bay, Zakynthos, Greece. © SEA TURTLE PHOTOGRAPHY / KOSTAS PAPAFITSOROS

The Internet of Turtles

By AIMÉE LESLIE, CHRISTINE HOF, DIEGO AMOROCHO, TANYA BERGER-WOLF, JASON HOLMBERG, CHUCK STEWART, STEPHEN G. DUNBAR, and CLAIRE JEAN

"One of the greatest challenges we face in conserving leatherbacks is seeing the big picture and taking local actions that can have global significance,"

wrote Brian Hutchinson and María Fernanda Pérez in 2006 in the first *SWOT Report*, vol. I, p. 17. This truth still applies, not only to leatherbacks, but also to all marine turtle populations. Yet that challenge has been partly overcome by the SWOT Program and its hundreds of contributors over the past 12 years. Those efforts—a global-scale database and nesting maps for all marine turtle species—are revolutionizing the way we see, analyze, and use marine turtle data and are aiding conservation decisionmaking worldwide.

Still, many challenges remain that impede our ability to understand turtle population dynamics and to monitor long-term trends. One significant challenge is the lack of a global database of information about marine turtle foraging grounds. Collecting data, however, is hindered by difficulties in identifying and reidentifying individual turtles over time. To date, researchers have typically relied on using metal flipper tags or other physical markers to identify individual turtles while they nest or when they are caught and released at sea.

Flipper tagging of marine turtles started in the 1950s and, for many years, was the only cost-effective, widely available technology. However, flipper tagging has a few important limitations. One problem is that tags seldom stay attached throughout the turtle's life. The process of affixing metal tags, although usually harmless, can require researchers to capture and thereby stress a turtle, and can also cause localized necrosis or infection. Moreover, permitting requirements to physically tag turtles are often cumbersome, thus limiting the number of tags that are deployed and preventing participation by untrained volunteers and citizen scientists. With such concerns, it is clear that a better method for identifying individual turtles would have substantial benefits for research and conservation.

Fortunately, advances in technology are opening up possibilities for improved turtle identification. For instance, molecular markers, which are obtained from turtle blood, tissue, or eggs, have been used to successfully identify turtles in various locations and contexts. They are highly effective, but samples are costly to analyze and generally require special permits to obtain. Photographic identification, however, has become very cost effective and generally requires no special permits. Although photo ID has been unreliable in the past, it is becoming an increasingly effective tool for identifying individual turtles and is gaining traction among sea turtle researchers. A global system for managing photographic identification data is urgently needed to help this technique realize its full potential.

One new conservation tool with the potential to greatly improve and facilitate data gathering for marine turtles uses photo identification data. The Image Based Ecological Information System (IBEIS) is a platform that combines data analytics with individual animal tracking for many species. It starts with a database of photographs contributed by both researchers and citizens. The user can enter a photograph and the system can identify an individual animal in minutes. If properly managed, the platform can put information about demographics, species distributions, individual interactions, and movement patterns at researchers' fingertips

A diver photographs a loggerhead turtle near Los Gigantes in Tenerife, Canary Islands.

for the first time. World Wildlife Fund (WWF) is currently working with IBEIS to build and test a version of its system for marine turtle photo identification, and the results to date are extremely promising.

Another example is TOORSOI (*Tortues marines du Sud Ouest de l'Océan Indien*), a database created by IFREMER (*Institut Français pour L'Exploitation de la Mer*) and Kélonia for use by turtle conservation projects in the Southwest Indian Ocean. The database helps store and organize information on tags, nesting data, and individual photos for identification, as well as biological information and threat data. TOORSOI also helps standardize data management and promote collaboration among areas connected by turtles' movements and activities.

WWF is joining efforts with SWOT, IBEIS, TOORSOI, and others to develop a unique, open source set of global marine turtle monitoring and analytical tools. The "Internet of Turtles" will provide the marine turtle conservation community at large with the following:

- A computer-assisted photo identification system that recognizes individual animals in minutes
- Standardized data management and advanced population analytics to bridge the gaps from science to conservation to management
- An interface and mobile application that incentivizes input from wildlife conservation professionals and citizen scientists and that facilitates field data collection

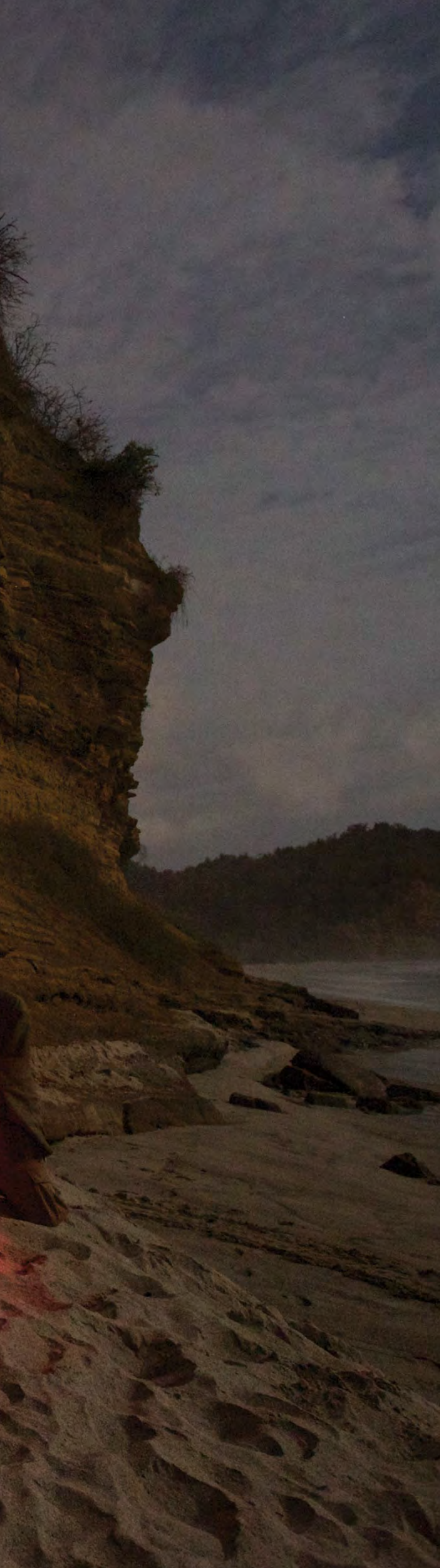
Projects that contribute to the Internet of Turtles will be able to (a) digitally collect and share data among entities and across countries and languages; (b) extract and analyze relevant turtle data at different scales, such as population and subpopulation, from all life stages, and from turtles dead or alive; (c) contribute to the regional management unit delineation and assessment process of the International Union for Conservation of Nature's Marine Turtle Specialist Group; and (d) provide up-to-the-moment clarity on the status of turtles wherever they are (in water or on land).

By joining hands in a community-driven, collaborative effort to understand how to recover turtle populations locally, nationally, and globally, we hope to have a greater effect than ever. Once built, the web-based photo ID system and global toolkit for turtles will help revolutionize the collection, analysis, and sharing of information for turtle conservation and management. Join the revolution. ■

SEA TURTLES OF
SOUTH AMERICA

In alphabetical order: ROCIO ÁLVAREZ-VARAS, RACHEL BERZINS, KARIN BILO, JOHAN CHEVALIER, DAMIEN CHEVALLIER, BENOIT DE THOISY, ALEJANDRO FALLABRINO, MARCO GARCÍA CRUZ, SHALEYLA KELEZ, MILAGROS LOPEZ-MENDILAHARSU, MARIA ANGELA MARCOVALDI, RODERIC B. MAST, CAROL MEDRANO, CRISTINA MIRANDA, MICHEL A. NALOVIC, LAURA PROSDOCIMI, JUAN M. RGUEZ-BARÓN, ALEXSANDRO SANTOS, LUCIANO SOARES, JOCA THOME, FELIPE VALLEJO, GABRIELA VÉLEZ-RUBIO

From northern Colombia to Tierra del Fuego, the South American continent stretches some 7,149 kilometers (4,443 miles) and is 4,353 km (2,705 mi) at its broadest. The fourth-largest continent, South America is number one in biodiversity. It is home to the world's largest rainforest wilderness and river system (the Amazon) and to the world's largest wetland (the Pantanal), and it has 144,567 km (89,830 mi) of coastline.



Five of the world's seven sea turtle species (hawksbill, green, leatherback, loggerhead, and olive ridley) call the Pacific, Atlantic, and Caribbean waters and the beaches of South America their home for at least part of their life cycles. And although uncommon, even the range-restricted Kemp's ridley is an occasional visitor to South American waters, leaving just one sea turtle that is a complete stranger to the continent: the Australian flatback. Hybrid sea turtles are also known to occur among the hard-shelled species in South America (see box, p. 19).

Sea turtles are among the most migratory creatures on Earth. Thus, it is no surprise that many turtles found in South America arrive there from far away. Some have hatched on distant shores in Africa, the Caribbean, Central America, and the western Pacific. By the same token, turtles hatched on South American beaches are also known to travel throughout the Atlantic and Pacific Oceans and the Caribbean Sea. A total of 12 distinct sea turtle subpopulations (also called regional management units, or RMUs) are found in South America, out of 38 that are described globally (see maps, pp. 20–25).

All five of South America's resident sea turtles nest on the continent in a vast tropical arc that stretches clockwise from Piura in northern Peru to the Brazilian state of Rio de Janeiro; this encompasses the Galápagos and other offshore islands (see maps, pp. 20–23). Sea turtles range significantly farther south of this nesting arc as they forage in the Pacific off Peru and Chile and in the Atlantic off southernmost Brazil, Uruguay, and Argentina.

The maps that accompany this article show data that are provided by SWOT partners and that document sea turtle nesting abundance along this continuum (pp. 20–23). The maps also show in-water movements from satellite tags deployed in South America (pp. 24–25), as well as selected stranding data for the three South American coastal countries where nesting does not occur (see box, p. 27).

Sea turtles are important components of the culture and folklore of South American people. Turtles have been sought for food and for other traditional uses throughout the continent's human history. Over the centuries, what began as subsistence-level human exploitation has evolved into a variety of more severe and pervasive anthropogenic threats. Today, those threats include the effects of fisheries, loss of habitat to coastal development and to resource extraction, poaching, boat strikes, pollution, and climate change.

As a result of those mounting threats and of the increasing environmental consciousness globally, all 11 coastal South American countries have responded with some form of national protective legislation for sea turtles. All are also participating in related intergovernmental treaties, including the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Migratory Species (CMS), and the Convention on Biological Diversity (CBD). Moreover, all but Colombia, France (French Guiana), Guyana, and Suriname are party to the Inter-American Convention (IAC) for the Protection and Conservation of Sea Turtles, which was established in 2001.

Regional networks also play an important role in organizing the South American sea turtle movement, including the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), the Southwest Atlantic Sea Turtle Network (ASO), the Groupe Tortues Marines France (GTMF), the South Atlantic Sea Turtle Network (SASTN), and the Eastern Pacific Hawksbill Initiative (ICAPO), to name a few.

The 1992 "Earth Summit" in Rio de Janeiro marked a turning point in the global conservation movement. It spawned an explosion in the number of national and local nongovernmental organizations (NGOs) dedicated to conservation in South America. Dozens of those groups focus on sea turtles. Scientific investigation has also advanced enormously in recent decades, with researchers from many

AT LEFT: Volunteers with Equilibrio Azul pose with a hawksbill turtle after fitting it with a satellite tag on La Playita Beach in Machalilla National Park, Ecuador. © FELIPE VALLEJO / WWW.EQUILIBRIOAZUL.ORG
PREVIOUS SPREAD: Green turtles and Galápagos sea lions fill the scene near Santa Cruz Island in Ecuador's Galápagos Islands. © TUI DE ROY / MINDEN PICTURES

nations, institutions, and disciplines now hard at work helping to answer key questions about the natural history and conservation of sea turtles. Those efforts are helping us to build a brighter future for sea turtles and their habitats in South America and beyond.

The following sections highlight some of the many interesting aspects of South America's sea turtles and regional perspectives on the conservation and research movement dedicated to understanding and protecting sea turtles on that continent.

BRAZIL AND THE SOUTHWEST ATLANTIC

The Atlantic coast and adjacent seas of Brazil, Uruguay, and Argentina are important nesting and feeding areas for all five of South America's resident sea turtle species. Nesting in this region occurs from Atol das Rocas and the Fernando de Noronha archipelago off the northeastern tip of Brazil's Rio Grande do Norte state and extends south to Quissamã in the state of Rio de Janeiro. The only nesting population of leatherbacks in the southwest Atlantic can be found in the state of Espírito Santo, Brazil (not seen on the maps, p. 21, due to its size).

Foraging animals are found even farther south in the waters off Uruguay and Argentina, and stranding data gathered since the late 1990s provide a sense of how far turtles range in those temperate waters (see box, p. 27). The southwest Atlantic is a true melting pot of mixed stocks from six or more RMUs: (a) green turtles that breed off Ascension Island, French Guiana, Suriname, Trinidad and Aves Island; (b) loggerheads, hawksbills, and olive ridleys that nest in Brazil; and (c) leatherbacks from Ghana and Gabon, the Caribbean, and Brazil.

Sea turtles throughout this region face pressure from poaching, pollution, fisheries interactions, and degradation of nesting and foraging habitats, to name a few of the more significant threats. Although legislation exists to protect sea turtles in Brazil, Uruguay, and Argentina, governments do not always have the resources to enforce protective measures.

The Southwest Atlantic Sea Turtle Network (ASO) was created in 2003 to foster greater collaboration in southern Brazil, Uruguay, and Argentina for the protection of sea turtles and their habitats. ASO represents dozens of local and regional NGOs and government agencies as well as hundreds of community members. Every two years, ASO hosts a large gathering to share scientific news, conduct environmental education, and develop conservation strategies. As a result of their collective efforts in recent years, ASO and its partners have significantly advanced policies to protect sea turtles from fisheries interactions, which is one of the most severe threats in the region.

Brazil plays a major role in South American (and global) sea turtle conservation and research, and it serves as an example to other countries. Projeto TAMAR, a partnership of the Centro TAMAR/ICMBio, government agencies, and Fundacão Pró TAMAR, has been active since 1980. Today, the group carries out sea turtle research and conservation from 22 stations on the coast and the offshore islands of Brazil. The members monitor Brazil's major turtle rookeries and have amassed long-term datasets that have been extremely useful in defining RMUs.

Besides contributing to conservation, Projeto TAMAR has made great strides in promoting ecotourism and engaging local communities through art, music, and dance. An important innovation introduced by Projeto TAMAR is the social production chain that includes the manufacture of t-shirts and other items to provide alternative livelihoods to former turtle harvesters and their families. At the same time, the sale of those goods raises funds to support conservation (see *SWOT Report*, vol. II, pp. 26–27, and vol. VIII, p. 33).

Another NGO based in the southern Brazilian state of Rio Grande do Sul, called NEMA, has been collecting systematic sea turtle stranding data since 1990. Those data have been instrumental to conservation efforts in Brazil, and have shown that southern Brazil has the highest stranding rates for loggerheads in the western Atlantic Ocean.

THE GUIANAS

The Guianas (Guyana, French Guiana, and Suriname) are known for their shifting shorelines (see *SWOT Report*, vol. III, pp. 22–23). Enormous amounts of sediment pour from the mouth of the Amazon River about 500 km (300 mi) southeast of Brazil's border with French Guiana. Those sediments disperse northward with the North Brazil Current, which results in unstable nesting beaches that erode and grow in largely unpredictable patterns, thus causing great shifts in habitat use by sea turtles.

Today, the Guianas region is known for its important leatherback, olive ridley, and green turtle colonies. Although only 50 km of French Guiana's approximately 378 km (31 mi of approximately 235 mi) of coastline are suitable for turtle nesting, two areas have been sites of long-term monitoring. The first is near the capital city of Cayenne, and the second is at the extreme west of the country near its border with Suriname. The second site, Awala-Yalimapo, was discovered in the 1960s and has been regularly monitored since the early 1980s. The area was referred to by renowned sea turtle biologist, Peter Pritchard, as "the Holy Grail of [leatherback] nesting sites." When not breeding, leatherbacks from this region migrate to the North Atlantic, where they forage on the abundant jellyfish they find there (see map, pp. 24–25).

Just across the Maroni (Marowijne) River to the west are Suriname's best-documented nesting beaches, Galibi and Matapica, which

are part of the same colony as Awala-Yalimapo. In addition to sharing this important leatherback rookery, this binational zone has some of the world's largest green turtles. Immature green turtles are also commonly observed around the offshore island here, although their genetic relation to the adults is unknown. Olive ridleys also nest and forage on those coasts and as far west as Venezuela. As in much of the rest of the continent, sporadic hawksbill nesting is also reported.

At the western edge of the Guianas, Guyana's best-known and most-studied nesting beach is Shell Beach, near the country's western border with Venezuela. This remote, pristine beach is lined by tropical forest and is accessible only by boat. Its distinctive orange sand, consisting of tiny shell fragments, is a nesting ground for green, hawksbill, leatherback, and olive ridley turtles. Local residents have been monitoring and protecting sea turtles on Shell Beach since 1988. The Guyana Marine Turtle Conservation Society was founded in 2000 to ensure continuity to those efforts. In 2011, Shell Beach was declared a protected area, and the responsibilities of management and monitoring were transferred to Guyana's Protected Areas Commission.

The Guianas are among the largest remaining coastal wilderness areas in the tropics. Large undeveloped extensions of shoreline remain in this region, often with unbroken rainforest leading right up to the sea's edge. This wildness is largely a blessing for turtles, because human interference is limited, but it also means that they occasionally fall victim to another predator—the jaguar.

One of the main threats to turtles throughout the Guianas, as elsewhere in the world, is bycatch from trawl, longline, and gillnet fisheries. As many as 25 percent of nesting leatherbacks in French Guiana show scars likely to have resulted from contact with fishing gear. Illegal, unreported, and unregulated fisheries activities are of particular concern, and efforts are under way to combat their effects in French Guiana and Suriname. Turtle excluder devices (TEDs) have been used by shrimp trawlers in Guyana and Suriname for more than 20 years, but they were not required in French Guiana until recently.

A collaborative fisheries research project between the French Guiana Regional Fishery and Ocean Farming Committee (CRPMEM), World Wildlife Fund, and others has looked carefully at bycatch reduction technologies for shrimp trawlers. That research has led to the development of the TTED, a trash and turtle excluder device. Beyond its role in protecting turtles, the TTED effectively minimizes injuries to other nontarget species such as sharks, rays, and other fish. At the same time, TTEDs save on fuel costs and improve the quality of shrimp catches. Building on that work, efforts are now under way to convince the European Union to tighten restrictions on shrimp imports from countries whose fisheries do not protect against sea turtle bycatch.

THE CARIBBEAN

In contrast to the wild coastline of the Guianas, the shores of Caribbean South America have seen significant human influence for more than 500 years, since those areas bore the brunt of Spanish colonization. Today, many major cities dot the shores of Venezuela and Caribbean Colombia, and nearly unbroken coastal highways flank the shores of both countries. Although nesting still occurs along South America's Caribbean coast, it has certainly been much reduced by centuries of human pressure.

CONTINUED ON P. 26

HYBRID TURTLES

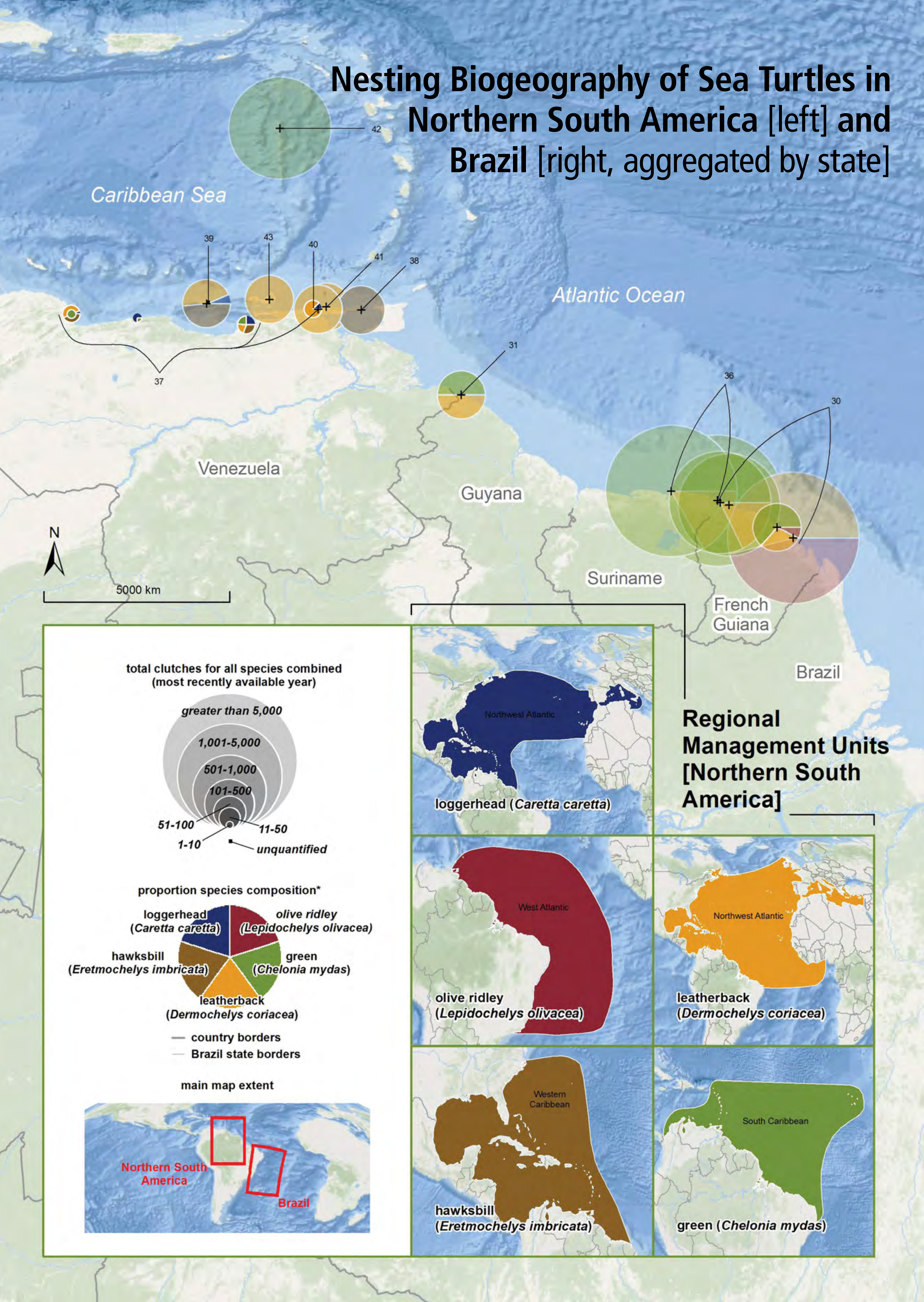
Hybridization of sea turtle species is a phenomenon that has been known about for a century or more. Interspecific hybrids appear to be remarkably prevalent in Brazil and the southwestern Atlantic, where multiple species share foraging and nesting areas, and where hybrids have been documented and studied with increasing rigor since the 1990s. (Hybridization has also been recently documented in Pacific South America.)

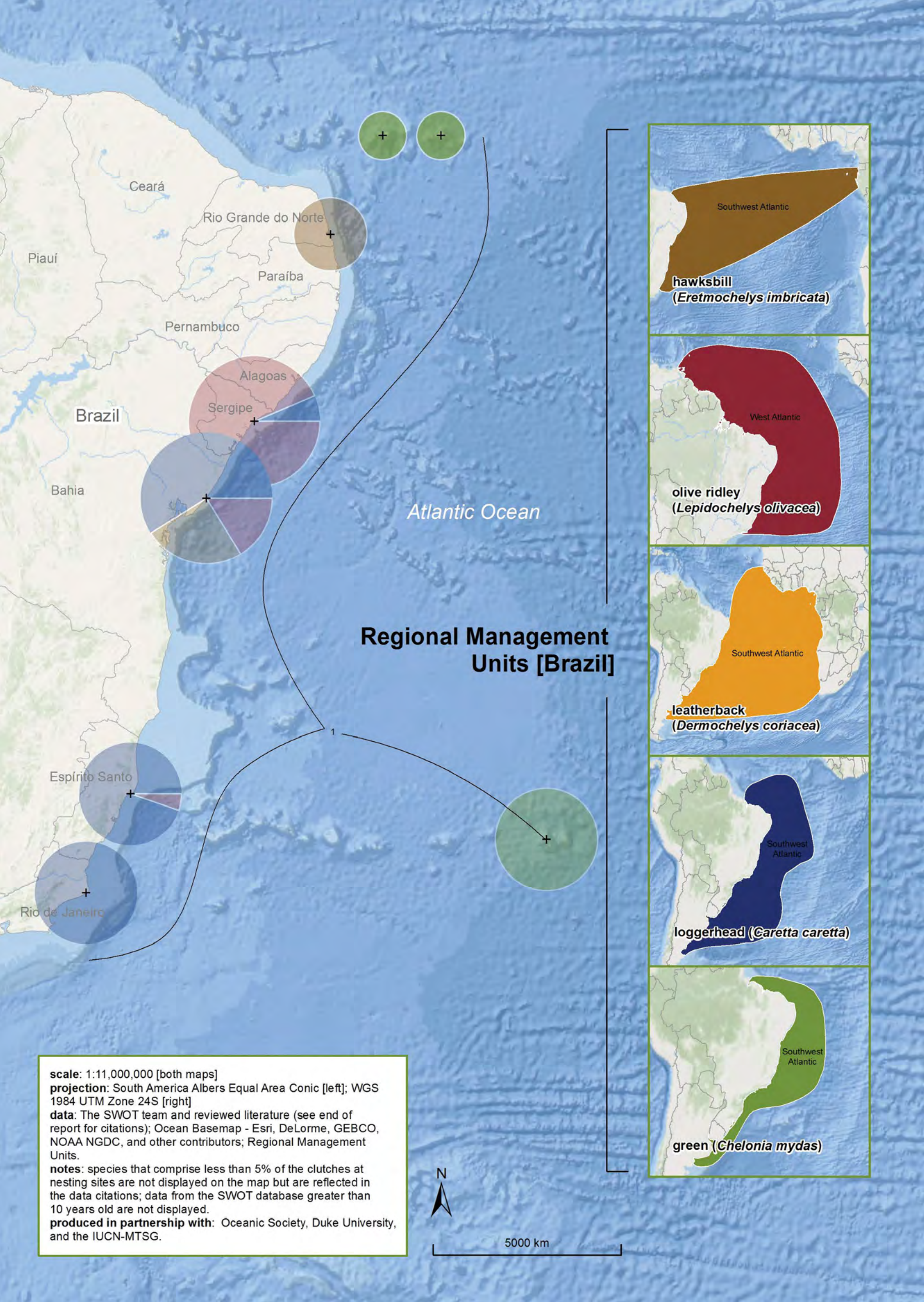
In one study, more than 40 percent of the nesting hawksbills that were genetically sampled by scientists in Bahia, Brazil, were found to be hybrids with loggerheads or, to a lesser extent, with olive ridleys. This proportion is incredibly high when compared with studies elsewhere that exhibit top rates of about 2 percent. Juvenile loggerhead-hawksbill hybrids have also been reported from nearby Uruguay and Argentina. Another study documented loggerhead-olive ridley hybrids in 27 percent of the loggerhead nesting population that was assessed in the Brazilian state of Sergipe.

The causes of this southwestern Atlantic hybridization hotspot are not fully known, but human influences are one hypothesis. Although hybridization is a natural occurrence, it is often induced by disturbances. And human behaviors have been disturbing and creating imbalances in turtle habitats and life histories on a global scale for a prolonged period. Thus, studies of hybridization can potentially help to inform the design of conservation strategies. This region of South America is an ideal testing ground.

ABOVE: Turtles such as this loggerhead–olive ridley hybrid are not uncommon in parts of Brazil. © PROJETO TAMAR AT LEFT: An olive ridley turtle swims off the coast of Brazil. © PROJETO TAMAR

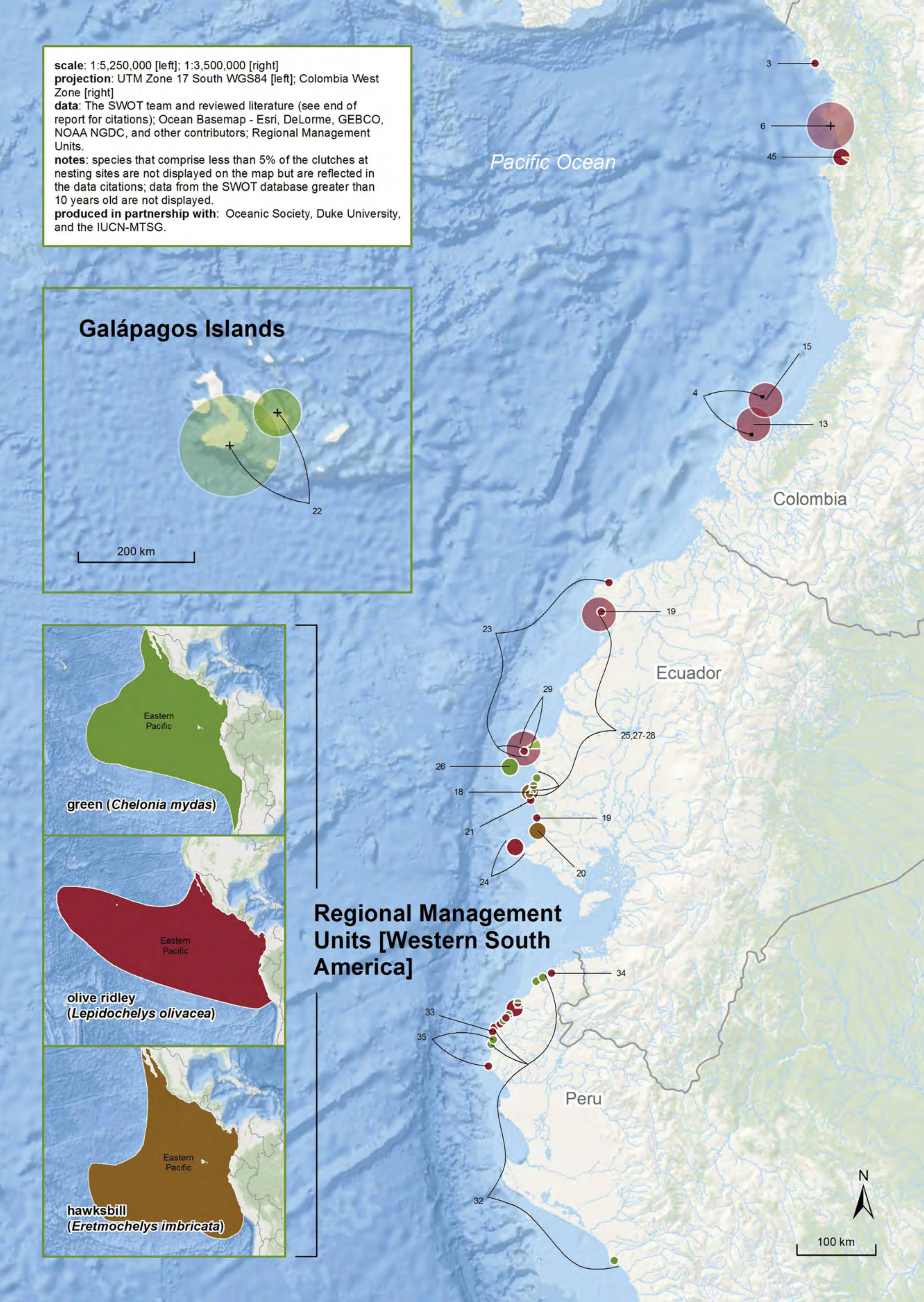
Nesting Biogeography of Sea Turtles in Northern South America [left] and Brazil [right, aggregated by state]





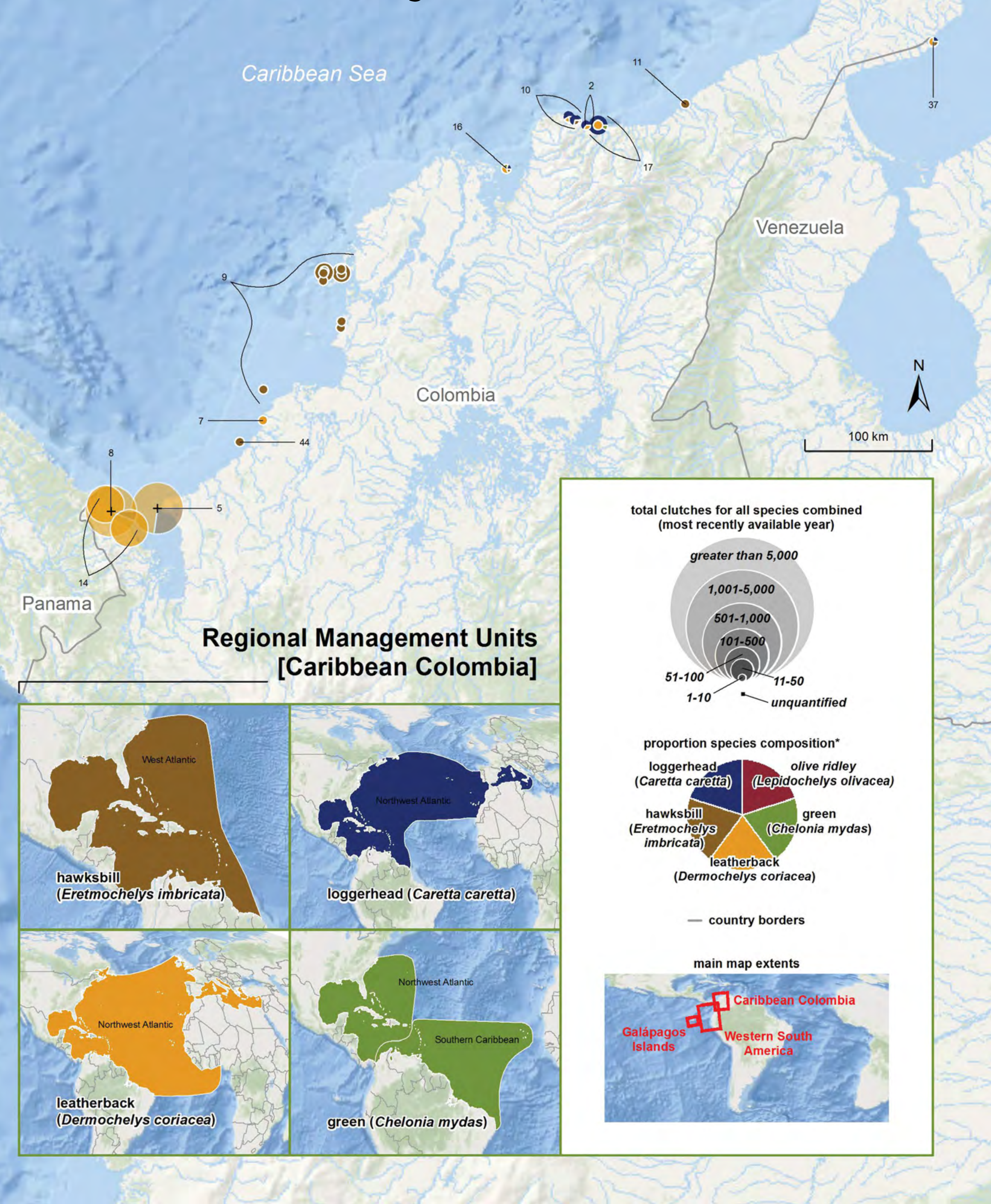
Regional Management Units [Brazil]

scale: 1:11,000,000 [both maps]
projection: South America Albers Equal Area Conic [left]; WGS 1984 UTM Zone 24S [right]
data: The SWOT team and reviewed literature (see end of report for citations); Ocean Basemap - Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors; Regional Management Units.
notes: species that comprise less than 5% of the clutches at nesting sites are not displayed on the map but are reflected in the data citations; data from the SWOT database greater than 10 years old are not displayed.
produced in partnership with: Oceanic Society, Duke University, and the IUCN-MTSG.

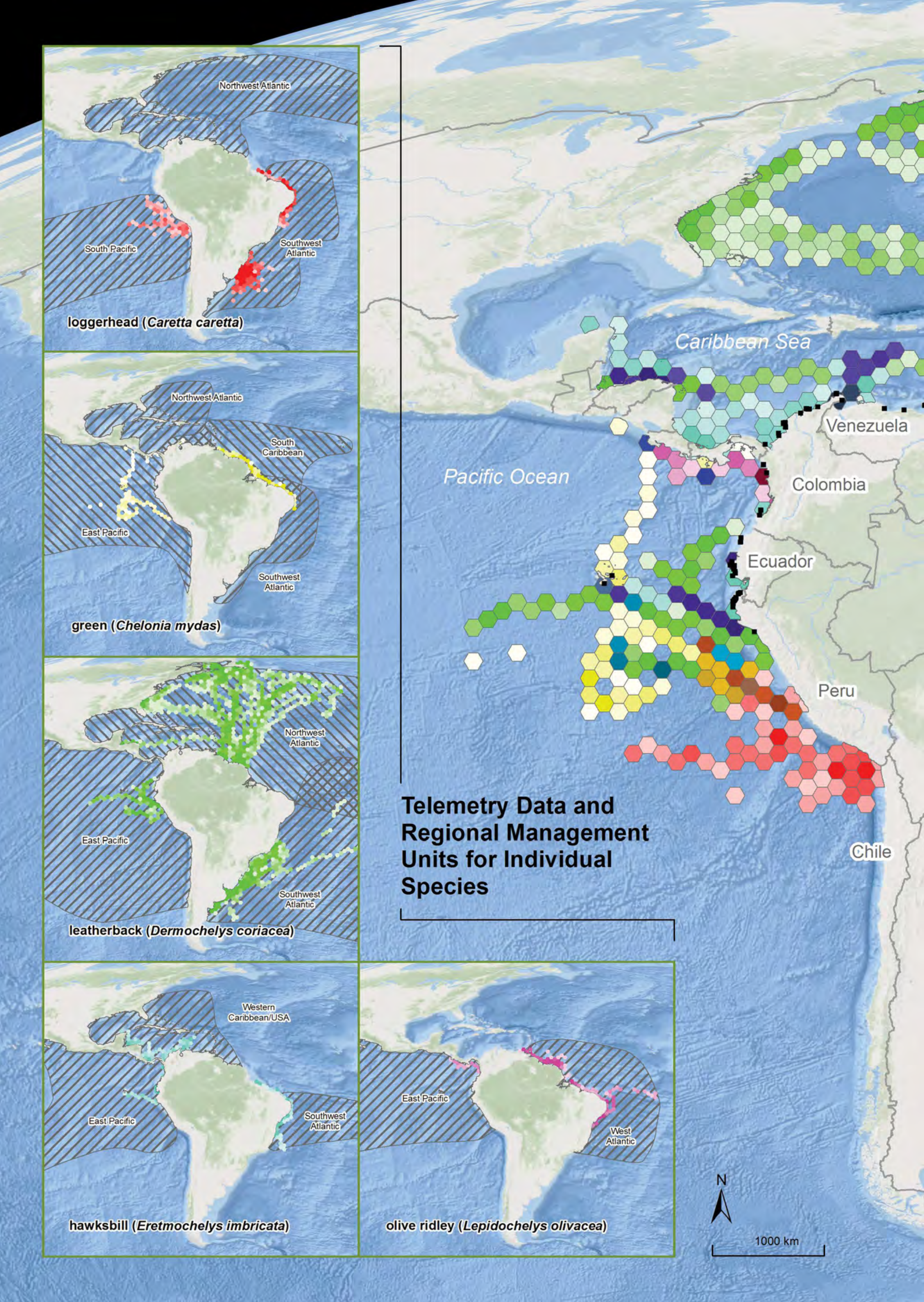


scale: 1:5,250,000 [left]; 1:3,500,000 [right]
projection: UTM Zone 17 South WGS84 [left]; Colombia West Zone [right]
data: The SWOT team and reviewed literature (see end of report for citations); Ocean Basemap - Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors; Regional Management Units.
notes: species that comprise less than 5% of the clutches at nesting sites are not displayed on the map but are reflected in the data citations; data from the SWOT database greater than 10 years old are not displayed.
produced in partnership with: Oceanic Society, Duke University, and the IUCN-MTSG.
Pacific Ocean
Galápagos Islands
22
200 km
3
6
45
15
4
13
Colombia
19
23
Ecuador
29
25,27-28
26
18
19
21
20
24
Regional Management Units [Western South America]
Eastern Pacific
green (Chelonia mydas)
Eastern Pacific
olive ridley (Lepidochelys olivacea)
Eastern Pacific
hawksbill (Eretmochelys imbricata)
34
33
35
Peru
32
N
100 km

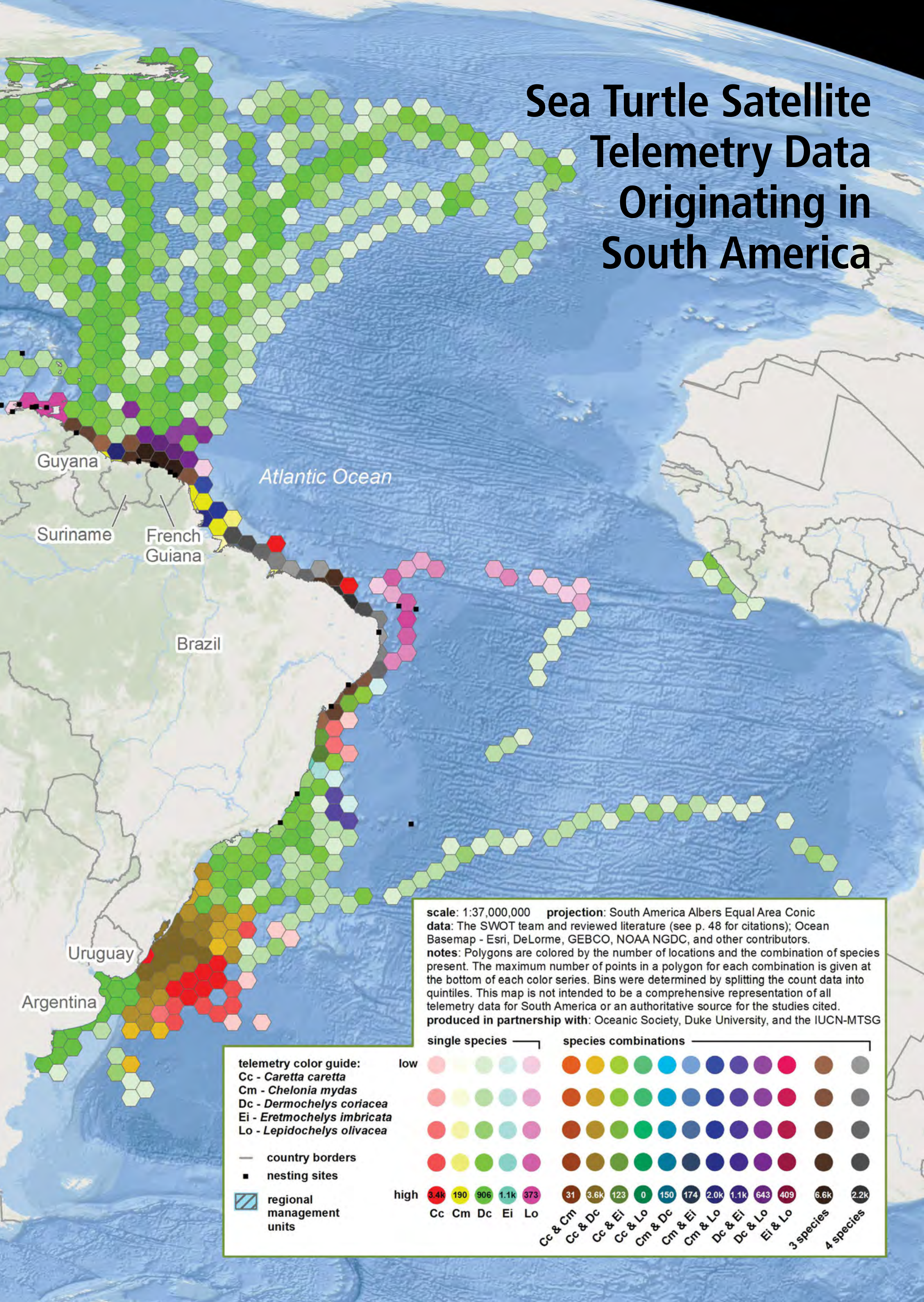
Nesting Biogeography of Sea Turtles in Western South America [left] and Caribbean Colombia [right]



Telemetry Data and Regional Management Units for Individual Species



Sea Turtle Satellite Telemetry Data Originating in South America



scale: 1:37,000,000 **projection**: South America Albers Equal Area Conic
data: The SWOT team and reviewed literature (see p. 48 for citations); Ocean Basemap - Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors.
notes: Polygons are colored by the number of locations and the combination of species present. The maximum number of points in a polygon for each combination is given at the bottom of each color series. Bins were determined by splitting the count data into quintiles. This map is not intended to be a comprehensive representation of all telemetry data for South America or an authoritative source for the studies cited.
produced in partnership with: Oceanic Society, Duke University, and the IUCN-MTSG

For instance, what was once a robust colony of nesting loggerheads (called *tortuga gogó* locally) that stretched from Colombia's Guajira Peninsula east into Venezuela is now reduced to only rare sightings. Hawksbills, which tend to nest on isolated beaches and in small numbers, still visit the region, but sadly they are widely harvested for their shells. Jewelry, trinkets, and cockfighting spurs made from hawksbill shell are still sold on the streets of Cartagena and elsewhere.

Until the 1990s, a turtle slaughterhouse was in full operation in Riohacha, Colombia. Its proprietress, the iconic Doña Fefa, sourced green turtles from more than a 100-mile radius (160-kilometer) and rendered them into meat, oil, and *chicharrón* (cracklings) for a local market. She reportedly wore a necklace of University of Florida flipper tags that had been originally affixed to green turtles in Tortuguero, Costa Rica, before they were caught in fishermen's nets in Colombia as they made their way to distant foraging grounds. Today, Conservation International–Colombia is working with Wayuu indigenous inhabitants in this region to monitor and protect turtles on the Guajira Peninsula, and the infamous slaughterhouse has been shuttered.

The leatherback is faring much better in this region, with a large nesting colony in the Gulf of Urabá, Colombia, and in nearby Armila, Panama. This leatherback colony is one of the largest in the greater Caribbean. Moderately sized nesting colonies also occur at a variety of sites in Venezuela. Leatherbacks that nest in Colombia and Panama migrate all the way to Canada, similar to the Guianas leatherback colony. In one case, a female named Red Rockette, who had been tagged with a transmitter in Canada months earlier, nested at Bobalito Beach in Colombia. When the transmitter was recovered and returned, it provided Canadian researchers with a treasure trove of data on Atlantic leatherback migrations.

In addition, Colombian NGOs and universities, including the Fundación Mamá Basilia and the JUSTSEA Foundation, have monitored leatherbacks at nearby Playona Beach since 2000. Those efforts contributed to the declaration of La Playona as a wildlife sanctuary in 2013.

The green turtle, despite its many threats in the Caribbean, is perhaps the most notable success story in this region. Foraging green turtles from rookeries in Aves Island, Venezuela; Tortuguero, Costa Rica; Mexico; and Panama are still abundant in those waters. Tiny Aves Island, located 670 km (416 mi) north of the Venezuelan mainland, is one of the most significant green turtle nesting sites in the hemisphere. Notwithstanding its extremely small size, the green turtle population nesting on Aves Island has doubled in just 30 years, to more than 1,000 nesting turtles per year. Green turtles on Aves have been protected since 1972, and they have been monitored for decades by researchers from the NGO FUDENA (*Fundación para la Defensa de la Naturaleza*), the Ministry of Environment and Natural Resources, and the Venezuelan Institute of Scientific Research.

Aves Island is a great example of how long-term conservation at nesting grounds can result in population recovery. Aves Island green turtles are believed to be a distinct and demographically isolated colony, and one where a curiously high number (hundreds) of breeding male turtles are typically present with breeding females. Curiously, when compared with other large rookeries, Aves Island adult females show a lower survival rate, thus suggesting exposure to high mortality outside of their nesting ground. Those findings highlight the need for conservationists to look beyond the nesting beach in designing management programs.

Sea turtle conservation and research have been growing in the region over the past decade. Venezuelan conservationists have taken important steps to (a) study the demography, genetics, ecology, foraging habitat use, and health of green turtles; (b) stem the loss of leatherback habitats; and (c) better understand the effects of bycatch. In Colombia, government authorities and NGOs also are investing in research and recovery efforts, and a new generation of researchers and conservationists is leading the charge.

THE PACIFIC

The sea turtle nesting beaches of Pacific South America form a gently reversed S-shaped coastline of rocky shore, mangrove swamps, sandy beaches, coastal promontories, inlets, and bays nearly 3,000 km (1,864 mi) long. In the north, the beaches lie alongside the planet's wettest and richest rainforests in the Colombian Chocó. After snaking south past rainforests, they transition to mangroves and dry forests in southern Ecuador and northern Peru. Well beyond the southernmost nesting beaches, turtles are found at sea for nearly the full length of Chile, and they frequent many of the offshore islands, such as Gorgona and Malpelo, Colombia; the Galápagos and Isla de la Plata, Ecuador; Lobos de Tierra, Peru; and distant Easter Island (Rapa Nui), Chile.

The Pacific coast abuts a vast tapestry of human development that ranges in scale from sparsely inhabited patches of virgin rainforest, to small towns and resorts along coastal highways, to swaths of shrimp farms built atop razed mangroves, to major coastal cities like Guayaquil and Lima. As on the rest of the continent, Pacific turtles are plagued by habitat degradation, fisheries bycatch, pollution, and the growing effects of climate change.

Olive ridley, green, hawksbill, and occasional leatherback turtles nest and feed along these shores. Leatherbacks from nesting colonies in Mexico and Central America, as well as young loggerheads from Australia, forage in the cold waters of the offshore Humboldt and South Equatorial Currents. Olive ridleys and green turtles are common on this side of the continent, and their populations are generally healthy, whereas leatherbacks, loggerheads, and hawksbills are rarer. The Eastern Pacific leatherback and hawksbill and the North Pacific loggerhead RMUs are among the most threatened on Earth (see *SWOT Report*, vol. VII, pp. 22–23).

In Pacific Colombia, researchers working toward temporal and spatial fishery closures and other protective measures have begun to analyze how turtles at sea use space for foraging and migration. Circle hooks have been introduced to diminish the effects of longline bycatch in the states of Chocó and Nariño. And in 2003, efforts were spearheaded to open new markets throughout Colombia for sustainably harvested and turtle-safe seafood.

Because of its remote location—1,000 km (620 mi) off the mainland—and the unique confluence of warm and cold waters, Ecuador's Galápagos Archipelago is as unique an environment for sea turtles as it is for all of its other native flora and fauna. The Galápagos is also a conservation success story for the local population of green (known locally as "black") turtles that are part of a long-monitored and protected RMU that includes nesters from Michoacán, Mexico.

In contrast, continental Ecuador has seen a construction boom caused by the success of Ecuador's main export, petroleum. That success has fueled uncontrolled development of beach homes, hotels, and

STRANDINGS IN SOUTHERN SOUTH AMERICA

Dead, injured, or sick sea turtles often wash up on beaches or in shallow water around the world. In some places, elaborate networks of citizen scientists collaborate to gather data that help build a more concise understanding of threats, both natural and human induced. In addition, dead turtles offer a rare opportunity to learn about sea turtle biology, pathology, and much more. Understanding the species, age classes, and genders of sea turtles that wash ashore—in relation to where and when—can help researchers describe turtle biogeography. Those data also reveal the intensities and seasonality of threats such as fisheries bycatch, boat strikes, disease, and cold stunning.

Long-term studies of marine turtle strandings in South America have provided an essential baseline for broadly understanding threats in foraging areas. At a local level, such studies are also very important in raising awareness among stakeholders and engaging communities in the hands-on aspects of sea turtle research and conservation. In Uruguay, marine turtle stranding data have been collected since 1999 by the NGO Karumbé. The group's 24-hour hotline and e-mail notification system for citizen scientists has been augmented since 2003 by systematic weekly beach surveys.

In Argentina, nine public and private institutions collaborate to manage the PRICTMA (*Programa Regional de Investigación y Conservación de Tortugas Marinas de Argentina*) Stranding Network, which gathers and manages data about turtles that wash ashore in the province of Buenos Aires. The program engages local residents, tourists, fishermen, lifeguards, park rangers, the Coast Guard, and others. In Chile, a local NGO, Qarapara Tortugas Marinas Chile, created the first national stranding database in 2014. The group populated it with records going back to 1990 about strandings of the four species found in that country. The NGO is now building a national stranding network.

This map shows stranding data from the South American countries where no sea turtle nesting occurs, but where turtles occur as migrants and foragers only. Most sea turtle nesting countries in South America also manage national and local stranding networks and databases (including Peru and Brazil). This map helps to demonstrate what happens in those temperate waters well south of where turtles would be expected to occur for nesting. It also shows the southernmost latitudinal ranges of such species in South America. Argentina data used here are annual averages for 2003–2014, summarized by region. For Chile, data show strandings from 1990–2015, by beach, and exclude Easter Island data. The Uruguay data are shown as annual averages for 2003–2012, summarized by region. Hawksbill strandings have also been documented in Uruguay (13 in total), but these are not displayed on the map. The stranding data for this map were provided by Karumbé (Uruguay), PRICTMA (Argentina), and Qarapara Tortugas Marinas (Chile).

boardwalks and has created threats to nesting turtles. In response, a young NGO, *Equilibrio Azul* (Blue Equilibrium), has been conducting sea turtle research, monitoring, and conservation projects on nesting green (black), hawksbill, and olive ridley turtles. Its work focuses on the protection of nests from feral animals and rising sea levels and on getting the word out about the importance of sea turtle conservation in Ecuador. The group is also helping Ecuador's government comply with its own laws—including enforcing the mandatory use of TEDs and honoring the regulations in Marine Protected Areas.

Peruvian waters are a foraging ground for green (black) turtles from the Galápagos and Mexico, young loggerheads from Australia, and leatherbacks from Costa Rica. Intensive fisheries, a major source of Peru's gross national product, unfortunately generate high bycatch of the foraging sea turtles in nets, longlines, and trawls.

Peru is also home to the southernmost nesting colonies of green (black) and olive ridley turtles in the American Pacific. This observation is a recent phenomenon. Although single olive ridley nests were documented in 1979 and in 1992, sea turtles were not known to nest in Peru until 2000. Since then, the NGO ecOceánica has found that nesting olive ridleys are on the rise and are seemingly moving southward. The first green turtle nest in Peru was seen in 2010, a range extension for that species. A second green turtle nest, in 2013, extended the species' nesting range even further. Whether those occurrences are in response to changes in global climate, to growth in turtle populations, to a loss of suitable habitat elsewhere, or merely to better monitoring is still unknown. But in this area of rapid coastal development, such an expansion creates new management challenges for the region.

Chile is the southernmost range of turtles at sea in the American Pacific. And greens, loggerheads, leatherbacks, and olive ridleys are found near shore, with the occasional hawksbill on offshore islands. Given the importance of the country's fisheries sector, bycatch effects on turtles are high in Chile. Pollution is also a problem because of runoff from large-scale mining, another of Chile's main industries. Both fisheries bycatch and pollution could be responsible for the high numbers of stranded turtles found along Chile's long coastline (see inset box above), though the exact causes are unknown. Unfortunately, Chile lacks strong protective legislation for turtles, apart from a poorly enforced 1995 ban on extraction of vertebrates. However, efforts to establish a protected area in Arica and another in the Atacama Region are under way. Those two important sanctuaries will help to protect important marine habitats for the southernmost foraging ground for greens in the entire Pacific. ■

In Jaragua National Park, Dominican Republic, a leatherback turtle shows visible scarring around the base of its flipper, likely from an encounter with fishing gear. © DOUG PERRINE / NATUREPL.COM

THE CONSERVATION STATUS OF LEATHERBACK POPULATIONS WORLDWIDE

By BRYAN WALLACE and BRIAN HUTCHINSON

If you are reading this magazine, you probably already know that leatherback turtles face threats to their survival worldwide and that they have become a high conservation priority in many places. Indeed, if we are to ensure the long-term survival of this species, leatherback conservation efforts are needed in every place they are found. Considering that there are 768 leatherback nesting sites from 65 countries documented in the SWOT database (as of 2014) and that leatherbacks' marine habitats span all major ocean basins, this goal is overwhelming and, likely, impossible. Thus, where should we focus our efforts to conserve the leatherback so we are most effective?

In past years, the Marine Turtle Specialist Group (MTSG) of the International Union for Conservation of Nature (IUCN) Species Survival Commission has assessed sea turtle status globally by using the IUCN Red List categories and criteria. The Red List is useful for comparing the risk of extinction for individual species. But for a species that is widely distributed and that has many different populations exposed to different environments and threats, such global assessments have not characterized differences in true extinction risk at the population level.

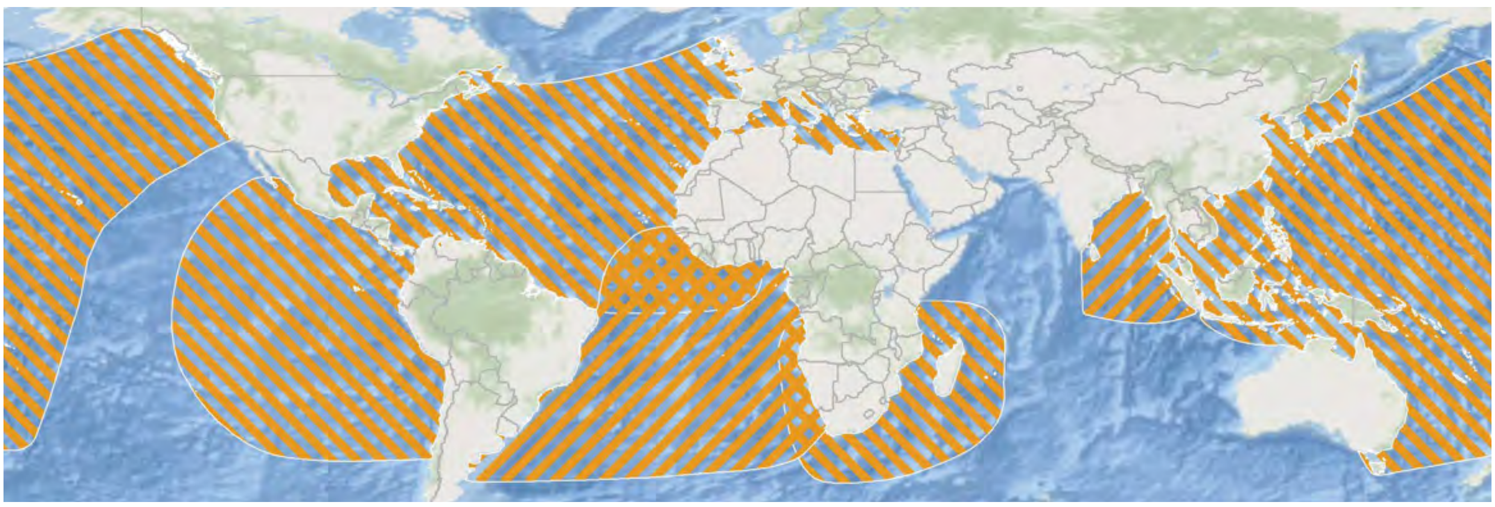
To address this issue, in 2013, the MTSG published a new Red List assessment of the leatherback turtle to provide accurate, up-to-date information about the status of leatherback populations worldwide. In a first for any sea turtle Red List assessment, each leatherback subpopulation was considered individually using Red List criteria to determine its conservation status. The results describe the wide variation in leatherback status by region. They also highlight subpopulations that have declined greatly over time or that are very small or geographically restricted.

Such assessments are important, because leatherback subpopulations are considered to be genetically and demographically distinct from one another. If a subpopulation becomes extinct, its ecosystem role and contributions to the genetic diversity of the global leatherback population will be lost forever. Those important nuances were lost in previous assessments of the leatherback that were done only at the global, species level.

Not only does the new assessment provide a more actionable overview of leatherback status, but also it has helped lay the groundwork for improved Red List assessments of all sea turtle species in the future. Those subpopulation-level assessments allow us to compare the past and present status of leatherbacks so we can identify causes of different population trajectories. In some parts of the world, leatherback populations are relatively stable, even increasing, thanks to effective conservation efforts that protect turtles and reduce threats on nesting beaches and in the water.

However, this good news does not mean that those leatherback populations will not continue to require conservation action. Populations that are at real risk of extinction in the near future provide a cautionary tale about populations that are currently stable. Sea turtle populations can decline much more rapidly than they can be rebuilt, so conservation gains must be maintained—if not increased—to ensure healthy populations.

The following are the results of the 2013 Red List assessment of the leatherback turtle. The complete assessments are available online at www.iucnredlist.org/details/6494/0.



GLOBAL – Vulnerable

The leatherback turtle is categorized as vulnerable globally for two reasons: (a) the global population of leatherbacks is estimated to have declined by 40.1 percent over the past three generations (estimated at 120 years), and (b) the causes of the decline are not reversible and have not ceased. Although the leatherback's status as vulnerable globally means that the species as a whole is considered to be facing a high risk of extinction in the wild, this status actually represents an improvement from the previous global listing as critically endangered in 2000. The earlier assessment focused on populations in the Pacific Ocean; data from Atlantic populations were not available at the time.

EAST PACIFIC OCEAN SUBPOPULATION – Critically Endangered

The East Pacific leatherback subpopulation nests along the Pacific coast of the Americas from Mexico to Ecuador. Its marine habitat extends west from the coastline to approximately 130°W and south to approximately 40°S. This subpopulation is listed as critically endangered because it has declined by 97.4 percent during the past three generations. Moreover, the causes of the decline (primarily egg harvest and fisheries bycatch) are not reversible and have not ceased.

WEST PACIFIC OCEAN SUBPOPULATION – Critically Endangered

The West Pacific leatherback subpopulation nests primarily in Indonesia (West Papua), Papua New Guinea, and the Solomon Islands—and to a lesser extent in Vanuatu. The marine habitat for this subpopulation extends (a) north into the Sea of Japan, (b) northeast and east into the North Pacific and to the west coast of North America, (c) west to the South China Sea and the Indonesian Seas, and (d) south into the high-latitude waters of the western South Pacific Ocean and Tasman Sea. This subpopulation has declined by 83 percent during the past three generations, and the once large nesting population in Terengannu, Malaysia, is now functionally extinct. Threats to this subpopulation (primarily human exploitation of females and eggs, low hatching success, and fisheries bycatch) have not ceased.

SOUTHWEST INDIAN OCEAN SUBPOPULATION – Critically Endangered

The Southwest Indian Ocean leatherback subpopulation nests principally along the Indian Ocean coast of South Africa (in KwaZulu-Natal province), but some nesting occurs in Mozambique. Its marine habitats extend around the Cape of Good Hope in both the Indian Ocean and Atlantic Ocean. The leatherback nesting population in South Africa has been monitored consistently for 50 years, and that population accounts for more than 90 percent of the total abundance of the subpopulation. The South Africa nesting population has declined by 5.6 percent during the past three generations and is continuing to decline. Furthermore, it contains just 148 mature individuals and a relatively restricted nesting range. The combination of those characteristics results in the critically endangered listing.

NORTHEAST INDIAN OCEAN SUBPOPULATION – Data Deficient

The Northeast Indian leatherback subpopulation nests primarily in the Andaman and Nicobar Islands (India); in Sri Lanka; and, to a lesser extent, in Thailand and in Sumatra, Indonesia. Continuous long-term abundance datasets are not available, and little is known about the genetic structure and geographic distribution of this subpopulation or about the types and severity of threats. Together, those factors make it impossible to determine the conservation status of Northeast Indian Ocean leatherbacks.

SOUTHEAST ATLANTIC OCEAN SUBPOPULATION – Data Deficient

The nesting epicenter for the Southeast Atlantic leatherback subpopulation lies in Bioko (an island in Equatorial Guinea), Gabon, and the Republic of Congo, with additional nesting in much smaller numbers extending north to Senegal and south to Angola. Its marine habitats are thought to extend from the Atlantic coast of Africa (a) south to the equator; (b) southwest to Brazil, Uruguay, and Argentina; and (c) southeast to South African waters. Although recent research on nesting abundance likely makes the Southeast Atlantic leatherback subpopulation the largest in the world, continuous long-term datasets (particularly from Gabon, where the majority of the population nests) and other key data were unavailable. The only possible listing is that of data deficient.

SOUTHWEST ATLANTIC OCEAN SUBPOPULATION – Critically Endangered

The Southwest Atlantic leatherback subpopulation nests only in southern Brazil and is genetically distinct from all other sampled rookeries in the Atlantic. The marine habitat for this subpopulation is thought to extend (a) north across the equator and east to the coast of Atlantic Africa, (b) southwest to Uruguay and Argentina, and (c) southeast to South African waters. The population has been increasing (232 percent over the past three generations), thanks to conservation efforts in Brazil. However, because the subpopulation is very small, with fewer than 50 mature individuals (estimated to be 35), and because it has a restricted nesting range, this subpopulation is critically endangered.

NORTHWEST ATLANTIC OCEAN SUBPOPULATION – Least Concern

The Northwest Atlantic leatherback subpopulation nests in the southeastern United States, throughout the mainland and insular Caribbean, and in the Guiana Shield. Its marine habitats extend (a) throughout the North Atlantic, including the Gulf of Mexico; (b) north of 50°N; (c) east into the Mediterranean; and (d) across the equator to northwestern Africa. One of the two largest leatherback subpopulations (with more than 50,000 nests laid per year), it has increased by 20.6 percent over the past three generations, thanks to intensive conservation efforts in many parts of its range. As the assessment highlighted, such efforts must be maintained if this population is to remain on its current stable course.

Viva Tartaruga!

GETTING THE WORD OUT IN CREATIVE WAYS

By SARA VIEIRA, VICTOR JIMENEZ, and JOANA HANCOCK

São Tomé and Príncipe, a small island nation in the middle of the Gulf of Guinea in western Africa, is somewhat lost and forgotten by the rest of the world. The few outsiders who do visit the country usually comment on the excellent coffee, the excellent chocolate (considered among the best in the world), and their shock at seeing sea turtle meat being openly sold in the market and sea turtles butchered on the islands' picture-perfect beaches. All three of these natural resources are exploited by the locals as important sources of sustenance and livelihood in this extremely poor and undeveloped country. Of the three resources, production of coffee and chocolate continues to thrive. But the sea turtles are not doing so well.

In 2014, the government formally prohibited the harvest, sale, and consumption of all sea turtle products in response to the declining sea turtle populations. This measure was a crucial step toward halting the overexploitation that in 2013 and 2014 alone resulted in a record 337 sea turtles captured and 40 percent of sea turtle nests collected by local residents along just 15 kilometers (9 miles) of beach. Yet despite the recently enacted law, sea turtle eggs, juveniles, and adults are still openly traded, and turtle meat remains in high demand.

To tackle a conservation challenge such as this requires going back to the grassroots—working with locals to understand what drives consumption, enhancing consumer awareness through education, and finding effective ways to counter age-old yet incorrect local beliefs. Indeed, lack of knowledge among locals is one of the biggest challenges that our conservation project faces, including the ideas that sea turtles take less than two years to reach sexual maturity, that they breed every year, and that they lay "many, many eggs." The most frequently heard local adage is "Turtles will never run out! They're tough; they're hard to kill!" ("*Tartaruga NUNCA acaba! Ela é rija, custa muito a morrer!*") Some people routinely use this misinformation and similar excuses to justify the continued exploitation of turtles. But how can we get the message out in a country where few people own a television—let alone have access to the Internet—and where people rely on radios, mobile phones, and face-to-face interaction to communicate?

GETTING THE MESSAGE OUT IN COASTAL COMMUNITIES

The Tatô Program was initiated in 2003 by the local nongovernmental organization (NGO) titled MARAPA and has been jointly run since 2012 with the Portuguese NGO, Associação Tartarugas Marinhas (ATM). It has been the key driver of sea turtle research and conservation in São Tomé and Príncipe. Ongoing efforts include the seasonal deployment of guards to monitor and protect the key nesting beaches and a variety of educational activities. The following are examples of some cheap, quick, and effective techniques that our project used to bridge knowledge gaps among as many residents as we could, ranging from children to adults. The techniques were used and tested in five coastal fishing communities—Morro Peixe, Fernão Dias, Micoló, Santana, and Porto Alegre—that have the longest tradition of trade and consumption of sea turtle products and are adjacent to the main nesting beaches where we have been working in recent years.

- Getting dirty. We gathered whole communities to paint murals with a sea turtle conservation motif at the entrances to their villages, thereby making sure that the first thing everyone sees when arriving in the village is a beautiful painting of the sea. This activity, done with and for the community, was a huge success because the murals—full of sea turtles, fish, sharks, and fishermen—represent their pride in their culture and their close relationship with the sea.
- Turning children into artists. We held drawing contests in primary schools around the theme "What would you do to save sea turtles?" The contests were designed to raise awareness about the protection and preservation of sea turtles among children in first through sixth grade and their teachers. The contest was presented to each class with a short, 15-minute seminar about the life cycle of sea turtles and their main threats in São Tomé and Príncipe. The children were asked to reflect and to use their artistic talents to depict ways to minimize human impacts on turtles. We delivered art supplies to teachers, who were also responsible for returning the drawings and materials to the ATM-MARAPA team. Approximately 4,500 children participated in this contest, and 78 were awarded prizes of stickers and school supplies.
- Presenting a turtle movie festival by the sea. We showed two animated films and one documentary about the life cycle of sea turtles at the very popular community movie nights. The screenings were preceded by a short quiz about sea turtles and a karaoke show with songs related to sea turtle conservation from the album Tamarear, which was produced by the Brazilian nonprofit organization Projeto TAMAR. We presented the screenings at 22 movie nights, with audiences of about 80 to 250 children and adults, who learned about sea turtle natural history in a fun and informal way.

AT LEFT, CLOCKWISE FROM TOP LEFT: A member of the coastal community Morro Peixe helps paint an educational mural. © VICTOR JIMÉNEZ; Weekly text messages about sea turtle conservation, such as this one, are sent to the entire population of São Tomé and Príncipe. © ANA BESUGO; Winners of a sea turtle conservation–themed student drawing contest pose with their artwork. © VICTOR JIMÉNEZ; A sea turtle conservation message in local dialect was painted on an abandoned boat near the main nesting area on São Tomé Island. © ANA BESUGO

REACHING BEYOND THE COAST

We wanted to reach beyond just the coastal communities to the entire nation's population, so we decided to go even further. With the activities described here, our message could not be missed.

USING THE NATIVE LANGUAGE

We painted two murals with sea turtle awareness messages written in the local dialect (called Fôrro) in strategic places near the main olive ridley nesting areas. The first mural was of an olive ridley, painted on one of the many huge boats that are beached and abandoned near Micoló. The mural included the slogan "*Sawôge de omali é cá dêpendê d'inê, mage vida d'inê cá dêpendê di bô!*" ("The health of the ocean depends on it, but its life depends on you!"). The painting is visible not only from most of the beach but also from the air, because the beach is near the capital's airport.

The second mural was painted over four days on one of the several retaining walls along the road that connects the capital city of São Tomé to Neves, the nation's second largest city. We painted a sea turtle skull accompanied by text in the local dialect saying, "*Uâm povo cú cebe na cá dana quá de têla dêfa!*" ("Wise people do not destroy their heritage!"). This painting not only is visible to drivers but also can easily be seen by fishermen at sea—impossible to miss!

BEEP BEEP—YOU HAVE A MESSAGE!

To reach an even greater number of people, we established an innovative partnership with CST, the leading national telecommunications company, to send weekly text messages about the importance of sea turtle conservation to the entire population of the archipelago. Text messages were sent from January until April, from the peak of sea turtle nesting activity until the end of the nesting season. The short messages were about the socio-economic and ecological importance of these emblematic species for the sustainable development of São Tomé and Príncipe.

The aforementioned were just a few of the creative methods we used to reach the people of São Tome and Principe with a turtle conservation message, and we were very pleased with the outcome. Within a year of our campaign, turtle mortality had dropped by 50 percent. Most importantly, people have embraced the message, and they now greet the Tatô Program's nature conservation officers with a smile, rather than a grim face. We hope that other projects that face similar challenges will be inspired by our ideas. Viva Tartaruga! ■

CAUGHT IN A NET

GREEN TURTLES AND THE TURTLE PEOPLE OF NICARAGUA

By CYNTHIA J. LAGUEUX and CATHI L. CAMPBELL

Night has fallen in eastern coastal Nicaragua. On the water's surface and rolling with the swells is an assortment of variably colored and often irregularly shaped buoys scattered across Nicaragua's fishing banks. Earlier in the day, while green turtles were off foraging among the area's expansive seagrass pastures, Miskitu Indian fishers set dozens of large-mesh nets above coral and rock outcroppings they call "sleeping rocks," where turtles come to rest during the night. Now, amid thrashing flippers, the buoys of those nets suddenly bob and disappear from view as a turtle becomes entangled and attempts to free itself from the net, descending again with a loud forced exhale. Another unsuspecting green turtle has been caught as it rose from its sleeping place to breathe. The captured turtle will float at the surface, entangled in the net and periodically struggling to escape, until dawn, when the fishers return to check their nets and retrieve their catch.

The extensive, shallow continental shelf of eastern Nicaragua is home to hundreds of thousands, possibly millions, of green turtles that forage on the abundant seagrass that grows there. This green turtle aggregation is a mixed stock from rookeries and developmental habitats throughout the greater Caribbean from Bermuda to Brazil and to the eastern reaches of the Caribbean Sea. Playa Tortuguero, in Costa Rica, is the principal nesting beach from which foraging turtles in Nicaragua originate. Tortuguero is one of the world's largest green turtle rookeries.

The Miskitu Indians of this region are known as the "Turtle People," and they have fished green turtles for hundreds of years on the shoals and banks of Caribbean Nicaragua. So renowned were they for their prowess at striking turtles with a harpoon that pirate schooners made sure to have at least one Miskitu onboard to ensure the availability of fresh meat while they prowled the world's oceans. In the 19th and early 20th centuries, Cayman Islanders introduced the use of entanglement nets to the Miskitu fishers so they could capture more turtles for export to satisfy exotic tastes for green turtle soup among the upper classes in distant lands.

Green turtles are no longer shipped from Nicaragua to Jamaica, the United States, or Europe by Caymanian schooners. Since 1978, when Nicaragua ratified CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), green turtles in Nicaragua have been protected from international trade. However, during the mid-1990s, we documented an annual catch of 10,000 to 12,000 green turtles for local consumption, which rivaled take levels for export from the late 1960s to early 1970s. During that period, Archie Carr, the late professor of zoology at the University of Florida, and Bernard Nietschmann, the late geographer at the University of California, Berkeley, first recognized and documented a decline in both the number of clutches laid by green turtles at Tortuguero and the catch rates on the Nicaraguan foraging grounds. Carr and his colleagues convinced the Costa Rican government to protect nesting females at Tortuguero. Together, Carr and Nietschmann were able to convince the Nicaraguan president, Anastasio Somoza DeBayle, with added pressure from the president's wife, to close Nicaragua's green turtle processing plants. In 1975, Tortuguero National Park was established in Costa Rica; by 1977, Nicaragua had completely closed its green turtle processing plants.

Although trade in turtles is prohibited, Nicaraguan law still allows the subsistence use of green turtles, and local demand from coastal inhabitants has supplanted the historical export demand. This provision in the law results in the annual capture, sale, and consumption of thousands of green turtles by Nicaragua's Caribbean coastal inhabitants (Miskitu, Rama, and Mayangna Indians; Afro-descendants; and mestizos). In recent years, we have documented an annual green turtle catch of between 5,000 and 8,000 animals, a decline since the 1990s that appears to result from reduced catch rates.

Despite government regulations that prevent the commercial sale of turtle products, local authorities in the coastal towns of Bilwi (Puerto Cabezas), Bluefields, Pearl Lagoon, and the Corn Islands are reluctant to prohibit the sale of green turtle meat on the streets and in the markets because of the high demand and the lack of economic alternatives on the coast. In addition to being caught for sale to local residents, green turtles are also caught to feed fishers working offshore in the Caribbean spiny lobster and sea cucumber fisheries. This uncontrolled green turtle fishery has detrimental effects on other nontargeted turtle species as well, such as hawksbills and loggerheads. Once captured, sea turtles are seldom released alive, although recent efforts to raise awareness have had a positive influence on the behavior of some fishers to safely release the turtles.

Currently, green turtle meat sells for between US$0.73 and US$1.27 per pound in coastal communities and towns, compared with US$1.38–$2.18 per pound for beef and US$2.00 per pound for chicken. Most often, turtle products are sold in portions as a mixture

of meat and the various organs, including lung, heart, liver, kidneys, intestine, reproductive organs, and chine (the cartilaginous edge of the carapace). Even the blood is consumed. The only parts of the animal that are not used are the carapace, plastron, and some viscera, which are discarded during the butchering process, the latter being consumed by the many dogs that typically gather for the slaughter. A few older men still process the calipee from the plastron (the main ingredient in the once-prized green turtle soup), then store it dried, with hopes that one day someone from "the outside" will arrive to purchase it, as happened decades ago when they were young men.

What is the future of the green turtle aggregation and the Turtle People of Caribbean Nicaragua? This area is one of the few remaining legal sea turtle fisheries in the world, in large part because of the declining or extirpated turtle populations throughout the region. Recent population modeling indicates that the high take level reported during the 1990s in Nicaragua was not sustainable, and recommendations for a more sustainable take level have been made.

Together with Nicaraguan colleagues, we have worked to improve the management of the green turtle fishery by doing the following:

- Setting a maximum size limit to protect the larger and mature turtles
- Extending the length of the closed season
- Establishing community quotas and allowing only communities with a tradition of turtle fishing to take green turtles
- Prohibiting the commercialization of green turtles in coastal towns
- Prohibiting the transport of green turtles or their meat inland or to the Pacific coast of Nicaragua
- Educating the authorities and engaging them in establishing regulations that work toward more sustainable take levels

Miskitu Indian fishers haul in a green turtle in Puerto Cabezas, Nicaragua. © JEFF ROTMAN / MINDEN PICTURES

The ability of managers to establish and enforce sound management practices is at the discretion of politicians and the political climate in the country. As a result, only a few of the aforementioned measures have been put in place, and even those are inconsistently enforced for a variety of reasons. Fishers and community members are less likely to comply with regulations if they suspect that other communities are not complying. Thus, inconsistent enforcement engenders apathy by all toward the laws. Furthermore, sea turtles are a common-pool resource, and it is logistically difficult for authorities to enforce the law over large areas of open sea.

Green turtles are not likely to disappear from the Caribbean coast of Nicaragua. However, as population declines continue, a time may come when the fishery is no longer economically profitable. In anticipation of that day, efforts must begin now to find appropriate alternative livelihoods to sustain fishers and their families, to reduce their dependence on green turtles for income, and to find alternative and inexpensive sources of protein to support the coastal population. Green turtles foraging in Caribbean Nicaragua need well-conceived conservation programs that look well beyond Nicaragua. Although a few green turtle rookeries in the region are robust (such as Tortuguero), some smaller or depleted nesting populations that feed in Nicaragua may be at great risk of extirpation from this fishery. A scientifically based management plan that is developed in the context of the Regional Management Unit and for the entire green turtle population should be created and enacted among all political regions of Nicaragua's Caribbean coast.

On a positive note, today there is greater awareness among the fishers, the coastal population, and the authorities in Nicaragua about the need to manage the green turtle fishery. But numerous challenges remain in Caribbean Nicaragua to sustainably manage long-term use of this endangered species. ■


O'NEILL
O'NEILL

ACTION ON GHOST GEAR

By MARTIN STELFOX, JILLIAN HUDGINS, and RIKI GUNN

Ghost gear—intentionally or unintentionally abandoned, lost, or otherwise discarded fishing gear—is a global conservation problem that affects dozens of marine species, including sea turtles. Ghost gear continues to catch target and nontarget species long after being lost, abandoned, or discarded, a process called ghost fishing. Historically, fishing gear was made from naturally occurring materials such as coconut, palm leaves, jute, or bamboo, which broke down quickly in the oceans. But over the past 60 years, fishers around the world have switched to gear made from synthetics such as nylon, polypropylene, and polyethylene. Those plastics are extremely resistant to ultraviolet radiation and may remain in the marine environment a very long time without degrading. Each year, around 640,000 tons of ghost gear are generated globally, accounting for around 10 percent of the world's marine debris.

Those sometimes enormous tangles of nets, ropes, buoys, hooks, floats, and other debris kill hundreds of thousands of marine animals every year. Ghost gear also threatens the marine environment by smothering coral reefs and seagrass beds and by introducing alien species. It can be detrimental to fisheries by depleting valuable fish species without generating financial benefit and can have a negative effect on marine-related tourism. Ghost gear can travel long distances from its point of origin and can accumulate in ocean gyres, making it a complex, transboundary problem that involves multiple stakeholders at different economic and social scales.

Marine debris, including ghost gear, affects all seven species of sea turtles in various ways. The life cycle of sea turtles makes them particularly vulnerable to entanglement in ghost gear because they occupy various habitats during different life stages. Ghost gear on nesting beaches may act as obstacles for nesting females or may entangle hatchlings trying to crawl to the ocean. The early life stages of sea turtles are relatively unknown, but it is generally accepted that once hatchlings reach the ocean, they drift with the currents and winds to convergence zones, where they encounter floating mats of algae that provide protection and shelter. Unfortunately, marine debris follows those same paths and accumulates in the same convergence zones. Moreover, ghost nets serve as a substrate for sedentary organisms such as bryozoans and barnacles, which attract opportunistic feeders such as juvenile turtles, which in turn attract larger predators, and so on. Many turtles become entangled when they use the ghost net mats as shelter and as a food source. We have witnessed an olive ridley turtle become entangled after it climbed atop a mat, possibly to warm up or to rest.

For sea turtles, entanglement can cause exhaustion, dehydration, decreased swimming ability, reduced feeding, life-threatening injuries, and eventually death. The number of turtles that survive entanglement in ghost gear is unknown. A turtle's struggle to get free of an entanglement may result in a debilitating injury, such as lost limbs or other physical disfigurement, which could reduce the animal's ability to swim, feed, and reproduce.

The entanglement of marine turtles in ghost gear is a significant but understudied cause of turtle mortality and habitat threats, especially in the Indian Ocean. Scientists, conservationists, and governments must work together urgently to better quantify the problem of ghost fishing and to find local, regional, and global solutions ...

In Maldives, we have recorded green, hawksbill, and olive ridley turtles with healed injuries consistent with surviving an entanglement. In northern Australia, where green, loggerhead, olive ridley, flatback, and hawksbill turtles are affected by ghost nets, we have found recently injured turtles both alive and dead. How the injuries may affect sea turtle populations as a whole is still unknown, and understanding long-term effects is difficult.

By its very nature, ghost fishing is difficult to measure, and efforts to quantify this problem and its effects on marine animals have been few and far between. Despite evidence suggesting that ghost gear affects sea turtles at various life stages, no globally standardized methods for data collection are in place to calculate mortality rates or identify hotspots. The Olive Ridley Project (ORP) and GhostNets Australia (GNA), two organizations dedicated to collecting data on ghost fishing and turtle entanglements, are helping to diminish this threat.

Since 2013, ORP has been working in Maldives, where fishing nets (except small bait nets) are not used. Instead, fishing is mostly done using either pole and line or hand lines. Therefore, most ghost gear found in Maldives has drifted in from neighboring Indian Ocean countries or is from illegal fishing operations. Between July 2013 and December 2015, ORP volunteers in Maldives reported more than 203 entangled olive ridley turtles, mostly juveniles. Additionally, 4 green turtles, 10 hawksbills, 1 leatherback, and 3 turtles of unknown species were reported entangled. Of the entangled turtles, 191 were released alive.

ORP volunteers have collected and discarded 259 net accumulations, which consist of almost 600 nets, ropes, bags, buoys, bottles, and other debris from India, Maldives, Oman, Pakistan, Sri Lanka, and Thailand. Throughout the Indian Ocean region, ORP held seminars and workshops that educated hundreds of fishers, schoolchildren, tourists, dive professionals, and community members about the dangers of ghost nets and about helping record valuable data.

In the Indian Ocean region, ORP is developing programs to encourage the reuse and recycling of fishing gear at the end of its useful life. Created in 2014 to focus on threats to turtles in Bangladesh, India, Maldives, Pakistan, and Sri Lanka, the Northern Indian Ocean Marine Turtle Task Force recognized ORP as the main organization working on ghost gear for the region. ORP also received a SWOT grant in 2015 (see p. 45) to support its important work.

Since 2004, GhostNets Australia has been working in remote regions of the Gulf of Carpentaria in northern Australia. There, GNA has been training and supporting groups of rangers from coastal indigenous communities to locate, retrieve, and dispose of ghost nets and to record entangled marine life (see *SWOT Report*, vol. IV, pp. 31–33). GNA has invested heavily in the rangers, creating the tools, providing relevant training, and building the group's capacity so

they can work beyond short-term funding cycles. The rangers now monitor nesting sites and protect turtle populations from egg predation by feral pigs, another serious threat in the region. To date, the rangers have removed approximately 13,000 ghost nets from the coasts of northern Australia, of which only 8.2 percent originated from Australian fisheries. The remainder of the gear floats in from the Arafura Sea to the north, which is bounded by Australia, Indonesia, Papua New Guinea, and Timor-Leste (East Timor).

More than 80 percent of the entangled animals observed by GNA have been sea turtles. Although the number of entanglements reported over the span of the program has risen in tandem with improved data collection, it is still considered an underestimate of the true effect of ghost nets on marine life. Concerned that the approximately 800 turtles recorded by the rangers from 2004 to 2012 was an underestimate—rangers were able to patrol beaches only three to six times a year—GNA partnered with two research projects to develop better estimates of the ghost net effects.

In 2012, a postgraduate student from Queensland University investigated the decay rates of marine turtles in tropical waters. At the same time, the Commonwealth Scientific and Industrial Research Organization conducted a risk assessment. Those two projects concluded that the actual number of sea turtles affected by ghost nets during the eight-year period likely was 4 to 20 times worse than the rangers estimated.

THIS PAGE: Olive Ridley Project Pakistan project coordinator, Absar Khan, removes a ghost net from the ocean floor while diving off Charna Island, Pakistan. © MARTIN STELFOX
PREVIOUS SPREAD: Local divers disentangle an olive ridley turtle from a ghost net in Baa Atoll, Maldives. © THOMAS BADSTUBNER

The transboundary effects of ghost gear and sea turtle interactions highlight the urgent need for collaborative efforts between the governments, fishers, and turtle researchers of neighboring regions. Regional databases should quantify turtle entanglements in ghost gear by recording details such as species, sex, size, location, and injuries sustained. Such a database could help answer questions regarding turtle mortality and help identify entanglement hotspots and problem fisheries. Genetic sampling of entangled turtles could highlight population dynamics and identify the origins of entangled turtles. By combining this information with oceanic current modeling, researchers could identify hotspot areas likely to need attention. New technologies, such as aerial drone surveys, could also help locate entangled animals to direct immediate attention as well as ground truth the predictive models.

Addressing the hazards of ghost gear requires educating local communities to build capacity and increase the quantity of data collected. Involving citizen scientists—members of the general public who contribute to scientific research—in data collection reduces costs and increases the geographic areas a research team can cover. However, citizen scientists must be well trained, whether they are rangers, divers, snorkelers, fishers, or boat captains, so that standard procedures are followed and the quality of data remains high.

The entanglement of marine turtles in ghost gear is a significant but understudied cause of turtle mortality and habitat threats, especially in the Indian Ocean. Scientists, conservationists, and governments must work together urgently to better quantify the problem of ghost fishing and to find local, regional, and global solutions both to clean up ghost gear and to prevent gear from being lost or discarded in the oceans in the future. ■

Conservation Progress
in the Bijagós Archipelago, Guinea-Bissau

By BETÂNIA FERREIRA AIRAUD, AISSA REGALLA, CASTRO BARBOSA, and DOMINGOS BETUNDE

A tropical country known for its parks and protected areas, Guinea-Bissau lies on the west coast of northern Africa. As part of the country's efforts to inventory and catalog areas of high conservation importance, biodiversity surveys were conducted there in the 1990s, particularly in the Bijagós Archipelago. The preliminary surveys found important nesting areas for green turtles as well as shallow marine areas with turtle foraging and mating grounds, which together were the main criteria for creation of two protected areas in 2000: João Vieira and Poilão Marine National Park, plus Orango National Park.

Since its creation in 2004 by the government of Guinea-Bissau, the Institute of Biodiversity and Protected Areas (IBAP) has met considerable success in its mission to protect sea turtles in the Bijagós Archipelago. IBAP has begun implementing a National Action Plan for the Conservation of Sea Turtles, with assistance from international partners, and has undertaken the monitoring and protection of green turtles that nest in João Vieira and Poilão Marine National Park and in Orango National Park.

Five sea turtle species have been confirmed in the Bijagós Archipelago, namely green, olive ridley, leatherback, hawksbill, and loggerhead. The green turtle nesting population is of particular interest internationally. Approximately 40,000 green turtle nests were laid on

the island of Poilão during the 2014 nesting season with more than 1,000 nesting attempts recorded on several nights. Although Poilão is the most important rookery for green turtles, hundreds or perhaps thousands of nests are laid on other islands in the Bijagós Archipelago and on the continental beaches of Guinea-Bissau.

The olive ridley is the second most abundant sea turtle in Bijagós, nesting mostly on the beaches of Orango National Park. In the 1990s, frequent surveys of the most important beaches in this park were carried out, and it was estimated that they hosted between 170 and 620 nests annually, although the estimates have declined to around 90 nests annually since 2012. A few dozen hawksbill and leatherback nests are also found every year on the island of Poilão, and in the Orango islands. Loggerheads are very rare in Guinea-Bissau, but a few loggerhead carapaces have been found in Bijagós, and they have also been observed near the Unhocomozinho Islands. Whether this species nests in Guinea-Bissau is uncertain. Satellite tracking of nesting loggerheads in Cape Verde has revealed that some animals come to those waters to feed; therefore, Guinea-Bissau may be solely part of the loggerheads' nonbreeding habitat.

Integrating local communities into conservation efforts is a particular challenge in Guinea-Bissau because of the great diversity of ethnic groups, each with different cultural rules, customs, and beliefs with regard to sea turtles. Although not commercialized, sea turtles are still commonly poached for traditional purposes. Before the 1990s, harvesting of eggs and nesting females was widespread and likely affected a sizable proportion of the country's sea turtles. One notable exception to this pressure was Poilão Island, a remote site that is considered sacred in the traditional beliefs of the Bijagó people. The island is uninhabited and only occasionally visited for ceremonies. For the past 10 years, it has benefited from the presence of park rangers and researchers. As a result, the island's nesting females and eggs are safe from human predation.

Converting turtle poachers and fishers into turtle patrollers and monitors is one of IBAP's main strategies and one of its greatest challenges.

Several traditions relate to sea turtle harvest among the people of Guinea-Bissau. For example, in the north, the Balantas and Felupes people do not eat sea turtle meat or eggs, especially of leatherbacks and green turtles, because they are considered sacred animal spirits. The nearby Serreres people also believe that leatherback meat can cause a disease comparable to leprosy. Where they exist, such native taboos provide a measure of protection for sea turtles.

In contrast, farther to the south—in the region occupied by the Tandas, Nalus, and Susos people—sea turtle meat and eggs are still consumed. And in the Bijagós Archipelago, sea turtles are a very important food source and figure prominently in the ancestral and traditional rituals and celebrations of the Bijagó people. For example, the carapaces of sea turtles are used during the Fanado ritual (a ceremonial rite of passage) as an offering and sign of respect for elders (called *Metenaque*), whereby young men (called *Camabis*) make an offering of a sea turtle in order to seek the protection of the Metenaque and the continuity of the Camabis' education. Sea turtles are an important component in other proclamation ceremonies and sacred rituals in which community elders offer a turtle to their sacred spirit and ancestors to thank them and to ask for more turtles. As part of the ceremony, the Metenaque consume the head, heart, stomach, and sexual organs of the turtle offerings, accompanied by palm wine.

Outside of such traditional ceremonies, the capture of sea turtles by the Bijagó people is rare. But when they do kill turtles, they use the meat and eggs, as well as the skin of the leatherback turtle. Turtle fat is rendered for cooking oil or massage oil for newborns, and turtle bones, eggs, and fat are used in traditional medicine as analgesics or to treat infertility in men and woman. Turtle carapaces are also commonly used as containers for domestic use, and eggshells are used as agricultural fertilizers.

Converting turtle poachers and fishers into turtle patrollers and monitors is one of IBAP's main strategies and one of its greatest challenges. Conservationists realized early on that the integration of coastal communities would be essential to achieving the country's long-term conservation goals, because Guinea-Bissau's national parks have communities within their boundaries that depend on the natural resources there, sometimes using the same species and resources that are targeted for protection.

IBAP now involves local communities in all decision-making processes in the national parks, including delineating the parks' rules. Local traditions and beliefs are always respected and taken into account when designing management interventions. For example, most traditional sacred sites are key areas targeted for preservation in the national parks, and whenever local ethnic groups want to use a sea turtle or other protected species for their ceremonies, they are given authorization to do so by the park authorities. All staff members for the protected areas are chosen from within the local communities, which builds good relationships and instills confidence among the parks' many stakeholders.

Although sea turtle poaching is still a reality in Guinea-Bissau, community participation and levels of awareness have increased considerably in the past years, and we remain hopeful for the future of sea turtles in our country. We think that by creating well-managed protected areas, by strengthening community participation, and by turning local people into monitoring agents and spokespeople in their communities, we will be able to create a resilient monitoring and protection network and to improve the conservation status of sea turtles in the Bijagós Archipelago for the long term. ■

THIS PAGE: On the island of Poilão in Guinea-Bissau, rangers from João Vieira and Poilão National Park tag an olive ridley turtle that was rescued after being tangled in a fishing net. © BETÂNIA FERREIRA AT LEFT: A local resident and ranger at João Vieira and Poilão National Park releases green turtle hatchlings on the island of Poilão in Guinea-Bissau. © J. F. HELIO AND N. VAN INGEN

Where Cape Cod juts into the Atlantic Ocean from the east coast of the United States, it forms Cape Cod Bay and the southern end of Massachusetts Bay. The area, which bears the grim moniker "the Deadly Bucket," is the site of the world's largest recurring sea turtle stranding phenomenon. Each year, primarily between October and January, hundreds of mostly juvenile turtles wash ashore weak and often dead as a result of cold stunning. Cold stunning is the state that turtles enter when they are exposed to cold water for a prolonged period—characterized by a slowed heart rate, decreased circulation, and lethargy that can lead to shock, pneumonia, and even death. Of the afflicted turtles found in Cape Cod, 85 percent are young Kemp's ridleys, which are considered critically endangered by the International Union for Conservation of Nature.

The staff of Massachusetts Audubon Society's Wellfleet Bay Wildlife Sanctuary has been rescuing stranded sea turtles on Cape Cod since the 1970s. Robert Prescott, the sanctuary's director, began the project in 1974 after seeing his first stranded Kemp's ridley. Today, sanctuary staff members and volunteers walk the beaches twice daily after high tide, searching for victims of cold stunning. "Our work is like a life-saving crew's," said Prescott. "If the turtle is alive, you have to go and get it. Each turtle counts. We never leave a live turtle on the beach, no matter what the conditions are."

THE DEADLY Bucket

By ESTHER HORVATH

In 2014, more than 1,400 sea turtles were stranded in Cape Cod Bay, exceeding all records. In fall 2015, more than 580 turtles had already been rescued, and that number will increase as the cold season continues. According to Prescott, researchers still do not know the cause of the higher number of strandings, but it could be the result of an increase in the global population of Kemp's ridleys.

Extreme weather is the main cause of the cold stunning and stranding. As the turtles attempt to migrate south to warmer waters, they become trapped in Cape Cod's hook-shaped landmass. When water temperatures drop to 50 °F (10 °C), they become cold stunned (hypothermic) and immobilized at the surface. High winds, coupled with extreme tides, often push the turtles closer to shore, leaving them stranded when the tide falls.

Sanctuary staff members often report injuries such as entanglement in fishing lines and boat strikes, which may result from the turtles' prolonged stunned condition. Once the sanctuary staff members find and rescue the stranded turtles, they transport them to the New England Aquarium in Boston. There the Marine Animal Rescue Team's experts warm the turtles, treat their injuries, and rehabilitate them. The rescuers then release the survivors back into the ocean when the waters have warmed.

"We provide the highest quality care to sick or injured sea turtles with the goal of releasing every turtle back into the ocean," says Connie Merigo, senior biologist of the Marine Animal Rescue Team. The team also sees its work as important for global education and conservation efforts. The team has successfully released 1,400 sea turtles in the past 20 years, about 1,200 of which were Kemp's ridleys. ■

In 2014, members of the New England Aquarium Marine Animal Rescue Team release 31 rescued and rehabilitated sea turtles at Little Talbot Island in Florida, U.S.A. © ESTHER HORVATH

Acting Globally

SWOT Small Grants 2015

Since 2006, SWOT small grants have helped partners around the world to realize their sea turtle research and conservation goals. To date, we have given 58 grants to 49 partners in more than 40 countries. SWOT grants are awarded annually to projects in each of SWOT's three areas of focus: (a) networking and capacity building, (b) science, and (c) education and outreach. The following are updates from each of our seven grantees in 2015. Visit **www.SeaTurtleStatus.org** to apply for a 2016 SWOT small grant!

BANGLADESH

Marinelife Alliance

Bangladesh is home to one of the world's most threatened olive ridley sea turtle populations. Marinelife Alliance (MLA) has been working to protect marine and coastal resources in Bangladesh since 1996. Despite MLA's successful sea turtle monitoring and conservation programs, the country's education and awareness of sea turtle biology, conservation, and management remain low. Using a 2015 SWOT grant, MLA will collaborate with local schools and communities to heighten awareness. The group's outreach and education programs will focus on the role sea turtles play in the marine ecosystem, on the threats they face, and on what people can do to conserve them. MLA will host a sea turtle festival in which local high school and college students will serve as guides and community outreach representatives. The SWOT grant will also fund ongoing educational efforts such as documentary screenings and exhibits in the local community.

BRAZIL

Marcos Daniel Institute

Located in Vitória, Espírito Santo, Brazil, the Marcos Daniel Institute's (IMD) main objective is to empower people to conserve nature. The Chelonia Mydas Project is an initiative of IMD to monitor and evaluate the health of sea turtles in Brazil. The project analyzes blood samples from turtles to evaluate clinical parameters and to measure pollutants that occur in sea turtles in different locations throughout Brazil. Previously, the project's researchers have found that Brazilian green turtles have detectable levels of oil pollutants. A 2015 SWOT grant is helping IMD to expand its work to understand how plasma oil hydrocarbon concentrations affect the health of sea turtles and how those concentrations vary by region and by species. This information will help to evaluate the risk that the oil industry poses to sea turtles in Brazil (including within marine-protected areas) and ultimately will help to ensure that appropriate mitigation measures are in place.

GHANA

Wildlife Division, Forestry Commission

Ghana is home to important nesting and foraging areas for five sea turtle species. Fisheries bycatch is a major source of sea turtle mortality in Ghana, and it has contributed to declines in Ghana's sea turtle populations. The current rate of incidental capture in fishing nets indicates an immediate need for solutions that actively involve fishing communities in efforts to mitigate the effects of bycatch on sea turtle populations. A 2015 SWOT grant will be used to train community leaders and fishermen in 10 communities throughout the Muni-Pomadze Ramsar site about safe handling and release practices for accidentally captured turtles. In addition, fishermen will receive materials to mend broken nets caused by sea turtle entanglement.

INDIAN OCEAN

The Olive Ridley Project

The Olive Ridley Project (ORP) will use its 2015 SWOT grant to tackle the problem of sea turtle entanglement in ghost nets (lost, discarded, or abandoned fishing gear) in the Indian Ocean. ORP will continue to train volunteers to remove ghost gear and to record important information about the gear and the animals entangled in it. By promoting the recycling of end-of-life fishing equipment, the SWOT grant will also help ORP to continue its efforts to reduce the amount of derelict fishing gear that ends up in the ocean. In the past two years, ORP volunteers have rescued 174 sea turtles and removed 350 ghost nets.

INTERNATIONAL

ProTECTOR Inc.

A 2015 SWOT grant will be used to cover a portion of a photo identification (PID) workshop at the 36th Annual Symposium on Sea Turtle Biology and Conservation in Lima, Peru, in February 2016. The workshop will examine computer-assisted PID software and practices to advance PID techniques throughout the sea turtle research and conservation community. The day-long workshop will give sea turtle researchers and computer programmers the opportunity to connect and discuss needs, opportunities, and goals of PID methods and technologies. The long-term goal of the PID workshop is to create a freely available global PID sea turtle database to advance sea turtle conservation.

SÃO TOMÉ AND PRÍNCIPE

Programa Tatô, ATM/MARAPA

São Tomé is home to important nesting and foraging areas of the critically endangered eastern Atlantic subpopulation of hawksbill turtles. Although monitoring has been conducted for more than a decade, recent interviews with local communities suggest that the previous studies may have missed important nesting sites. Moreover, foraging habitats for this population have not yet been identified. Programa Tatô, ATM/MARAPA, will use a 2015 SWOT grant to identify unknown nesting and foraging areas for this species. A group of researchers and local fishermen will survey nesting beaches and conduct in-water monitoring along 140 kilometers (87 miles) of coastline. The results from the project will be used to prioritize areas for future monitoring and protection and ultimately will contribute to the creation of the first sea turtle management plan for São Tomé and Príncipe islands.

PERU

ecOceánica

Recent studies have confirmed the presence of nesting green and olive ridley turtles along Peru's highly developed northern coastline. The findings make Peru's coast the southernmost sea turtle nesting habitat in the eastern Pacific. Because this discovery is relatively recent, minimal government protection programs or regulations exist in the region. Using a 2015 SWOT grant, staff members from ecOceánica will work to raise awareness of the presence of nesting sea turtles in the Tumbes and Piura regions of northern Peru. ecOceánica will conduct outreach and capacity-building activities among beachfront hotels, tourists, and residents. The group's goal is to create a citizen science network that will contribute to improving management and protection strategies for sea turtles in Peru.

SWOT Data Contributors

SOUTH AMERICA

We are grateful to all who generously contributed their sea turtle data for inclusion in the maps on pages 20–25. We are especially grateful to the following individuals who went above and beyond to help facilitate data contributions from their respective countries: Juan M. Rguez-Barón (Colombia), Marco García Cruz (Venezuela), Felipe Vallejo and Cristina Miranda (Ecuador), Alexsandro Santos (Brazil), Karin Bilo (Guyana and Suriname), Rachel Berzins (French Guiana), Anaïs Gainette (French Guiana), Shaleyla Kélez (Peru), Gabriela Vélez-Rubio (Uruguay), Laura Prosdocimi (Argentina), Rocio Álvarez (Chile), and Tony Nalovic (French Guiana). We simply could not have done this without you—**thank you**.

GUIDELINES OF DATA USE AND CITATION

The data that follow correspond directly to the maps on pages 20–25. In the case of nesting data included in the maps on pages 20–23, every data record is numbered to correspond with its respective point on the map. To use data for research or publication, you must obtain permission from the data provider(s).

Nesting Data Citations

DEFINITIONS OF TERMS

Clutches: A count of the number of nests laid during the monitoring period. **Nesting females:** A count of nesting female turtles observed during the monitoring period. **Crawl:** A female turtle's emergence onto the beach to nest. Such counts may or may not include false crawls. **Estimated clutches:** An estimate of the number of nests of eggs laid in a season. Methods of estimation vary. **Year:** The year in which a given nesting season ended (e.g., data collected between late 2014 and early 2015 are listed as year 2015). Nesting data are reported here from the most recent available nesting season. Beaches for which count data are not available are listed as "unquantified." Additional metadata are available for many of the data records, and may be found online at http://seamap.env.duke.edu/swot.

Brazil

DATA RECORD 1

Data Source: Projeto TAMAR Database (SITAMAR). 2014.
Nesting Beaches: Atol das Rocas (state of Rio Grande do Norte); state of Sergipe (Abaís, Pirambu, Ponta dos Mangues); state of Espírito Santo (Anchieta, Comboios, Povoação, Pontal do Ipiranga, Guriri, Itaunas); state of Bahia (Arembepe, Praia do Forte, Costa do Sauipe, Sitio do Conde); state of Pernambuco (Fernando de Noronha); state of Rio Grande do Norte (Pipa); state of Rio de Janeiro (Quissama, Farol, Atafona, São Francisco do Itabapoana); Trindade Island (state of Espírito Santo)
Years: 2011—Atol das Rocas; 2014 all others
Species and Counts: *Caretta caretta*—0; 762; 1,918; 5,350; 0; 27; 1,881; 0 clutches, respectively; *Chelonia mydas*—375; 3; 0; 110; 267; 25; 0; 1,327 clutches, respectively; *Dermochelys coriacea*—0, 0, 70, 0, 0, 0, 1, 0 clutches, respectively; *Eretmochelys imbricata*—0; 69; 6; 2,248; 0; 883; 14; 0 clutches, respectively; *Lepidochelys olivacea*—0; 10,981; 106; 1,481; 0; 2; 5; 0 clutches, respectively
Comments: Nesting data are given as combined totals for all monitored beaches within each state, except in the instance of offshore islands, which are listed separately.
SWOT Contacts: Maria Angela Marcovaldi, Alexsandro Santos, Frederico Tognin, Armando Barsante, Cesar Coelho, Claudio Bellini, Gustave Lopez, Jaqueline Castilhos, João Carlos Thomé, Cecilia Baptistotte, and Denise Rieth

Colombia

DATA RECORD 2

Data Source: Aminta Jauregui, G., and Universidad Jorge Tadeo Lozano. 2016. Sea turtle nesting in Don Diego and Mendihuaca, Colombia: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Don Diego; Mendihuaca
Year: 2015 **Species and Counts:** *Caretta caretta*—7 and 2 clutches, respectively; *Dermochelys coriacea*—0 and 1 clutches, respectively
SWOT Contacts: Guiomar Aminta Jauregui, Carmen Lucia Noriega Hoyos, and Albin Rodriguez

DATA RECORD 3

Data Source: Amorocho, D., A. Tobón, and A. Gaos. 2015. Quantifying hawksbill nesting via rapid assessments along the Pacific Coast of the Darien Gap-Choco regions of Panama and Colombia. CIMAD, WWF, ICAPO. Project supported by USFWS Grant.
Nesting Beaches: Chaguera; Tortuguera
Year: 2015 **Species and Counts:** *Lepidochelys olivacea*—8 and 8 clutches, respectively
SWOT Contacts: Diego Amorocho and Alexander Tobón López

DATA RECORD 4

Data Source: Amorocho, D. 2008. *Informe del Taller Estandarizacion de Metodologias en Investigacion y Monitoreo para la Conservacion de Tortugas Marinas en Colombia.* Convenio MAVDT-WWF.
Nesting Beaches: Blanca (Parque Nacional Natural Gorgona); Parque Nacional Natural Sanquianga
Year: 2007 **Species and Counts:** *Lepidochelys olivacea*—both sites unquantified
SWOT Contact: Diego Amorocho

DATA RECORD 5

Data Source: **(1)** Barreto, L., and Fundación Conservación Ambiente Colombia. 2016. Sea turtle nesting in Bobalito, Colombia: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016). **(2)** Páez V.P., C. Ramírez-Gallego, and K.G. Barrientos-Muñoz. 2015. Tortuga verde. *Chelonia mydas.* In Morales-Betancourt, M.A., C.A. Lasso, V.P. Páez, and B. Bock (eds.). 2015. *Libro Rojo de Reptiles de Colombia.* Instituto de Investigación de Recursos Biológicos Alexander von Humboldt (IAvH), Universidad de Antioquia. Bogotá, D. C., Colombia.
Nesting Beach: Bobalito
Years: 2012 and 2013 **Species and Counts:** *Caretta caretta*—1–25 clutches (2012); *Chelonia mydas*—2 clutches (2013); *Dermochelys coriacea*—26–100 clutches (2013); *Eretmochelys imbricata*—1–25 clutches (2013)
SWOT Contacts: Lilian Barreto, Elizabeth Ortíz, Nestor Sánchez, and Karla Barrientos-Muñoz

DATA RECORD 6

Data Sources: **(1)** Barrientos-Muñoz, K., C. Ramírez-Gallego, and L. Rivas. In press. *Primer reporte de anidacion de* Chelonia mydas *para el Pacifico Colombiano en El Valle, Choco.* **(2)** Amorocho, D. 2008. *Informe del Taller Estandarizacion de Metodologias en Investigacion y Monitoreo para la Conservacion de Tortugas Marinas en Colombia.* Convenio MAVDT-WWF.
Nesting Beach: El Valle
Year: 2008 **Species and Counts:** *Chelonia mydas*—4 clutches; *Lepidochelys olivacea*—165 clutches
SWOT Contacts: Diego Amorocho, Karla Barrientos-Muñoz, and Cristian Ramírez-Gallego

DATA RECORD 7

Data Source: Caicedo, D., and Fundación Omacha. 2016. Leatherback nesting in Moñitos, Colombia: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beach: Moñitos
Year: 2013 **Species and Counts:** *Dermochelys coriacea*—2 clutches
SWOT Contact: Dalila Caicedo

DATA RECORD 8

Data Source: Cordoba Becerra, A., and Parques Nacionales Naturales de Colombia. 2016. Sea turtle nesting in Santuario de Fauna Acandí, Playón y Playona: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Santuario de Fauna Acandí, Playón y Playona
Year: 2014 **Species and Counts:** *Dermochelys coriacea*—223 clutches; *Eretmochelys imbricata*—15 clutches
SWOT Contacts: Aureliano Cordoba Becerra and Santuario de Fauna Acandí, Playón y Playona

DATA RECORD 9

Data Source: Elvira Angarita Jimenez, L., R. Franke-Ante, and Parques Nacionales Naturales de Colombia, Dirección Territorial Caribe. 2016. Sea turtle nesting in Bolivar province, Colombia: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Baru; Isla Fuerte; Isla Rosario; Isla del Tesoro; Playa Blanca; Playa Chichiman; Playa Palitos; Playa Salina; Punta Gigante (all in Bolivar province)
Years: 2009, 2010, 2010, 2010, 2008, 2010, 2010, 2010, and 2009, respectively **Species and Counts:** *Eretmochelys imbricata*—1, 3, 2, 17, 13, 1, 3, 3, and 3 clutches, respectively
SWOT Contacts: Luz Elvira Angarita Jimenez and Rebeca Franke-Ante

DATA RECORD 10

Data Source: Franke-Ante, R., Parques Nacionales Naturales de Colombia, and Dirección Territorial Caribe. 2016. Sea turtle nesting in Parque Nacional Natural Tayrona, Colombia: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: All sites are in Parque Nacional Natural Tayrona—Arrecifes; Boca del Saco; Cañaveral; Castillete; El Cabo San Juan del Guia; Gumarra; La Piscina; Playa del Medio; Playita Escondida
Years: Records span 2007 to 2013 **Species and Counts:** *Caretta caretta*—2, 2, 1, 2, 2, 1, 1, 3, and 5 clutches, respectively; *Dermochelys coriacea*—2, 1, 1, 4, 0, 1, 0, 1, and 0 clutches, respectively; *Eretmochelys imbricata*—2, 1, 1, 2, 1, 1, 1, and 1 clutches, respectively
SWOT Contact: Rebeca Franke-Ante

DATA RECORD 11

Data Source: Jhovany Rosado Gomez, A., and Parques Nacionales Naturales de Colombia. 2016. Hawksbill nesting in Santuario de Faunay Flora Los Flamencos, Colombia: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Punta los Guamachitos—Santuario de Fauna y Flora Los Flamencos
Year: 2010 **Species and Counts:** *Eretmochelys imbricata*—1 clutch
SWOT Contact: Anderson Jhovany Rosado Gomez

DATA RECORD 12

Data Source: Merizalde, L.A. 2015. *Monitoreo de tortugas marinas dentro del marco del Acuerdo De Conservación entre la comunidad Wayuu de Bahía Hondita, Alta Guajira Colombiana y la alianz. institucional CERREJON–Conservación Internacional–Fondo de Accion Para el Desarrollo del Medio Ambiente y La Niñez–Corpoguajira.* Informe final 2014.
Nesting Beaches: Punta Gallinas; Bahía Hondita
Year: 2013 (Punta Gallinas) and 2015 (Bahía Hondita) **Species and Counts:** *Caretta caretta*—6 and 5 clutches, respectively; *Chelonia mydas*—2 and 0 clutches, respectively
SWOT Contacts: Luis Alonso Merizalde and Conservation International

DATA RECORD 13

Data Source: Muñoz Lasso, O.F. 2009. *Programa de monitoreo y protección de tortugas marinas en el Parque Nacional Natural Sanquianga 2009.* Informe técnico preliminar.
Nesting Beach: Los Mulatos
Year: 2009 **Species and Counts:** *Lepidochelys olivacea*—26–100 clutches
SWOT Contact: Juan Manuel Rodríguez-Barón

DATA RECORD 14

Data Source: Patiño-Martinez, J., A. Marco, L. Quiñones, and B. Godgley. 2008. Globally significant nesting of the leatherback turtle (*Dermochelys coriacea*) on the Caribbean coast of Colombia and Panama. Biological Conservation 141 (8): 1982–1988.
Nesting Beaches: Capitancito; Playeta
Year: 2007 **Species and Counts:** *Dermochelys coriacea*—26–100 and 26–100 clutches, respectively

DATA RECORD 15

Data Source: Payan, L.F. 2014. *Datos colectados y procesados en el marco de la elaboración del Plan de Manejo del Parque Nacional Natural Gorgona.*
Nesting Beach: Palmeras
Year: 2013 **Species and Counts:** *Chelonia mydas*—1–25 clutches; *Lepidochelys olivacea*—26–100 clutches
SWOT Contacts: Diego Amorocho and Ana Eugenia Herrera

DATA RECORD 16

Data Source: Pinzon, C., and Tortugas Marinas de Santa Marta. 2016. Sea turtle nesting in Via Parque Isla de Salamanca, Colombia: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beach: Atazcosa (Via Parque Isla de Salamanca)
Years: 2007 to 2015 **Species and Counts:** *Caretta caretta*—1 clutch (2014); *Chelonia mydas*—1 clutch (2015); *Dermochelys coriacea*—2 clutches (2015); *Eretmochelys imbricata*—1 clutch (2007)
SWOT Contact: Carlos Pinzon

DATA RECORD 17
Data Source: Rodriguez, T., and Parque Nacional Natural Sierra Nevada de Santa Marta. 2016. Sea turtle nesting in Parque Nacional Natural Sierra Nevada de Santa Marta, Colombia: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beach: Quintana (Parque Nacional Natural Sierra Nevada de Santa Marta)
Years: 2014 and 2015 **Species and Counts:** *Caretta caretta*—10 clutches (2015); *Chelonia mydas*—1 clutch (2015); *Dermochelys coriacea*—2 clutches (2014)
SWOT Contacts: Tito Rodriguez and Parque Nacional Natural Sierra Nevada de Santa Marta

DATA RECORD 44
Data Source: Barrientos-Muñoz K.G., V. Páez, and C. Ramírez Gallego. In preparation. *The Hawksbill Turtle in Colombia: Distribution, Use, Threats and Future Research and Conservation Actions.*
Nesting Beach: Isla Tortuguilla
Year: 2015 **Species and Count:** *Eretmochelys imbricata*—10 clutches
SWOT Contact: Karla Barrientos-Muñoz

DATA RECORD 45
Data Source: Ramírez-Gallego, C., S. Sanclemente, and K.G. Barrientos-Muñoz. In preparation. *First Report of Nesting of the Leatherback Sea Turtle (*Dermochelys coriacea*) on the North Pacific Coast of Colombia.*
Nesting Beach: Termales
Year: 2015 **Species and Counts:** *Dermochelys coriacea*—2 clutches; *Lepidochelys olivacea*—20 clutches
SWOT Contact: Karla Barrientos-Muñoz

Ecuador

DATA RECORD 18
Data Sources: (1) Baquero, A. 2009. Sea turtle nesting in Parque Nacional Machalilla, Ecuador: Personal communication. In SWOT Database Online 2010. **(2)** Zarate, P. 2008. Hawksbill nesting in Ecuador: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. III (2008).
Nesting Beach: Parque Nacional Machalilla
Year: 2009 **Species and Counts:** *Eretmochelys imbricata*—13 clutches
SWOT Contacts: Andrés Baquero and Alexander Gaos

DATA RECORD 19
Data Source: Baquero, A., J.P. Muñoz, Pena, and Equilibrio Azul. 2010. Olive ridley nesting in Mompiche and Montanita, Ecuador: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. V (2010).
Nesting Beaches: Mompiche; Montanita
Year: 2008 **Species and Counts:** *Lepidochelys olivacea*—2 and 1 clutches, respectively
SWOT Contacts: Andrés Baquero and Equilibrio Azul

DATA RECORD 20
Data Source: Carillo, B. 2015. *Reporte de anidación de tortugas carey, Reserva Marina " El Pelado." Dirección Provincial de Ambiente de Santa Elena.* Ministerio de Ambiente del Ecuador
Nesting Beach: Playa Rosada
Year: 2014 **Species and Counts:** *Eretmochelys imbricata*—29 clutches
SWOT Contacts: Cristina Miranda and Felipe Vallejo

DATA RECORD 21
Data Source: Equilibrio Azul. 2009. Sea turtle nesting in Las Tunas, Ecuador: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. V (2010).
Nesting Beach: Las Tunas
Year: 2008 **Species and Counts:** *Lepidochelys olivacea*—10 clutches
SWOT Contact: Equilibrio Azul

DATA RECORD 22
Data Source: Espinoza, E., A. Proaño, M. Parra, and J.S. Torres. 2014. *Monitoreo de la anidación de tortuga verde* Chelonia mydas *en Galápagos, temporada 2012–2013 y 2013–2014.* Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2014.
Nesting Beaches: Las Bachas; Quinta Playa (both in Galápagos Islands)
Years: 2013 and 2012, respectively **Species and Counts:** *Chelonia mydas*—188 and 4,785 clutches, respectively
SWOT Contacts: Cristina Miranda and Felipe Vallejo

DATA RECORD 23
Data Source: Herrera, M., D. Coello, and C. Flores. 2009. Notas preliminares: Cabo San Lorenzo, su importancia como area de reproduccion de tortugas marinas en el Ecuador.
Nesting Beaches: El Abra; Las Pinas; Same
Year: 2007, 2007, and 2009, respectively
Species and Counts: *Lepidochelys olivacea*—1 clutch each
SWOT Contacts: Marco Herrera, Dialhy Coello, and Equilibrio Azul

DATA RECORD 24
Data Source: Ladines, B. 2014. *Monitoreo y protección de nidos de tortugas marinas en la Reserva de Producción de Fauna Marina Costera Puntilla de Santa Elena (REMACOPSE), durante el período 2013–2014.* Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2014.
Nesting Beaches: Punta Brava; Tres Cruces
Year: 2013 **Species and Counts:** *Lepidochelys olivacea*—11 and 13 clutches, respectively
SWOT Contacts: Cristina Miranda and Felipe Vallejo

DATA RECORD 25
Data Source: Miranda, C. 2015. Equilibrio Azul Sea Turtle Monitoring Project, Ecuador: Unpublished data.
Nesting Beaches: La Playita; Los Frailes; Portete; Puerto Lopez; Salaite
Year: 2014 **Species and Counts:** *Chelonia mydas*—3, 1, 0, 0, 4 clutches, respectively; *Dermochelys coriacea*—0, 0, 0, 1, 0 clutches, respectively; *Eretmochelys imbricata*—33, 0, 0, 1, 0 clutches, respectively; *Lepidochelys olivacea*—1, 0, 69, 2, 0 clutches, respectively
SWOT Contacts: Cristina Miranda and Felipe Vallejo

DATA RECORD 26
Data Source: (1) Miranda, C. 2015. Equilibrio Azul Sea Turtle Monitoring Project, Ecuador: Unpublished data. **(2)** Equilibrio Azul. 2009. Sea turtle nesting in Bahía Drake, Ecuador: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. V (2010). **(3)** Pena, M., A. Baquero, J. Munoz, F. Puebla, J. Macias, and X. Chalen. 2009. El Parque Nacional Machalilla: Zona critica de anidacion para la tortuga carey (*Eretmochelys imbricata*) y verde (*Chelonia mydas*) en el Ecuador y el Pacifico Oriental. Temporadas 2007–2009. In *Memorias del III Simposio Regional sobre Tortugas Marinas del Pacifico Suroriental.*
Nesting Beach: Bahía Drake
Years: 2008 and 2012 **Species and Counts:** *Chelonia mydas*—48 clutches (2012); *Lepidochelys olivacea*—1 clutch (2008)
SWOT Contacts: Cristina Miranda, Felipe Vallejo, and Equilibrio Azul

DATA RECORD 27
Data Source: (1) Miranda, C. 2015. Equilibrio Azul Sea Turtle Monitoring Project, Ecuador: Unpublished data. **(2)** Pena, M., A. Baquero, J. Munoz, F. Puebla, J. Macias, and X. Chalen. 2009. El Parque Nacional Machalilla: Zona critica de anidacion para la tortuga carey (*Eretmochelys imbricata*) y verde (*Chelonia mydas*) en el Ecuador y el Pacifico Oriental. Temporadas 2007–2009. In *Memorias del III Simposio Regional sobre Tortugas Marinas del Pacifico Suroriental.*
Nesting Beaches: Salango; Tortuguita
Years: 2008 and 2014 **Species and Counts:** *Chelonia mydas*—1 and 2 clutches, respectively (2014); *Eretmochelys imbricata*—4 and 2 clutches, respectively (2008)
SWOT Contacts: Cristina Miranda, Felipe Vallejo, and Equilibrio Azul

DATA RECORD 28
Data Source: (1) Pena, M., A. Baquero, J. Munoz, F. Puebla, J. Macias, and X. Chalen. 2009. El Parque Nacional Machalilla: Zona critica de anidacion para la tortuga carey (*Eretmochelys imbricata*) y verde (*Chelonia mydas*) en el Ecuador y el Pacifico Oriental. Temporadas 2007–2009. In *Memorias del III Simposio Regional sobre Tortugas Marinas del Pacifico Suroriental.* **(2)** Zarate, P. 2008. Sea turtle nesting in Ecuador: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. III (2008).
Nesting Beach: Frailes
Year: 2008 **Species and Counts:** *Eretmochelys imbricata*—6 clutches
SWOT Contact: Equilibrio Azul

DATA RECORD 29
Data Source: Ponce, L. 2014. *Resultados del segundo periodo anual de monitoreo de tortugas marinas en el Refugio de Vida Silvestre y Marino Costera Pacoche y su zona de influencia Manta-Manabi, Ecuador. Junio de 2013–marzo 2014.* Inter-American Convention for the Protection and Conservation of Sea Turtles. Ecuador Annual Report 2014.
Nesting Beaches: La Botada; San Lorenzo
Year: 2013 **Species and Counts:** *Chelonia mydas*—5 and 9 clutches, respectively; *Dermochelys coriacea*—0 and 1 clutches, respectively; *Lepidochelys olivacea*—64 and 87 clutches, respectively
SWOT Contacts: Christina Miranda and Felipe Vallejo

French Guiana

DATA RECORD 30
Data Source: Berzins, R., J. Chevalier, D. Chevallier, and B. de Thoisy. 2016. Sea turtle nesting in French Guiana: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Awala Yalimapo; Azteque; Ile de Cayenne; Kourou
Year: 2015 **Species and Counts:** *Chelonia mydas*—2,228 clutches; 869 nesting females; 49 clutches; and 88 clutches, respectively; *Dermochelys coriacea*—480 clutches; 6 nesting females; 3,146 clutches; and 41 clutches, respectively; *Eretmochelys imbricata*—0, 0, 13, and 0 clutches, respectively; *Lepidochelys olivacea*—7; 0; 2,687; and 10 clutches, respectively
SWOT Contacts: Rachel Berzins, Catharina Bilo, Jeremie Ripaud, Anais Gainette, Johan Chevalier, Alexandre Habert, Damien Chevallier, Laurent Kelle, Benoit de Thoisy, Claudine Sakimin, Romeo de Freitas, Suresh Kandaswamy, and Sopheia Edghill

Guyana

DATA RECORD 31
Data Source: Guyana Marine Turtle Conservation Society and World Wildlife Fund Guianas. 2016. Sea turtle nesting in Guyana: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Shell Beach—Almond Beach
Year: 2015 **Species and Counts:** *Chelonia mydas*—170 clutches; *Dermochelys coriacea*—170 clutches; *Eretmochelys imbricata*—10 clutches; *Lepidochelys olivacea*—3 clutches
SWOT Contacts: Claudine Sakimin, Romeo de Freitas, Suresh Kandaswamy, Sopheia Edghill, Catharina Bilo, and Michael Hiwat

Peru

DATA RECORD 32
Data Source: ecOceánica. 2015. Sea turtle nesting in Peru: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: (1) Bonanza; **(2)** Cabo Blanquillo; **(3)** El Nuro; **(4)** Las Pocitas; **(5)** Lobitos; **(6)** Los Organos; **(7)** Los Pinos; **(8)** Playa Bravo; **(9)** Puerto Eten; **(10)** Punta Sal; **(11)** Punta Veleros; **(12)** Vichayito
Years: (1) 2013; **(2)** 2014; **(3)** 2011 and 2014; **(4)** 2013 and 2014; **(5)** 2013; **(6)** 2013; **(7)** 2012; **(8)** 2014; **(9)** 2013; **(10)** 2014; **(11)** 2010; **(12)** 2013 **Species and Counts: (1)** *Chelonia mydas*—1 clutch; **(2)** *Lepidochelys olivacea*—1 crawl; **(3)** *Chelonia mydas*—1 clutch and *Lepidochelys olivacea*—2 clutches, respectively; **(4)** *Chelonia mydas*—2 clutches and *Lepidochelys olivacea*—1 clutch, respectively; **(5)** *Chelonia mydas*—1 clutch; **(6)** *Lepidochelys olivacea*—2 clutches; **(7)** *Chelonia mydas*—1 clutch; **(8)** *Chelonia mydas*—4 clutches and *Lepidochelys olivacea*—15 clutches; **(9)** *Chelonia mydas*—1 clutch; **(10)** *Chelonia mydas*—1 clutch and *Lepidochelys olivacea*—1 clutch; **(11)** *Chelonia mydas*—1 crawl; **(12)** *Lepidochelys olivacea*—1 clutch
SWOT Contact: Shaleyla Kélez

DATA RECORD 33
Data Source: Rivas Mogollon, E.L., Z.A. Vega Guarderas, and C.J.J. Saavedra Lozada. 2013. Sea turtle monitoring in El Alto, Piura, Peru. *Marine Turtle Newsletter* 137: 15–16.
Nesting Beach: Punta Restin
Year: 2011 **Species and Counts:** *Lepidochelys olivacea*—2 clutches
SWOT Contact: Shaleyla Kélez

DATA RECORD 34
Data Source: Vera, M., J. Llanos, E. Torres, C.A. Rosales, and F. Van Oordt. 2008. Primer registro de anidamiento de *Lepidochelys olivacea* (Eschscholtz 1829) en la playa Nueva Esperanza, Tumbes, Peru. In S. Kelez, F. van Oordt, N. de Paz, and K. Forsberg (eds.), *Libro de Resumenes. II Simposio de Tortugas Marinas en el Pacifico Sur Oriental*, p. 105.
Nesting Beach: Nueva Esperanza
Year: 2008 **Species and Counts:** *Lepidochelys olivacea*—1 clutch
SWOT Contact: Shaleyla Kélez

DATA RECORD 35
Data Source: Wester, J.H., S. Kélez, and X. Velez-Zuazo. 2010. Nuevo limite sur de anidacion de las tortuga verde *Chelonia mydas* y golfina *Lepidochelys olivacea* en el Pacifico Este. II Congreso Nacional de Ciencias del Mar del Peru. Piura, Peru.
Nesting Beaches: Bomba; Tres Cruces
Year: 2010 **Species and Counts:** *Lepidochelys olivacea*—1 clutch; *Chelonia mydas*—1 clutch
SWOT Contact: Shaleyla Kélez

Suriname

DATA RECORD 36
Data Source: Nature Conservation Division and World Wildlife Fund Guianas. 2016. Sea turtle nesting in Suriname: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Galibi; Matapica
Year: 2015 **Species and Counts:** *Chelonia mydas*—12,711 and 5,751 clutches, respectively; *Dermochelys coriacea*—134 and 1,163 clutches, respectively; *Lepidochelys olivacea*—5 and 15 clutches, respectively
SWOT Contacts: Claudine Sakimin, Romeo de Freitas, Suresh Kandaswamy, Sopheia Edghill, Catharina Bilo, and Michael Hiwat

Venezuela

DATA RECORD 37
Data Source: Antonio Garcia Cruz, M., H. Barrios-Garrido, N. Espinoza, N. Wilderman, L. Morán, H. Guada, P. Vernet, A. Arias-Ortiz, C. Balladares, and E. Fajardo. 2016. Sea turtle nesting in Venezuela: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Castilletes (Bahia de Malimansipa and Morro "El Diablo"); Golfo Triste, Estado Carabobo (7 nesting beaches); Isla La Tortuga (4 islands, 13 nesting beaches); Parque Nacional Mochima (18 nesting beaches); Querepare; Sietemares
Years: Records span 2008 to 2015 **Species and Counts:** *Caretta caretta*—1 crawl, 2, 11, 9, 3, and 3 clutches, respectively; *Chelonia mydas*—0, 1, 2, 8, 0, and 1 clutches, respectively; *Dermochelys coriacea*—5 crawls, 17, 78, 7, 125, and 0 clutches, respectively; *Eretmochelys imbricata*—1, 14, 84, 11, 1, and 0 clutches, respectively
SWOT Contacts: Marco Antonio Garcia Cruz, Hector Barrios-Garrido, Ninive Espinoza, Nathalie Wilderman, Lisandro Morán, Hedelvy Guada, Pedro Vernet, Angela Arias-Ortiz, Clemente Balladares, and Eneida Fajardo

DATA RECORD 38
Data Source: Balladares, C., and Oficina Nacional de Diversidad Biológica, Ministerio de Ecosocialismo y Agua, Caracas, Venezuela. 2016. Sea turtle nesting in Macuro/Macurito, Venezuela: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beach: Macuro/Macurito (Golfo de Paria)
Year: 2015 **Species and Counts:** *Chelonia mydas*—4 clutches; *Dermochelys coriacea*—5 clutches; *Eretmochelys imbricata*—101 clutches
SWOT Contacts: Clemente Balladares and Marco Antonio Garcia Cruz

DATA RECORD 39
Data Source: Dow, W.E., and K.L. Eckert. 2007. *Sea turtle nesting habitat—A spatial database for the wider Caribbean region.* Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and The Nature Conservancy. WIDECAST Technical Report No. 6. Beaufort, NC.
Nesting Beach: La Tortuga
Year: 2007 **Species and Counts:** *Caretta caretta*—unquantified; *Chelonia mydas*—unquantified; *Dermochelys coriacea*—unquantified; *Eretmochelys imbricata*—unquantified
SWOT Contacts: Hedelvy Guada and Wendy Dow

DATA RECORD 40
Data Source: Fajardo, E., and Grupo Trabajo de Tortugas Marinas de Venezuela/CICTMAR (Centro de Investigación y Conservación de Tortugas Marinas). 2016. Sea turtle nesting in Puy Puy, Venezuela: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beach: Puy Puy
Year: 2015 **Species and Counts:** *Caretta caretta*—3 clutches; *Dermochelys coriacea*—21 clutches
SWOT Contacts: Eneida Fajardo and Marco Antonio Garcia Cruz

DATA RECORD 41
Data Source: Guada, H. 2016. Sea turtle nesting in Cipara, Venezuela: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beach: Cipara
Year: 2015 **Species and Counts:** *Caretta caretta*—7 clutches; *Chelonia mydas*—4 clutches; *Dermochelys coriacea*—140 clutches
SWOT Contact: Hedelvy Guada

DATA RECORD 42
Data Source: García Cruz, M., and Laboratorio de Ecología y Genética de Poblaciones, Centro de Ecología, Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela. 2016. Sea turtle nesting in Refugio de Fauna Silvestre Isla de Aves, Venezuela: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beaches: Refugio de Fauna Silvestre Isla de Aves
Year: 2008 **Species and Counts:** *Chelonia mydas*—2,042 clutches
SWOT Contact: Marco Antonio García Cruz

DATA RECORD 43
Data Source: Vernet, P., Grupo de Trabajo de Tortugas Marinas del Estado Nueva Esparta (GTTM-NE), A. Arias-Ortíz, and Instituto Venezolano de Investigaciones Científicas, Sede Zulia, Venezuela. Sea turtle nesting in Isla Margarita, Venezuela: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Nesting Beach: Northwest sector of Isla Margarita (beaches of El Cardón, Parguito, El Agua, El Humo, Pto. Real)
Year: 2008 **Species and Counts:** *Dermochelys coriacea*—194 clutches
SWOT Contacts: Pedro Vernet, Angela Arias-Ortiz, and Marco Antonio Garcia Cruz

Telemetry Data Citations

The following data records refer to satellite telemetry datasets from tags that were deployed in South America and were combined to create the map on pp. 24–25. These data were generously contributed to SWOT by the people and partners listed subsequently. In mapping the data, obviously erroneous points (e.g. on land) were filtered. In some cases, the Douglas Argos-Filter (Douglas, D.C. et al. 2012) was also used to remove unrealistic points based on swim speed and turning angle. Some datasets were filtered prior to being shared with SWOT and were not filtered further. The map is for illustrative purposes and should not be considered an authoritative source of tracking data for the studies cited. 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, the following abbreviations are used in the data source fields below: (1) "STAT" refers to "Coyne, M.S., and B.J. Godley. 2005. Satellite Tracking and Analysis Tool (STAT): An integrated system for archiving, analyzing and mapping animal tracking data. Marine Ecology Progress Series 301: 1–7."; (2) "SWOT Online Database" refers to "Kot, C.Y., E. Fujioka, A.D. 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." When listed, these sources indicate that the dataset was contributed online through STAT and/or SWOT.

SWOT ID: 951
Project Title: Brazil Trawl-Caught Turtles
Project Partners: Fisheries Bycatch Research Group, Dani Monteiro, FURG, Projecto Tartarugas no Mar
Data Sources: (1) STAT. **(2)** SWOT Online Database.

SWOT ID: 1292
Project Title: Caribbean Colombian Hawksbill Satellite Tracking (proCTM)
Project Partners: Sea Turtles and Mammal Conservation Program UTADEO-Colombian Caribbean, Jorge Tadeo, Lozano University
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 1 adult, 1 subadult, and 3 juvenile *Eretmochelys imbricata*; tags deployed on turtles in Caribbean Colombia during 2009–2011 and 2015.

SWOT ID: 1338
Project Title: Galápagos Green Turtle Satellite Tracking
Data Sources: (1) Jeffrey Seminoff, NOAA-NMFS Southwest Fisheries Science Center. **(2)** STAT. **(3)** SWOT Online Database.
Metadata: 11 adult *Chelonia mydas*; tags deployed on turtles in the Galápagos Islands of Ecuador.
SWOT Contact: Jeffrey Seminoff

SWOT ID: 1336
Project Title: Iniciativa Carey del Pacifico Oriental—ICAPO—Eastern Pacific Hawksbill Initiative
Project Partners: NOAA Southwest Fisheries Science Center, Fundación Zoológica de El Salvador, Instituto de Ciencias del Mar y Limnología de la Universidad de El Salvador, Proyecto Carey! del Pacifico Oriental, Ocean Conservancy, Comite de Desarrollo Empresarial y Medio Ambiente de Puerto Parada, Centro Tecnológico para Estudios del Mar No. 14, Pro Peninsula, Grupo Tortuguero and Equilibrio Azul
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 26 adult and 5 juvenile *Eretmochelys imbricata*; tags deployed on turtles throughout the eastern Pacific region from 2008 to 2015. Only tracks from turtles tagged in South America are displayed on the map.
SWOT Contacts: Jeffrey Seminoff and Alexander Gaos

SWOT ID: 1312
Project Title: Juveniles de la Guajira
Project Partners: Conservation stewardship of green sea turtles, Grupo de custodios de tortugas marinas de Bahía Hondita, Conservacion Internacional Colombia, College of Arts and Sciences of University of Miami, Department of Biology of University of Miami, C. Vasquez
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 1 juvenile *Chelonia mydas*; tag deployed on a turtle in northern Caribbean Colombia.

SWOT ID: 1148
Project Title: Neonates Tagged off Brazil
Project Partners: Fisheries Bycatch Research Group, Yonat Swimmer, Projeto TAMAR, NOAA, University of Central Florida
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 4 juvenile *Caretta caretta*; tags deployed on turtles in 2013 off the coast of Brazil.

SWOT ID: 931
Project Title: Peru Cabezonas
Project Partners: Jeffrey Mangel, ProDelphinus, NOAA Southwest Fisheries Science Center, Peter Dutton, Jeff Seminoff, Denise Parker
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.
Metadata: 15 subadult *Caretta caretta*; tags deployed in Ilo and Pucusana, Peru, from 2003 to 2007, on turtles that were bycaught in line fisheries.
SWOT Contact: Jeffrey Mangel

SWOT ID: 1334
Project Title: Peru Leatherback Tracking Project
Project Partners: Jeffrey Mangel, ProDelphinus, Marine Turtle Research Group
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 3 juvenile *Dermochelys coriacea*; tags deployed in Peru in 2014 and 2015 on turtles that had been bycatch of net fisheries.
SWOT Contact: Jeffrey Mangel

SWOT ID: 1332
Project Title: ProDelphinus Peru Hawksbill Tracking Project
Project Partners: Jeffrey Mangel, ProDelphinus, NOAA Pacific Islands Fisheries Science Center
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 4 juvenile *Eretmochelys imbricata*; tags deployed in Constante, Peru, in 2014 on turtles that had been entangled in gillnets.
SWOT Contact: Jeffrey Mangel

SWOT ID: 1330
Project Title: ProDelphinus Peru Leatherback Tracking Project
Project Partners: Jeffrey Mangel, ProDelphinus, NOAA Pacific Islands Fisheries Science Center
Data Source: STAT.
Metadata: 2 subadult and 1 adult *Dermochelys coriacea*; tags deployed in San Jose, Peru, in 2014 on turtles that had been bycatch of net fisheries.

SWOT ID: 1326
Project Title: Sea Turtles of Valle del Cauca – Bahía Málaga
Project Partners: Conservation International, PRETOMA
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 1 juvenile *Lepidochelys olivacea*; tag deployed in Puerto España, on the Pacific coast of Colombia.
SWOT Contact: Maike Heidemeyer

SWOT ID: 984
Project Title: Study of the Biology of Sea Turtles in Brazil through Satellite Telemetry
Project Partners: Projeto TAMAR-IBAMA
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 15 adult *Eretmochelys imbricata*, 5 adult *Dermochelys coriacea*, 10 adult *Caretta caretta*, and 10 adult *Lepidochelys olivacea*; tags deployed in Brazil in 2005 and 2006.
SWOT Contact: Gustave Lopez

SWOT ID: 1306
Project Title: WWF Sea Turtle Satellite Tracking in Latin America and the Caribbean
Project Partners: WWF LAC Species Program, Parques Nacionales de Colombia (DT Pacífico, Parque Nacional Gorgona, Parque Nacional Utria), Iniciativa Carey del Pacífico Oriental (ICAPO), Autoridad de los Recursos Acuáticos de Panamá (ARAP), Fundación Natura—Colombia, Asociación Caguama—Colombia, Fundación Charles Darwin—Galápagos, Ecuador, Latin America Sea Turtles (LAST)
Data Sources: (1) STAT. **(2)** SWOT Online Database.
Metadata: 1 adult *Lepidochelys olivacea* and 1 adult *Chelonia mydas*; tags deployed in Pacific Colombia and the Galápagos Islands in 2013 and 2014. Additional data from tags deployed on hawksbill turtles in Panama and Costa Rica were not displayed on the map.
SWOT Contact: Diego Amorocho

Project Title: Argentina Leatherback Tracking
Project Partners: Laura Prosdocimi, PRICTMA
Data Source: Prosdocimi, L. 2016. Satellite tracking of leatherback turtles in Argentina: Personal communication. In *SWOT Report—The State of the World's Sea Turtles*, vol. 11 (2016).
Metadata: 3 adult *Dermochelys coriacea*; tags deployed in Argentina.
SWOT Contact: Laura Prosdocimi

Project Title: Study of Habitat Use by Loggerhead Turtles in Southern Brazil
Project Partners: Danielle Monteiro, Projeto Tartarugas Marinhas—NEMA/FURG
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).
Metadata: 16 *Caretta caretta*; tags deployed in southern Brazil.

Project Title: Chile Green Turtle Tracking
Project Partners: Walter Sielfeld, Paula Salinas, Dario Contreras
Data Source: Sielfeld, W., et al. 2015. Preliminary data. Universidad Arturo Prat—Gobierno Regional de Arica y Parinacota—Tortumar Chile 2015.
Metadata: 1 adult *Chelonia mydas*; tag deployed in Chile.

Project Title: French Guiana Marine Turtle Tracking
Project Partners: Damien Chevallier, CNRS
Data Source: Chevallier, D. 2016. Satellite tracking of marine turtles in French Guiana: Personal communication. In *SWOT Report—State of the World's Sea Turtles*, vol. XI (2016).
Metadata: 10 adult *Chelonia mydas*; 20 adult *Lepidochelys olivacea*; 10 adult *Dermochelys coriacea*; tags deployed in French Guiana.

Project Title: Satellite Tracking of Marine Turtles in the Guianas
Project Partners: Daniel Evans, Sea Turtle Conservancy, Karin Bilo, WWF Guianas
Data Source: Evans, D., and K. Bilo. 2016. Satellite tracking of marine turtles in the Guianas: Personal communication. In *SWOT Report—The State of the World's Sea Turtles*, vol. XI (2016).
Metadata: 19 adult Dermochelys coriacea; 10 adult Chelonia mydas; tags deployed in Suriname and Guyana
SWOT Contact: Karin Bilo

Authors and Affiliations

Betânia Ferreira Airaud	Institute of Biodiversity and Protected Areas of Guinea-Bissau, Guinea-Bissau
Rocio Álvarez-Varas	Qarapara Tortugas Marinas Chile, Chile
Diego Amorocho	World Wildlife Fund (WWF) Latin America and Caribbean, Colombia
Castro Barbosa	Institute of Biodiversity and Protected Areas of Guinea-Bissau, Guinea-Bissau
Tanya Berger-Wolf	Wild Me, Oregon, United States
Rachel Berzins	Office National de la Chasse et de la Faune Sauvage, Kourou, French Guiana
Domingos Betunde	Institute of Biodiversity and Protected Areas of Guinea-Bissau, Guinea-Bissau
Karin Bilo	WWF Guianas, Paramaribo, Suriname
Cathi L. Campbell	Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, United States
Johan Chevalier	Réserve naturelle de l'Amana, French Guiana
Damien Chevallier	CNRS–IPHC, Département Ecologie, Physiologie et Ethologie, Strasbourg, France
Benoit de Thoisy	Association Kwata, Cayenne, French Guiana
Stephen G. Dunbar	ProTECTOR Inc. and Loma Linda University, California, United States
Emily Duncan	Marine Turtle Research Group, Centre for Ecology and Conservation, University of Exeter, Cornwall, United Kingdom
Alejandro Fallabrino	Karumbé, Montevideo, Uruguay
Marco A. García-Cruz	IVIC, Caracas, Venezuela, and Archie Carr Center for Sea Turtle Research, Florida, United States
Riki Gunn	GhostNets Australia, Australia
Victor J. Guri	Associação Tartarugas Marinhas, São Tomé e Príncipe
Joana M. Hancock	Centre of Ecology, Evolution, and Environmental Changes (Faculty of Sciences of Lisbon University) and Associação Tartarugas Marinhas, São Tomé e Príncipe
Christine Hof	WWF Australia, Australia
Jason Holmberg	Wild Me, Oregon, United States
Esther Horvath	Baby Giants Project, New York, United States
Jillian Hudgins	Olive Ridley Project, Maldives
Brian J. Hutchinson	Oceanic Society and IUCN-SSC Marine Turtle Specialist Group, Washington, DC, United States
Claire Jean	Kélonia, Réunion, France
Shaleyla Kelez	ecOceánica, Lima, Peru
Cynthia LaGueux	Archie Carr Center for Sea Turtle Research and Department of Biology, University of Florida, United States
Aimee Leslie	WWF International, Geneva, Switzerland
Milagros López-Mendilaharsu	Projeto TAMAR/Fundação Pró TAMAR, Brazil
Maria Angela Marcovaldi	Projeto TAMAR/Fundação Pró TAMAR, Brazil
Roderic B. Mast	Oceanic Society and IUCN-SSC Marine Turtle Specialist Group, Washington, DC, United States
Carol Medrano	Qarapara Tortugas Marinas Chile, Chile
Cristina Miranda	Equilibrio Azul, Ecuador
Michel A. Nalovic	IUCN Marine Turtle Specialist Group, Group de Travaille Tortue Marine France, French Guiana Regional Fisheries Committee, Cayenne, French Guiana
Kostas Papafitsoros	Humboldt University of Berlin, Germany
Laura Prosdocimi	PRICTMA, Argentina
Aissa Regalla	Institute of Biodiversity and Protected Areas of Guinea-Bissau, Guinea-Bissau
Juan M. Rguez-Barón	JUSTSEA Foundation, Colombia
Alexsandro Santos	Projeto TAMAR/Fundação Pró TAMAR, Brazil
Gail Schofield	Centre for Integrative Ecology, Deakin University, Geelong, Victoria, Australia
Luciano Soares	Archie Carr Center for Sea Turtle Research, University of Florida, United States
Martin Stelfox	University of Derby and Olive Ridley Project, United Kingdom
Chuck Stewart	Rensselaer Polytechnic Institute, New York, United States
Joca Thomé	Centro TAMAR/ICMBio, Brazil
Felipe Vallejo	Equilibrio Azul, Ecuador
Gabriela Vélez-Rubio	Karumbé, Montevideo, Uruguay
Sara A. Vieira	Associação Tartarugas Marinhas, São Tomé e Príncipe
Bryan P. Wallace	Abt Environmental Research and Duke University Marine Lab, United States

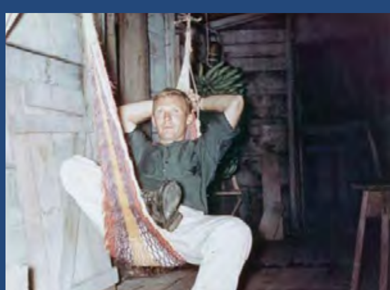
In Memoriam

COURTESY OF HEDELVY J. GUADA

Joaquin Buitrago Borrás (1956–2014)

A Venezuelan-born research scientist, Joaquin worked to protect sea turtles for most of his life. His dedication, humility, and willingness to share knowledge with students and colleagues will leave a great void in Venezuela and with his colleagues around the world.

COURTESY OF SEA TURTLE CONSERVANCY



Larry Ogren (1930–2016)

A lifelong champion of sea turtle conservation, Larry was a trailblazer, a one-of-a-kind naturalist and outdoorsman, and an award-winning conservationist. A friend and inspiration to many in the sea turtle conservation community, he will be dearly missed.

COURTESY OF SANDRA HOCHSCHEID

Luigi Ferretti (1958–2016)

A veterinarian for more than 20 years with the Aquarium and Sea Turtle Rescue Center in Naples, Italy, Luigi will be remembered as a man of science and humanism and as one who has done much for sea turtles. He was a joyful, kind, and sincere person with an unparalleled love for all living creatures, regardless of the number of legs (or flippers) they had.

SWOT report

The State of the World's Sea Turtles

State of the World's Sea Turtles
Oceanic Society
P.O. Box 844
Ross, CA 94957
U.S.A.

www.SeaTurtleStatus.org