

special feature

— THE SEA TURTLES OF —
AFRICA
—

ANDREWS AGYEKUMHENE, EDWARD ARUNA, BETÂNIA FERREIRA AIRAUD, PHIL ALLMAN,
ISIDORE AYISSI, JÉRÔME BOURJEA, MAYEUL DALLEAU, TOMAS DIAGNE, ALEJANDRO
FALLABRINO, ANGELA FORMIA, JACQUES FRETEY, ALEXANDRE GIRARD, MARC GIRONDOT,
JOANA HANCOCK, SHAYA HONARVAR, ADOLFO MARCO, RODERIC MAST, ROLAND
MISSILOU-BOUKAKA, STEVE MORREALE, JEANNE A. MORTIMER, MIKE OLENDI, RONEL
NEL, FRANK V. PALADINO, NATHAN ROBINSON, ARISTIDE TAKOUKAM KAMLA, MANJULA
TIWARI, CASPER VAN DE GEER, SARA VIEIRA, and LINDSEY WEST



Africa's sea turtles were once among the least studied in the world, and mounting threats to their survival, such as fishing, poaching, coastal development, and pollution, still require further study and urgent attention. Today, a growing number of institutions and individuals are shedding new light on sea turtle science, and they are helping find solutions to the continent's sea turtle and ocean conservation challenges.

Africa is bounded by seemingly limitless turtle habitats in the Atlantic and Indian Oceans and in the Mediterranean and Red Seas to the north and northeast. The principal challenge to fully understanding Africa's sea turtles is the enormous scale and complexity of the task. Africa's 54 countries (63 political territories) cover approximately one-third of the land surface of Earth—an area the size of China, India, the United States, and most of Europe combined. The African coastline stretches some 26,000 kilometers (16,150 miles) across 71 degrees of latitude (7,881 kilometers/4,897 miles) and 68 degrees of longitude (7,548 kilometers/4,690 miles). Africa also encompasses an enormous exclusive economic zone (EEZ), with an ocean footprint of approximately 6,023,900 square kilometers (3,743,100 square miles). Africa's human diversity is equally unbounded, with thousands of distinct linguistic groups and tribal cultures overlain by hundreds of years of colonial history in many areas. For example, South Africa alone has a dozen official languages.

We have chosen to exclude the Mediterranean and Red Seas (to be addressed by SWOT in the future) and to focus in this article and accompanying maps only on Africa's continental shores, from the Straits of Gibraltar in Morocco to the Horn of Africa in Somalia, plus the offshore archipelagos and island nations, including the Canary Islands (Spain), Cabo Verde, Bijagós (Guinea-Bissau), Bioko (Equatorial Guinea), São Tomé and Príncipe, Madagascar, the Comoros, Mauritius, La Réunion (France), and the Seychelles, to name a few of the largest. This sizable area comprises 33 countries and their territories and is a zone of superlative global importance for sea turtles (see maps, pp. 24–29).

Five of the world's seven sea turtle species (leatherbacks, olive ridleys, green turtles, hawksbills, and loggerheads) inhabit these waters and nest on Africa's continental shores—from Mauritania south to Angola on Africa's Atlantic coast, and from South Africa north to Somalia on the Indian Ocean coast, plus the aforementioned archipelagos. Even the Kemp's ridley, endemic to the North Atlantic and the Gulf of Mexico, occasionally wanders into African waters. The only sea turtle species completely absent from Africa is the Australian flatback.

Sea turtles are among the most widely ranging creatures on Earth, and many sea turtles that nest outside Africa spend time in African waters as well. Those seasonal visitors may have hatched on distant shores in South America, the Caribbean, and the Central Atlantic (Ascension Island). Similarly, turtles born on West African beaches can be found throughout the Atlantic and Caribbean, and

green and loggerhead turtles born on Africa's Indian Ocean shores travel far north to the Arabian Peninsula. Leatherbacks that nest in South Africa and nearby Mozambique migrate through the frigid waters around the Cape of Good Hope to forage off Namibia. Some African turtles barely migrate at all, spending their whole lives as local residents (see inset, p. 21). Of the 58 sea turtle subpopulations worldwide (called regional management units, or RMUs), 18 overlap with Africa and its Indian and Atlantic Ocean islands.

All African sea turtles are facing human-made threats, and pressure from humans has taken an enormous toll. The ecological footprint of all African countries increased by 240 percent from 1961 to 2008, according to the Global Footprint Network, due to growing populations and increased per capita consumption. By 2050, Africa's population is projected to reach as high as 2.47 billion people, this compared to 1.02 billion in 2010 and 0.294 billion in 1961. Turtles are an important component of local culture and practices for many African coastal communities, and have provided food and other traditional uses for millennia. Over the centuries, human impacts to turtles have evolved from subsistence-level hunting to more severe and pervasive threats, often driven by widespread poverty and food shortages. Today, sea turtles in Africa face threats from fisheries, consumption of adults and eggs, boat strikes, pollution, and climate change. Moreover, many coastal areas of Africa are developing significant infrastructure that is fueling habitat loss, and deep-sea ports are springing up like mushrooms to meet the tremendous global demand for African resources (see pp. 8–9).

In response to growing threats and increasing environmental awareness, most coastal African countries have enacted laws specifically to protect sea turtles. All the coastal countries of Africa are also parties to the Convention on International Trade in Endangered Species of Wild Fauna and Flora and the Convention on Biological Diversity, and all but Namibia and Sierra Leone are parties to the Convention on Migratory Species. In addition, two intergovernmental agreements focus on sea turtles on both sides of Africa: the Indian Ocean South East Asian Marine Turtle Memorandum of Understanding and the Memorandum of Understanding Concerning Conservation Measures for Marine Turtles of the Atlantic Coast of Africa.

Regional networks also play an increasingly important role in organizing the African sea turtle movement, including the Gold Coast Sea Turtle Conservation Network, the Sea Turtle Professional Network in Central Africa (Rastoma), and the Western Indian Ocean–Marine Turtle Task Force. Since 2014, the *African Sea Turtle Newsletter*, produced by the Ocean Ecology Network, has served as a multilingual communications tool among the continent's far-flung sea turtle researchers.

NORTHWEST AFRICA

Morocco to Guinea, and the Canary and Cabo Verde Archipelagos

The region from Morocco to Guinea on continental Africa straddles two major geomorphological domains: (a) the coastal dunes of the Sahel in Morocco and Senegal and (b) the vast river deltas from southern Senegal south to Guinea. The former is characterized by arid deserts that abut the coast, and the latter is a maze of deltas, cliffs, estuaries, and mangrove lagoons. The continental shelf in this zone extends 30 kilometers (19 miles) from the coast, except in Guinea-Bissau, where it broadens to 200 kilometers (124 miles). Cold, nutrient-rich upwellings support high levels of marine productivity in this region, and the main marine turtle foraging and nesting areas can be found in these rich waters at sites such as Banc d'Arguin National Park (Mauritania), the transboundary Biosphere Reserve of the Senegal River's lower delta (Mauritania–Senegal), the Saloum Delta (Senegal), the Bolama Bijagós Archipelago Biosphere Reserve (Guinea-Bissau), and the Tristão–Alcatraz Marine Protected Area (Guinea).

In chronicles dating from the 15th century, explorers provide accounts of abundant sea turtles throughout West Africa and the nearby archipelagos of the Canary Islands (Spain) and Cabo Verde, as well as of their widespread exploitation at the time. Today, loggerheads nest predominantly in Cabo Verde; green turtles in Guinea-Bissau's Bijagós Archipelago; and, sporadically, olive ridleys, leatherbacks, hawksbills, and loggerheads along the coast from Mauritania to Guinea-Bissau.

Southern Morocco reported large numbers of nesting turtles in the late 1950s, but more recent reports suggest a dramatic decline. In 2008, the Association for the Protection of Sea Turtles in Morocco was formed to address that dire situation. The presence of primarily juvenile loggerheads and leatherbacks in Moroccan waters suggests that the area may be an important foraging or developmental habitat or a migratory corridor.

Lying about 570 kilometers (350 miles) off the coast of Senegal, the Cabo Verde Archipelago boasts the third-largest loggerhead rookery in the world. Up to 20,000 nests are laid on Boa Vista Island alone in some seasons, representing 85 percent or more of the nesting in Cabo Verde. The Northeast Atlantic loggerhead RMU is listed as among the 11 most threatened sea turtle populations (see *SWOT Report*, vol. VII, 28). Despite national laws, active conservation projects, and some military protection, turtles are still hunted in Cabo Verde, and coastal construction and tourism pressures are also exacting a serious toll. On some beaches, poachers kill up to 90 percent of nesting females and harvest the eggs. To address the protection of this globally important sea turtle population, a Cabo Verdean sea turtle network called TAOLA was founded in 2009.

Loggerheads, green turtles, and leatherbacks are found in the waters around the Canary Islands, but hawksbills and Kemp's ridleys are rare. The Canary Islands are of greatest significance as foraging and migratory habitats for sea turtles from both sides of the Atlantic Ocean. Young loggerheads often are observed between the Canaries and Madeira as well, likely migrants following the Gulf Stream from North American nesting beaches. Young green turtles also are observed during the summer months off Gran Canaria and Lanzarote.

Mauritania still harbors small numbers of nesting turtles, including an aggregation of green turtles, south of the capital, Nouakchott. A local project, Digmile, has worked with the Mauritanian Institute for Oceanographic Research and Fisheries (IMROP) at this site since 2014 and has noted sporadic loggerhead nesting. An alarming outcome of IMROP's surveys has been the discovery of hundreds of stranded juvenile and adult loggerheads, presumably killed in fishing nets while foraging in the rich nearshore waters. Mauritania's Banc d'Arguin National Park is an important foraging area for green turtles from the Bijagós Archipelago. Despite 20th-century reports of nesting leatherbacks in Mauritania and Senegal, such sightings are extremely rare today, although the area seems to be an important foraging zone for leatherbacks from the Americas.

Senegalese coastal waters are well known as a migratory corridor, and four East Atlantic species (green, loggerhead, olive ridley, and leatherback) are known to nest sporadically in the country. Very little is understood about their abundance and seasonality. Hawksbills appear to be even rarer. The African Chelonian Institute (ACI) conducts beach surveys in northern Senegal from Dakar to St. Louis (a distance of 184 kilometers, or 114 miles) to assess sea turtle and cetacean mortality on those remote and little-developed shores. An astonishing 65 dead sea turtles of four species were found in the first of those surveys. Researchers believe that the massive mortality is a result of bycatch impacts from the very intensive offshore fishing in the region. ACI is now working with partners to find ways to reduce such tragic and unsustainable loss.

Green turtles also nest on the tiny coast of The Gambia between Bakau and Kartung, where the nongovernmental organization (NGO) Turtle SOS The Gambia monitors and protects the 27 kilometers (17 miles) of beach and conducts public awareness programs for communities and tourists. Noteworthy numbers of immature green turtles live in The Gambia's nearshore waters.

Little is known about the frequency of olive ridley and hawksbill turtles in this subregion, although both species are known to nest in the Bijagós Archipelago (Guinea-Bissau) and on Katrack Island (Guinea). The National Center for Fisheries Science in Boussoura (CNSHB), the Guinean Kaloe Kurè Project, and the French Association Chélonée have been working together to learn more about sea turtles on Katrack and to do outreach with local communities there.

Guinea-Bissau has one of the most important nesting populations of green turtles in the world at Bijagós, a coastal archipelago comprising 88 islands and islets, covering an area of nearly 10,000 square kilometers (6,214 square miles). Five sea turtle species have been confirmed in Bijagós, including at Poilão Island where about 40,000 green turtle nests were recorded in 2014 and perhaps thousands more on nearby islands. The olive ridley is the second most abundant species in Bijagós, with roughly 90 nests annually on Orango Island. A few dozen hawksbill and leatherback nests have also been reported. Loggerhead nests are very rare, but a few carapaces have been found in the archipelago, indicating that it may be nonbreeding habitat for the species. For a full description of the importance of Guinea-Bissau's sea turtles, see *SWOT Report*, vol. XI, 40–41.

PREVIOUS SPREAD: A hawksbill turtle nests on the beach of D'Arros Island in the Amirante Islands of the Seychelles. The Seychelles are home to the most important hawksbill nesting populations in the western Indian Ocean and home to one of the largest national populations in the world. © THOMAS P. PESCHAK

WEST AFRICA

Guinea to Nigeria

The south-facing coastline of West Africa—encompassing the countries of Guinea, Sierra Leone, Liberia, Côte d’Ivoire, Ghana, Togo, Benin, and Nigeria—is a mosaic of high-energy beaches, mangrove estuaries, and pockets of coastal rainforest. The estuaries in this zone are nurseries for many important coastal fisheries, and the longshore current traveling through the Gulf of Guinea is a highway for migrating marine mammals and turtles. The region is rich in tradition and culture and is home to more than 100 ethnic groups that have managed their marine resources for centuries.

Historical records indicate that loggerheads, hawksbills, green turtles, leatherbacks, and olive ridleys (in order of increasing

abundance) nest throughout this region. Political, economic, and social barriers, however, have prevented long-term research and conservation programs from fully understanding the biogeography and demography of sea turtles. There is little doubt that the region’s turtles face significant threats from poaching, fishery interactions, habitat degradation, and oil exploration. Those hazards underscore the importance of prioritizing baseline population and distribution studies for monitoring the long-term health of sea turtles and their habitats.

Guinea has a nesting population of olive ridleys, hawksbills, and green turtles, and the Kaloe Kurè Project supports community-

based nest protection in the country’s Tristão Archipelago. Similar community-based work takes place in Sierra Leone and Liberia to protect nesting leatherbacks, green turtles, hawksbills, loggerheads, and olive ridleys. Five species of sea turtles have been documented in Sierra Leone, but only green and leatherback turtles routinely nest in the area. The highest density of nesting in Sierra Leone occurs on the Turtle Islands, Sherbro Island, and Turner’s Peninsula. The Reptile and Amphibian Program of Sierra Leone was recently formed to introduce education programs as a tool for reducing the primary threats of mortality in that country: fishery bycatch, sand mining, and poaching for food and ornamental use of the carapaces. Sea Turtle Watch and Save My Future Foundation in Liberia work in local communities to curtail the widespread harvest of sea turtles on beaches and at sea. These groups collect baseline data on the nesting species there, which are leatherbacks, greens, olive ridleys, and

hawksbills. It is estimated that up to 95 percent of the nests may be poached in some coastal areas.

The Sea Turtle Project in Côte d’Ivoire has worked along the country’s entire coastline since 2001 to help community members develop eco-friendly businesses as an alternative to poaching eggs and nesting turtles. The project has documented green turtle, olive ridley, and leatherback nesting, but to date it has not observed hawksbills or loggerheads. The most important nesting beach in Côte d’Ivoire is near the village of Mani, adjacent to the Liberian border. Since 2009, the NGO Conservation des Espèces Marines has been monitoring 30 kilometers (19 miles) of coastline there and supporting community development projects, such as solar power and fresh water wells. Those efforts have substantially improved local livelihoods and strengthened sea turtle conservation efforts.

The Ghana Turtle Research Project (GTRP) began a long-term tagging project in 2006 that has documented green, leatherback, and olive ridley turtles nesting on multiple beaches. Only two loggerhead nests have been confirmed in the past three years, but anecdotal reports indicate that loggerheads may be more frequent visitors to Ghana. Although fishermen and wildlife officers report seeing hawksbills nesting occasionally, the GTRP has not been able to confirm that information. Ghanaian communities practice traditional taboos against harming sea turtles, but the effectiveness of those taboos in modern times is diminishing (see pp. 40–41). Cape Coast University and the University of Ghana are working with GTRP to test modified fishing gear to reduce sea turtle bycatch.

Recent surveys in Togo and Benin indicate that olive ridley and leatherback turtles may be the only two species nesting in those countries; however, fishermen routinely catch green turtles (primarily juveniles and subadults) and hawksbills as well. Market surveys indicate that sea turtle meat and fat are routinely consumed, and may even be imported from other countries. During recent arrests in Togo and Benin, sea turtle shells were seized, along with large quantities of elephant ivory, indicating that sea turtles may be threatened as part of a well-organized wildlife trafficking network.

The Nigerian Institute for Oceanography and Marine Research has documented hawksbill, green, leatherback, and olive ridley turtles nesting along the Nigerian coastline, but the organization has not confirmed loggerhead nesting to date.

Threats to sea turtles abound in nations on the Gulf of Guinea. Rich oil reserves have resulted in significant development that severely threatens coastal habitat (see pp. 8–9). High fish productivity has resulted in increased commercial and artisanal fishing pressures, and local fishers, in particular, use small-mesh nets that are likely increasing turtle mortality. Recent increases in palm oil and petroleum exports have also led to the creation of ports, which often displace turtle nesting beaches. Fortunately, the number of conservation NGOs working in the region continues to increase as well, and those organizations are demonstrating significant success in reducing poaching and harvesting of nesting females. Noteworthy progress is also being made to reduce sea turtle bycatch through the use of alternative fishing gear and methods. Nigeria is also one of only two countries—along with Gabon—that have formally adopted the use of turtle excluder devices in their shrimp-trawling fleets.



A female leatherback turtle nests in front of Enokyi Village in western Ghana, an area monitored by the Bahari Karuna Project, www.wildseas.org. © KOSTAS PAPAITSOROS

CENTRAL WEST AFRICA Cameroon to Angola

The Central African countries are Cameroon, Equatorial Guinea (including Bioko Island), Gabon, São Tomé and Príncipe, the Republic of the Congo, the Democratic Republic of the Congo, and Angola. All five eastern Atlantic turtle species are known to nest in this part of the continent, although loggerheads are rare, having been reported only anecdotally on beaches in the Republic of the Congo. Leatherbacks and olive ridleys are common nesters from September to March, followed in abundance by green turtles and hawksbills.

This region is also home to some remarkable and globally significant sea turtle phenomena, including the largest leatherback rookery in the world, centered in Gabon and ranging south into the northern part of the Republic of the Congo. From September to April, more than 125,000 leatherback clutches are laid on these beaches, representing an estimated 20,500 breeding females per year and 41,000 breeding females overall. The island of Bioko (Equatorial Guinea) boasts the second-highest number of nesting leatherbacks in western Africa, as well as the second highest number of nesting green turtles in the eastern Atlantic (behind Poilão in Guinea-Bissau; see earlier in this article).

The tiny island nation of São Tomé and Príncipe also harbors important sea turtle nesting and feeding sites and is home to what is believed to be the last significant hawksbill rookery in the eastern Atlantic. Hawksbills nesting at Príncipe Island possess a unique genetic haplotype that has been reported in foraging populations in the western and eastern Atlantic but at no other nesting site in the world. This genetically distinct hawksbill subpopulation is at extremely high risk of extinction because the number of females is believed to be fewer than 50. Hence, preserving the subpopulation is among the top 11 sea turtle conservation priorities worldwide (see *SWOT Report*, vol. VII, 26).

Olive ridley turtles also nest throughout the region but without the synchronized, large-scale nesting spectacles (called *arribadas*) found in the American Pacific and Orissa, India. Gabon's olive ridley nesting population has recently been reported as the biggest in the Atlantic, with nearly 10,000 clutches per year and possibly more than 8,000 breeding females. Nesting density seems to increase farther south, possibly reaching its peak in Angola.

Central Africa also harbors important feeding grounds for green turtles and hawksbills among the many estuaries, bays, seagrass beds, and rocky substrates found along the coast, along the fringes of the continental shelf, and surrounding the many islands of the EEZ. At the border between Gabon and Equatorial Guinea lies one such feeding area, Corisco Bay. Others include Pointe-Indienne in the Republic of the Congo, the rocky grounds around Kribi and Limbé in Cameroon, adjacent to the mainland of Equatorial Guinea, and other sites in southern São Tomé and Príncipe.

Sea turtles face a wide variety of hazards throughout West-Central Africa, including coastal development and the threats that accompany it, such as light and plastic pollution, deposition of logging timbers, and other beach obstructions. More important, large numbers of turtles fall prey to unsustainable egg take and bycatch of adult turtles by coastal fisheries. In the Republic of the Congo, the NGO *Rénatura* has worked to facilitate the release of many of the thousands of incidentally captured green turtles at Pointe-Indienne,

but artisanal fishing impacts remain a significant threat throughout the region. Industrial fisheries are also evolving rapidly in the Gulf of Guinea, including longlines and trawlers, and growth is likely to increase. Since 2012, the government of Gabon has implemented a program of onboard observers who record catch and bycatch data, and treat and release captured sea turtles on pelagic industrial vessels. Despite these ameliorating measures, growing evidence suggests that industrial fisheries in the Gulf of Guinea are severely depleting marine resources, including sea turtles.

Illegal take of nesting female turtles and their eggs also remains a significant threat, despite many new laws protecting sea turtles, such as those enacted in Republic of the Congo and Gabon in 2011 and in São Tomé and Príncipe in 2014. In addition, the creation of a national park system in Gabon in 2002 placed approximately 58 percent of the coastline under protection. The Gabon Sea Turtle Partnership (a network of national and international organizations protecting sea turtles in Gabon) estimates that 80 percent of the leatherback and olive ridley nests (the two most common nesting species) now occur within protected areas, where poaching has been virtually eliminated. Notwithstanding some local success stories, however, the enforcement of nature protection laws is insufficient and continues to be a significant challenge throughout western Central Africa.

Attention to sea turtle conservation in Central Africa began in earnest in 1998, with the European Community's ECOFAC program (a program for the conservation and rational use of forest ecosystems in Central Africa, commonly called *Ecosystèmes Forestiers d'Afrique Centrale*). Since then, local NGOs have flourished, including groups such as the Kitabanga Project in Angola; ACODES in the Democratic Republic of the Congo; *Rénatura* and Wildlife Conservation Society in the Republic of the Congo; Agence Nationale des Parcs Nationaux, Agence Nationale des Pêches et de l'Aquaculture, *Aventures sans Frontières*, Centre National des Données et des Informations Océanographiques, Fondation Liambissi, Ibonga, Manga, Wildlife Conservation Society, and World Wildlife Fund in Gabon (all of which are coordinated under the umbrella of the Gabon Sea Turtle Partnership); Instituto Nacional de Desarrollo Forestal y Manejo de Areas Protegidas—Tortugas Marinas de Guinea Ecuatorial, Bioko Marine Turtle Program, and Bioko Biodiversity Protection Program in Equatorial Guinea; MARAPA and Associação Tartarugas Marinhas in São Tomé; Príncipe Trust in Príncipe; and Tube Awu, Kudu A Tube, Association Camerounaise de Biologie Marine, and African Marine Mammal Conservation Organization in Cameroon. Many of the aforementioned groups have worked together since 2012 as part of a regional network, *Rastoma*, that is showing great promise as an organizer for sea turtle conservation in Central Africa and beyond.

Positive news for turtles comes with the designation of new Marine Protected Areas (MPAs) in places such as Gabon, where the government aims to protect more than 20 percent of its EEZ and has also committed to sustainable fisheries management. Other MPAs have been proposed at Loango Bay (Republic of the Congo), which would encompass the Pointe-Indienne green turtle feeding ground, and the Manyange na Elombo-Campo Marine National Park (southern Cameroon).

SOUTHERN AFRICA Namibia, South Africa, and Mozambique

The southwestern tip of the African continent is not typically associated with sea turtles, as it is cradled by the cold Benguela Current off its western shores. This area is highly productive and hosts an abundance of marine life and associated human activities, including multiple commercial and artisanal fisheries. Seals, seabirds, sharks, cetaceans, and sea turtles enjoy the abundance of pelagic resources off the Namibian coast, but those creatures also suffer the impact of intense extractive activities.

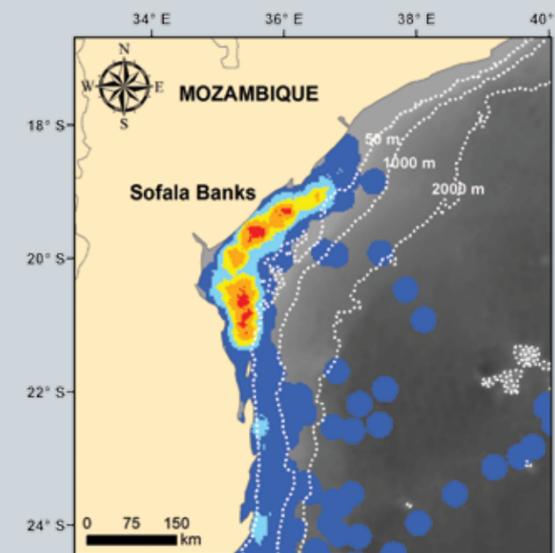
Leatherbacks, in particular, enjoy the rich marine productivity provided by the Benguela Current. Satellite tracking and flipper tag returns indicate that leatherbacks from three RMUs (Gabon, Brazil, and the Southwest Indian Ocean) frequent the waters off Namibia. Researchers have also recorded strandings of sea turtles along Namibia's Skeleton Coast, possibly a result of lethal interactions with fisheries, but no sea turtle nesting is known to take place along the Atlantic coastline of either Namibia or South Africa.

Sea turtle nesting in South Africa occurs only on the Indian Ocean coastline and is restricted to a 200-kilometer (124 mile) stretch of beach in KwaZulu-Natal that borders Mozambique. There, the largest portion of loggerhead and leatherback turtle nesting in the southwest Indian Ocean can be found. South Africa's 53-year-long conservation and monitoring program is one of the longest continuous sea turtle monitoring and protection efforts in the world and is arguably one of the greatest conservation success stories on the African continent. Sea turtle protective legislation was introduced at the turn of the 20th century and has been heavily enforced since the mid-1960s, when active conservation and monitoring started on 60 kilometers (37 miles) of beach. Since then, loggerhead numbers have doubled to about 1,000 nesting females per season, and leatherbacks are stable at approximately 100 females per season. The nesting and inter-nesting habitats and the offshore reefs are well protected in a contiguous marine and terrestrial protected area known as the iSimangaliso Wetland Park, a World Heritage Site. Green turtles and hawksbills also are present and are frequently sighted by SCUBA divers and fishers, but very little is known about them. Genetic samples have been collected and are yet to be analyzed, but most of those individuals probably come from rookeries in the Mozambique Channel.

The Mozambique Channel, bounded by Mozambique and Madagascar, is rich in marine biodiversity and hosts nesting populations of four turtle species—loggerhead, leatherback, green turtle, and hawksbill—with foraging olive ridleys frequenting the east African and west Malagasy seaboard. Along the Mozambique coast, loggerheads and leatherbacks nest in the south, and green turtles and hawksbills nest on the country's central and northern beaches. Sea turtle monitoring programs led by NGOs, local authorities, tour operators, and special interest groups have done an amazing job for more than two decades. Three consistent programs exist in Mozambique, providing monitoring and protection in the south (Ponta de Ouro), south-central (Inhambane), and north (see pp. 44–45), with nine locations being monitored and

LEATHERBACK COASTAL FORAGING COHORT IN MOZAMBIQUE

By NATHAN ROBINSON, STEVE MORREALE, and FRANK PALADINO



High-use habitats for foraging leatherback turtles (shown in red and orange) in the Sofala Banks of Mozambique. This area represents a relatively unique example of leatherback turtles remaining resident in shallow coastal waters year round.

Leatherback turtles conduct some of the longest migrations in the animal kingdom, traveling across entire ocean basins and confounding conservation efforts for this species. A promising discovery has recently been made concerning the leatherback turtles nesting in the iSimangaliso Wetland Park of South Africa. More than half of the females nesting at this globally important rookery seem to *not migrate* to distant foraging areas but rather forage in the coastal waters and the nearby Mozambique Channel a mere (at least in leatherback terms) 500 kilometers (310 miles) away. Moreover, this cohort seems to remain resident year round in shallow waters (less than 50 meters [164 feet] deep) in a relatively small area. As these foraging leatherback turtles share the Sofala Bank with the Mozambican shrimp-trawling fishery—a fishery with known sea turtle bycatch—a unique opportunity presents itself to encourage the creation of a spatially explicit protected area or to use bycatch mitigation tools, such as turtle excluder devices. The Mozambique Channel is a unique marine hotspot, because of not only the rare presence of a resident coastal aggregation of leatherback turtles, but also an array of other noteworthy and endangered marine megafauna, including dugongs, whale sharks, mantas, numerous cetaceans, and even coelacanths!

16 organizations involved. Satellite tracking has highlighted the coastal waters of Mozambique as a critical feeding area for loggerheads and leatherbacks from South Africa and for green turtles from all Indian Ocean nesting sites (especially from the Bazaruto and Quirimbas areas). Those same foraging grounds are also important for hawksbill nesting.

EAST AFRICA AND THE INDIAN OCEAN ISLANDS

Tanzania, Kenya, Somalia, Madagascar, Mauritius, the French Overseas Territories, the Comoros, and the Seychelles

The southwest Indian Ocean principally hosts four species of nesting sea turtles: hawksbills in the tropical north, leatherbacks and loggerheads in the south, and green turtles throughout. A fifth species, the olive ridley, is known only as a sporadic nester, although it is a frequent forager in the region. Green turtles, hawksbills, and olive ridleys nest on the mainland and on the island coasts of Kenya, Tanzania, and Somalia, although the turtles of Somalia have been poorly studied because of the country's longstanding political turmoil.

Five sea turtles are found in Kenya: greens, olive ridleys, and hawksbills nest and forage there, and leatherbacks and loggerheads forage only. The Lamu Seascape hosts one of the largest breeding colonies for Kenyan greens, accounting for more than half of the turtle nests reported for the entire Kenyan coast. Lamu is a rich biotope that faces a multitude of threats stemming from increasing human populations, including wildlife and resource exploitation, to infrastructure development (harbors and ports) and climate change. Around Watamu, on the central Kenyan coast, Local Ocean Conservation (LOC) monitors nesting beaches and ensures the safety of nests laid there. LOC also runs a turtle rehabilitation center, leads a successful bycatch release program that has conducted more than 15,000 rescues, and does education and outreach work in local communities. On Kenya's south coast, LOC also runs the Diani Turtle Watch program, led by a team of volunteers who are trained to monitor, relocate, and excavate nests. As in Lamu, nesting beaches in Watamu, Malindi, and Diani are under threat from development, and turtles coming up to nest are at risk from poachers.

In Madagascar, loggerhead and leatherback turtles nest in the south in unknown numbers that seem to be significantly lower than the numbers found along the facing coasts of Mozambique and South Africa. In north and west Madagascar, nesting hawksbills and green turtles occur, especially on the small islets, such as Nosy Iranja.

In the Mascarene Islands, marine turtle nesting is rare today in Mauritius and the French territory of La Réunion, although old texts testify to a glorious and abundant past for sea turtles there, primarily green turtles and hawksbills. St. Brandon, an isolated group of small islands near Mauritius, may still host some important nesting activity, and nesting hawksbills have recently been reported on Rodrigues as well, although both situations require further study. Mascarene waters host important developmental habitats, including inshore areas that are used by hawksbill and green turtles and pelagic habitats occupied by all five species. Subadult loggerheads have been satellite tracked from La Réunion to as far north as Oman, where they

Despite increased attention to turtle conservation in this region, many shared challenges remain. Traditional use of eggs and turtles still takes place, and gillnet, trawl, and longline fisheries affect turtles at sea. The greatest emerging concern along the east African seaboard is the rapid expansion of hydrocarbon extraction in places such as northern Mozambique. The real impact of such activities remains to be seen.

probably originated, suggesting a developmental cycle for those animals that encompasses the complete ocean basin.

The Seychelles hosts the most important nesting populations of hawksbill turtles in the region and one of the largest national populations in the world. In 1994, after implementing a compensation and reinstallation program for artisans in response to overexploitation of the species, the Seychelles passed highly effective legislation that banned trade in hawksbill shells. Hawksbills reach their greatest abundance in the Inner Islands and the Amirantes groups of the Seychelles, and they occur in much smaller numbers in the remote southern islands. In contrast, only small numbers of green turtles nest in the Inner Islands and Amirantes, but the species is abundant in the southern islands, especially in the Aldabra group (Aldabra, Assumption, Cosmoledo, and Astove).

France (Épaves Islands—Europa, Juan de Nova, Glorieuses, Tromelin—and Mayotte) and the Comoros (Mohéli) also host very important nesting populations of green turtles, and very small numbers of hawksbill turtles nest there too. Those island groups together make up one of the global hotspots for nesting green turtles. A continuum of seagrass beds throughout the region constitutes one of the world's principal foraging areas for juvenile and adult green turtles.

Southwest Indian Ocean turtles are victims of many small- and large-scale threats. The marine habitats and low-lying island nesting beaches throughout the region may be severely affected by climate change and sea-level rise in the decades to come. Despite that sea turtle meat is occasionally toxic and has led to numerous cases of human mortality in small villages, capture of turtles for food is still a major threat in the region, as it is throughout Africa; satellite tracking indicates that the practice is specifically occurring in East Africa and Madagascar. In north Madagascar, near the Radama Islands, massive poaching events targeting green turtles have been reported in recent years as well, and an organized market selling turtle products to Asia is suspected.

As elsewhere in Africa, local NGOs and communities are taking a lead in conservation and research, including Sea Sense in Tanzania and the World Wildlife Fund and Local Ocean Trust in Kenya. In Madagascar, the Wildlife Conservation Society recently created two locally managed MPAs that will protect sea turtles and encompass the most important nesting sites identified for green and hawksbill turtles in the country. Blue Ventures also manages MPAs together with local fishing communities in the village of Andavadoaka in western Madagascar, a region culturally associated with high poaching levels. At La Réunion Island, collaboration between longline fisheries and the Kélonia Sea Turtle Care Center rescues some 20 turtles each year. In the Seychelles,

a national network of more than 20 long-term beach-monitoring programs collects scientific data, creates community awareness about conservation of turtles and their habitats, and patrols the beaches to prevent poaching. Efforts are also being made to reduce sea turtle bycatch through the introduction of turtle excluder devices in the Mozambique industrial shrimp fishery in the Sofala Bank, led by Mozambique's National Fisheries Research Institute (IIP) and

WWF-Mozambique as part of the BYCAM project. Purse seine fisheries operating in the western Indian Ocean are making progress in reducing interactions between turtles and fish aggregating devices (FADs) by working to develop ecological FADs under the recommendations of the Indian Ocean Tuna Commission. The Spanish purse seine fleets have implemented measures in the Seychelles to reduce damage caused by FADs that wash ashore in the outer islands.

Conclusion

The past three decades of attention from researchers and conservationists from many sectors have allowed us to place Africa's sea turtles on the global map for the first time ever. What was once a gaping hole in our global understanding of sea turtles is now being slowly but surely filled by hundreds of committed people from dozens of national, regional, and globally interested entities, at scales ranging from individual beach workers up to corporate boardrooms and multinational decisionmakers.

As elsewhere on Earth, Africa's sea turtles are flagship species. Our improved knowledge of their biogeography, natural history, and relationships with humans fuels the growing movement to

protect not only sea turtles, but also the habitats they represent and the hundreds of millions of interdependent life forms therein, including humans. Through the lens of Africa's sea turtles, we begin to see how human impacts—such as unchecked coastal development, climate change, and broad-scale unsustainable fishing—represent threats to human survival as well. Confronting what is known among conservationists and developers as the *African conundrum*—that is, the desperate and immediate need for economic development and poverty alleviation versus the long-term need and moral responsibility to protect biodiversity for the future—is the challenge that lies ahead. ■

SWOT FEATURE MAPS: AFRICA

The following pages (24–29) feature the first comprehensive maps of sea turtle nesting biogeography and satellite telemetry in Africa and the Western Indian Ocean. They were produced in collaboration with dozens of individuals and organizations and with special assistance from Jérôme Bourjea, Mayeul Dalleau, Alexandre Girard, Marc Girondot, Shaya Honarvar, and Jeanne Mortimer.

Nesting Biogeography

The maps of sea turtle nesting biogeography (see pp. 24–25 and 26–27) feature nesting data from 253 locations along the Atlantic and Indian coasts of Africa and from the islands of the western Indian Ocean, as far east as the Seychelles. We have also mapped protected areas (which appear in pink) to highlight the protection afforded to many key sea turtle nesting sites, as well as to draw attention to current gaps in protection. The nesting data used to create the maps were provided voluntarily to SWOT or were sourced from literature. The data come from almost 80 sources. Each data point is numbered to correspond with a record that includes detailed metadata and source information (see pp. 48–52).

In creating the maps, we used the most recent available data from each nesting site; if the available data were more than 10 years old or the nesting count for the record was unquantified, we labeled the site as “unquantified,” represented as a black square (see map legend). Data from all species present at a nesting site were combined to determine the size of a representative pie chart at each site; each chart is color coded to indicate the proportion of each species nesting at that site. If a species composed less than 5 percent of the total nesting abundance at a multispecies nesting site, it was not shown in the chart but is included in the citations (see pp. 48–52). In some cases, data from multiple nesting sites were combined (at the discretion of the data providers) to make the nesting numbers easier to interpret on the maps.

The nesting maps display all data as annual numbers of clutches. When a different count type was provided by the data source (for example, crawls), we converted those counts to clutches using regionally appropriate conversion factors. Conversion factors were derived from nearby nesting sites of the same species that reported nesting activity in multiple types of counts. It is important to note that the number of clutches is not the same as the number of nesting female turtles.

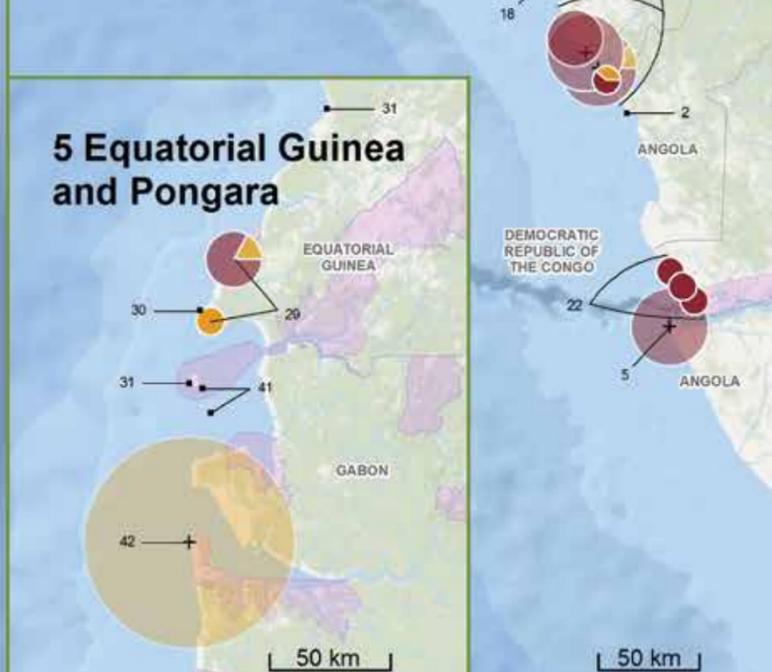
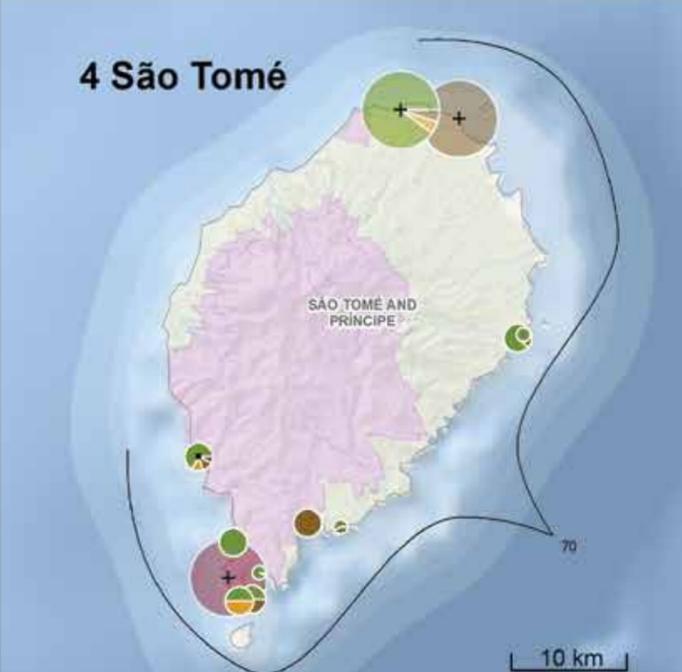
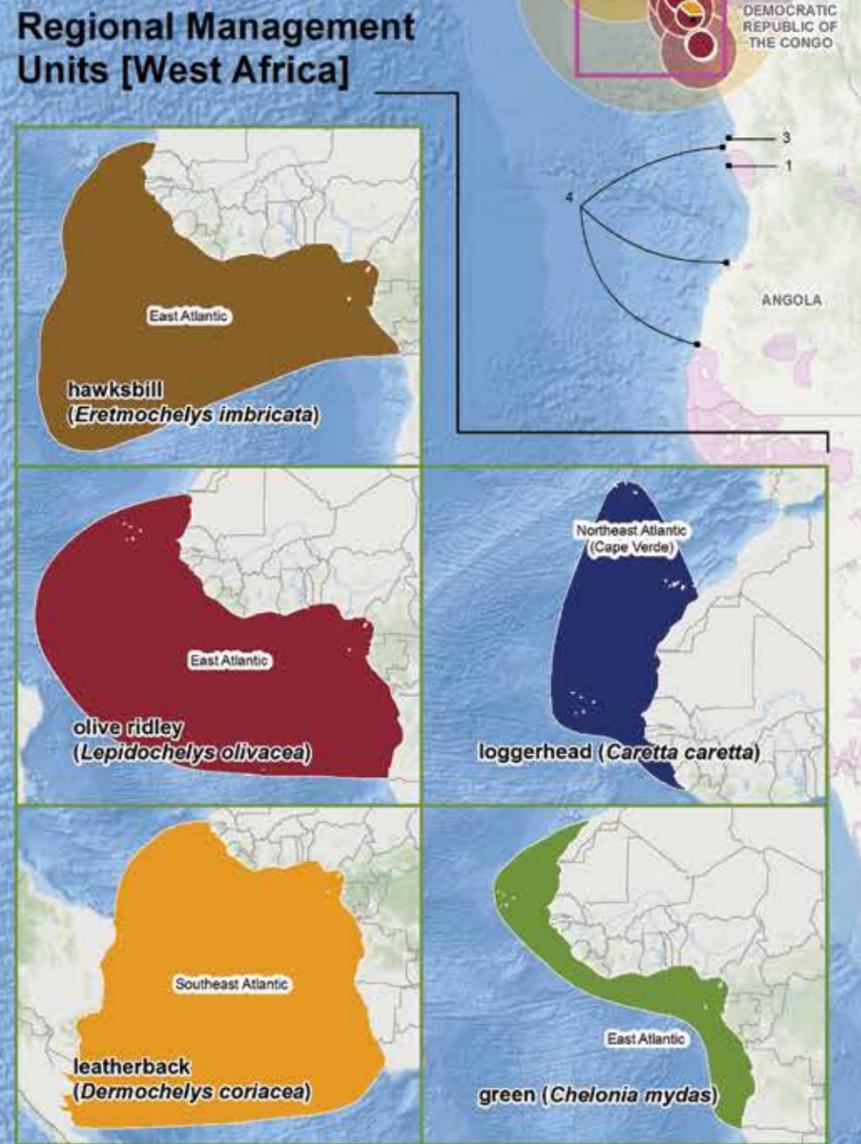
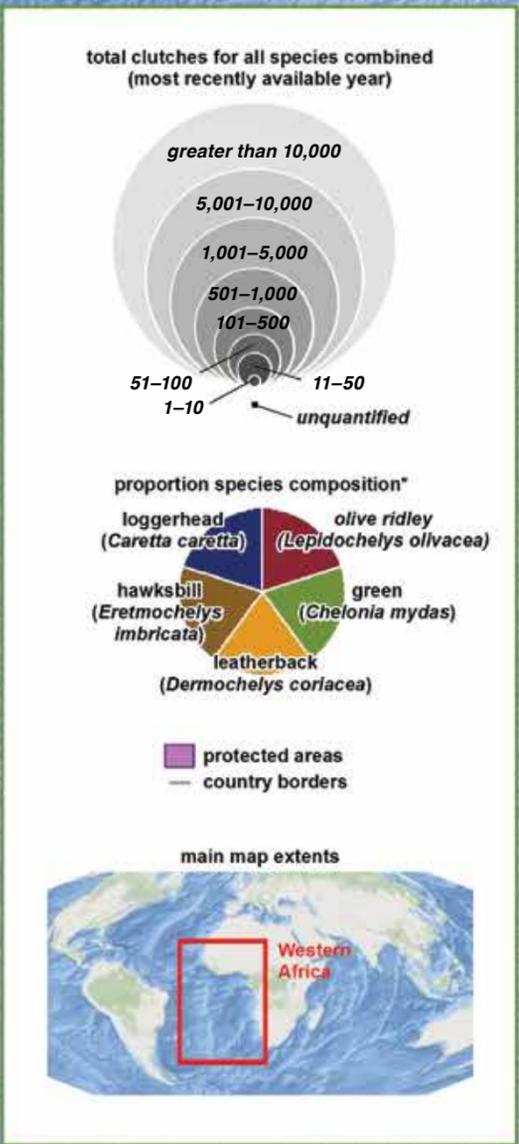
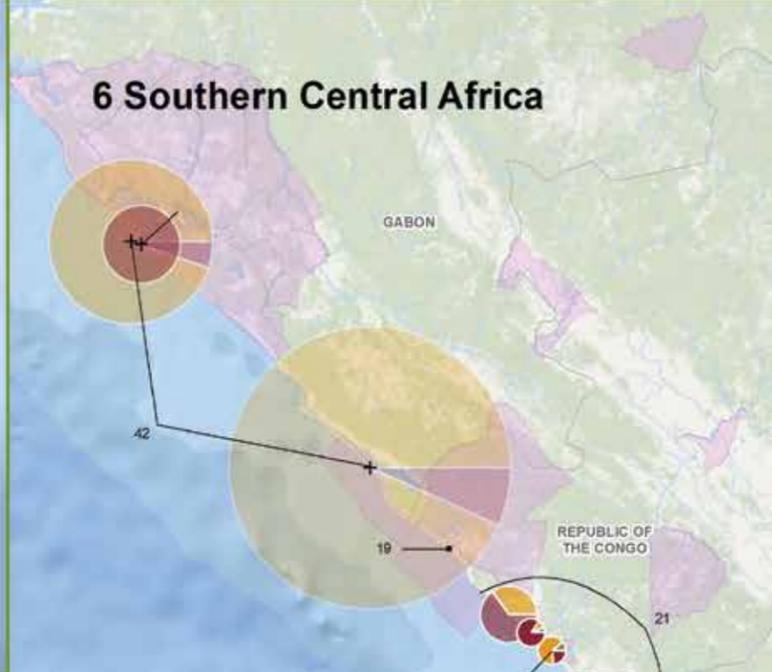
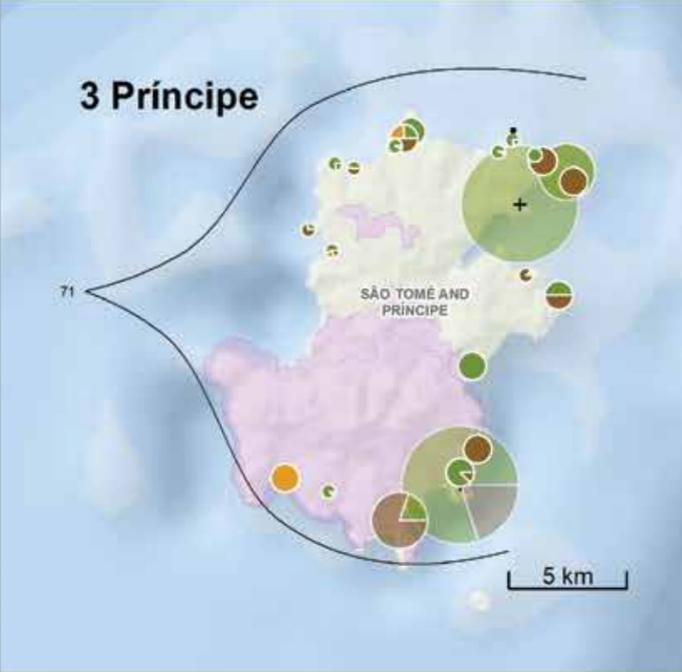
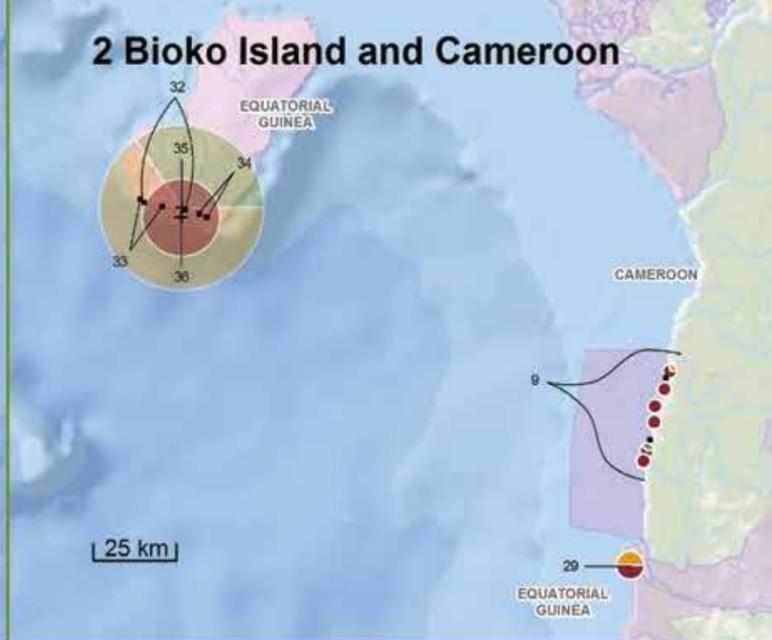
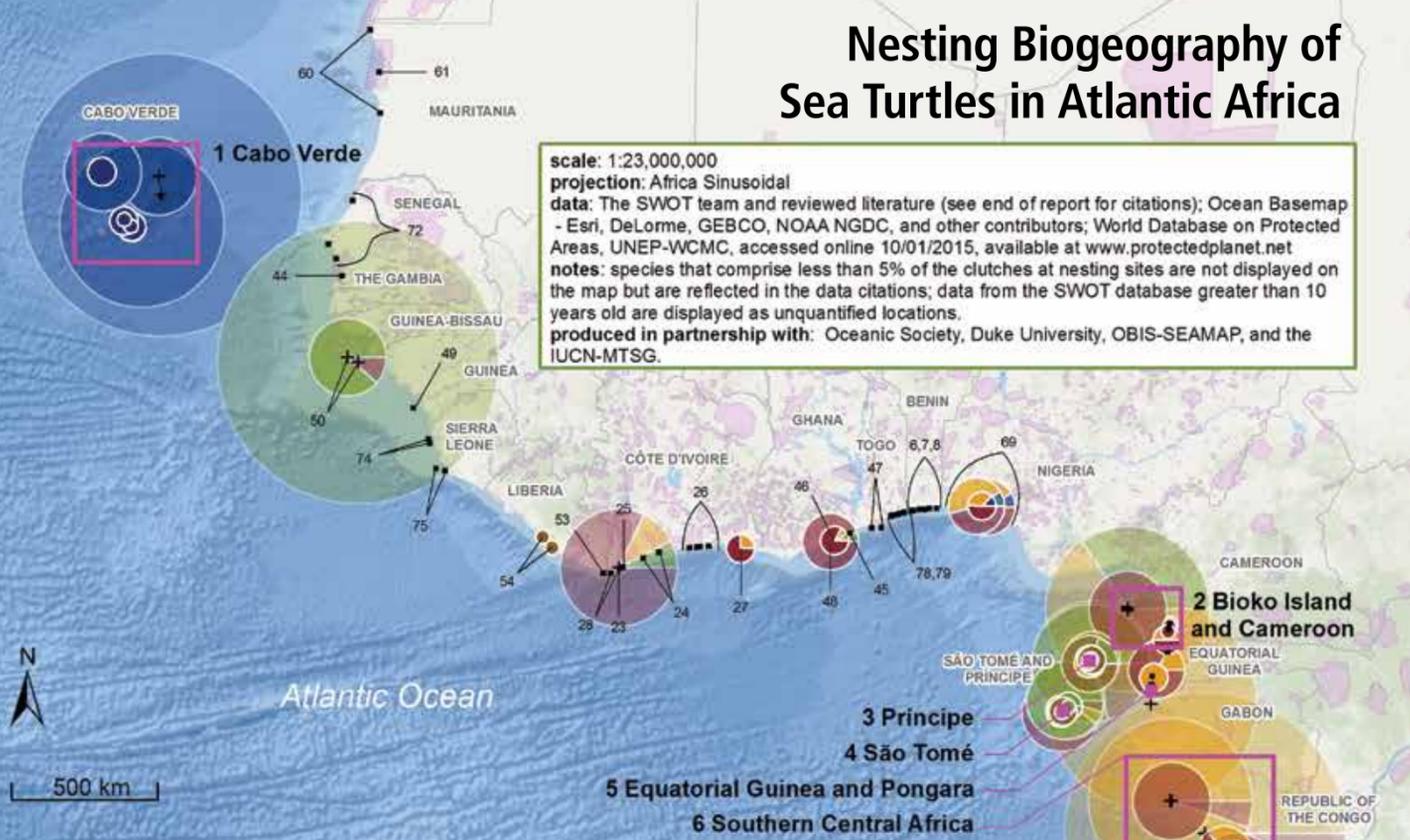
Satellite Telemetry

The map of sea turtle satellite telemetry on pages 26–27 presents combined data from 294 satellite-tracked sea turtles representing five species (loggerhead, green, leatherback, hawksbill, and olive ridley), as well as data for each species individually. These data are overlaid with information on regional management units (inset maps, p. 27). Known nesting sites (but not abundances) are also mapped as black squares. In the map, we included only tracks from tags deployed in Africa and the Western Indian Ocean, thereby excluding some turtles that have been tracked from outside of Africa into African waters. Data were provided voluntarily to SWOT by more than 27 partners; details of each project can be found in the data citations on pages 51–52. For more information on the mapping methodology, see the map's legend.

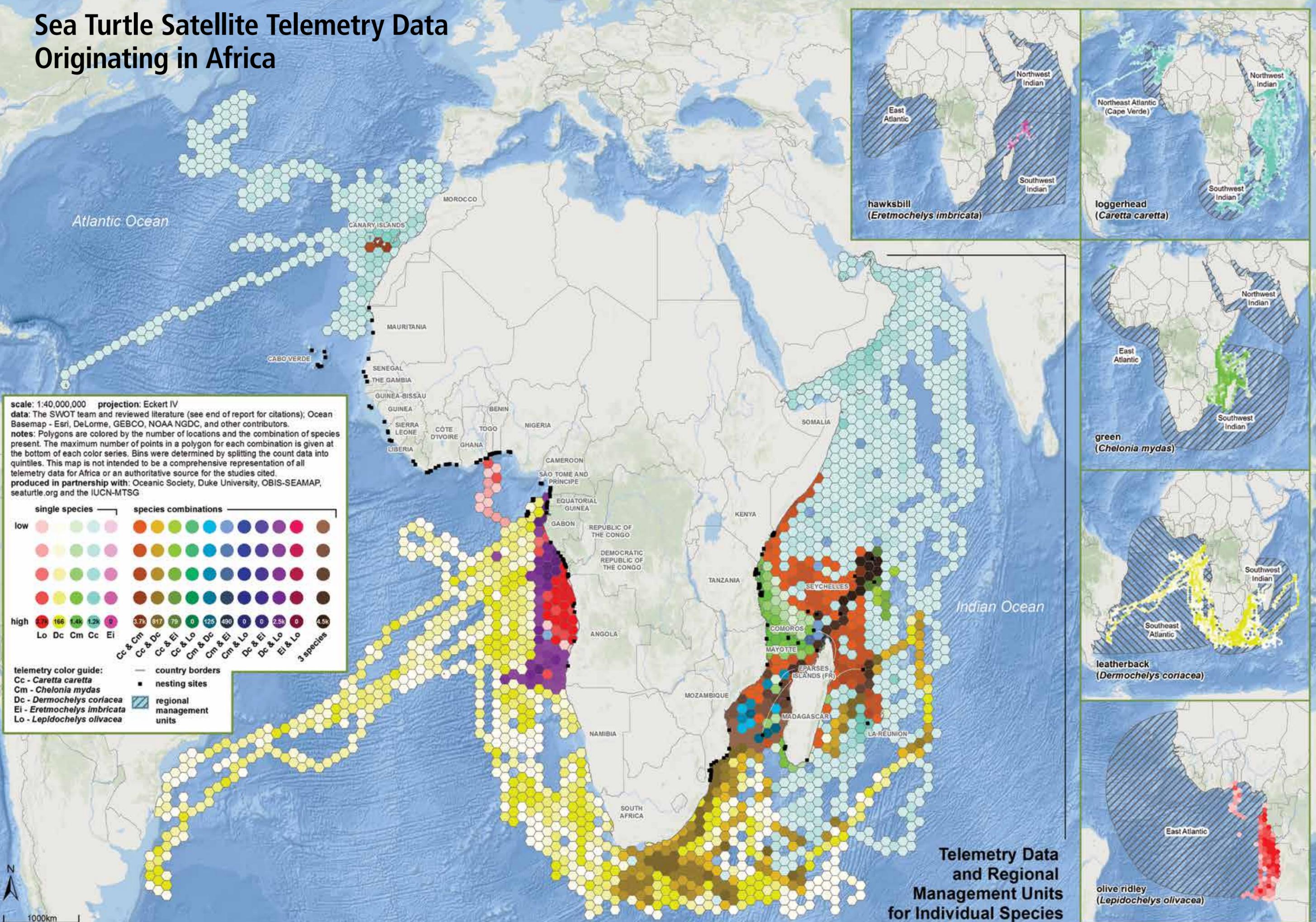
Most of the contributed nesting and satellite telemetry data, as well as the entire SWOT global database, can be found online at <http://seamap.env.duke.edu/swot>.

Nesting Biogeography of Sea Turtles in Atlantic Africa

scale: 1:23,000,000
 projection: Africa Sinusoidal
 data: The SWOT team and reviewed literature (see end of report for citations); Ocean Basemap - Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors; World Database on Protected Areas, UNEP-WCMC, accessed online 10/01/2015, available at www.protectedplanet.net
 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 displayed as unquantified locations.
 produced in partnership with: Oceanic Society, Duke University, OBIS-SEAMAP, and the IUCN-MTSG.



Sea Turtle Satellite Telemetry Data Originating in Africa

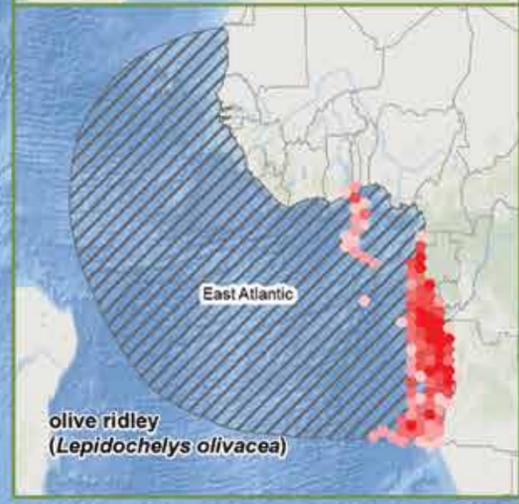
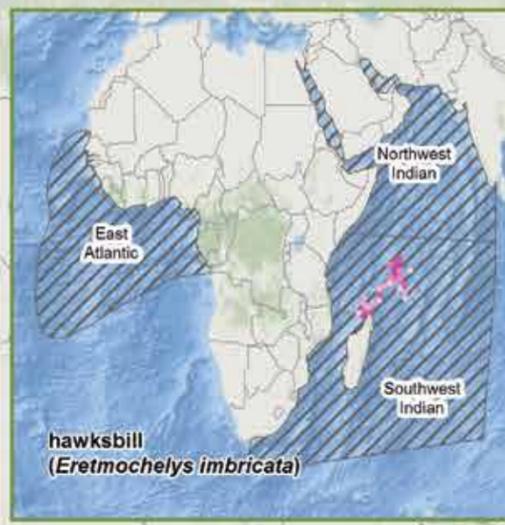


scale: 1:40,000,000 projection: Eckert IV
 data: The SWOT team and reviewed literature (see end of report for citations); Ocean Basemap - Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors.
 notes: Polygons are colored by the number of locations and the combination of species present. The maximum 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 Africa or an authoritative source for the studies cited.
 produced in partnership with: Oceanic Society, Duke University, OBIS-SEAMAP, seaturtle.org and the IUCN-MTSG

single species	species combinations
low	
high	
Lo Dc Cm Cc Ei	Cc & Cm Cc & Dc Cc & Ei Cm & Lo Cm & Dc Cm & Ei Dc & Lo Dc & Ei Ei & Lo 3 species

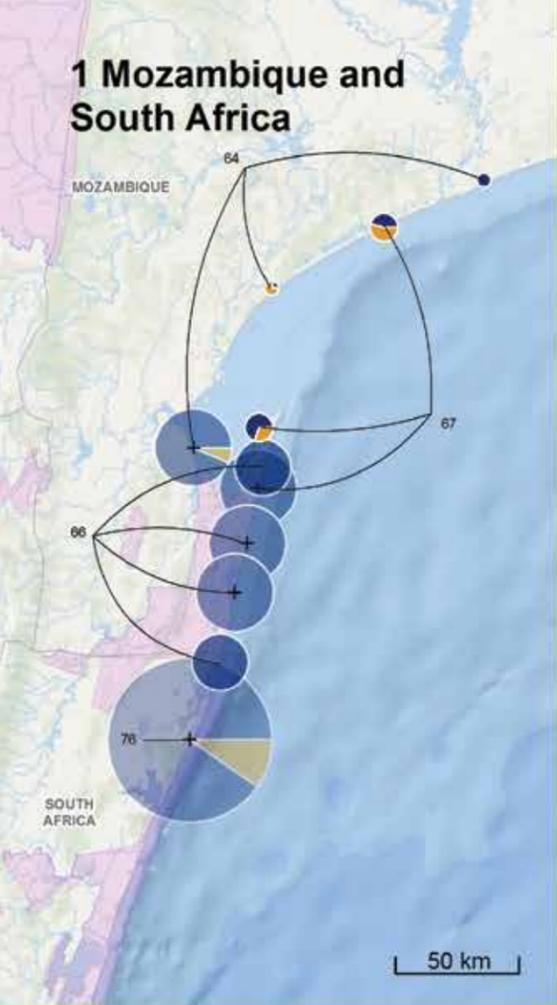
telemetry color guide:
 Cc - *Caretta caretta*
 Cm - *Chelonia mydas*
 Dc - *Dermochelys coriacea*
 Ei - *Eretmochelys imbricata*
 Lo - *Lepidochelys olivacea*

— country borders
 ■ nesting sites
 ▨ regional management units

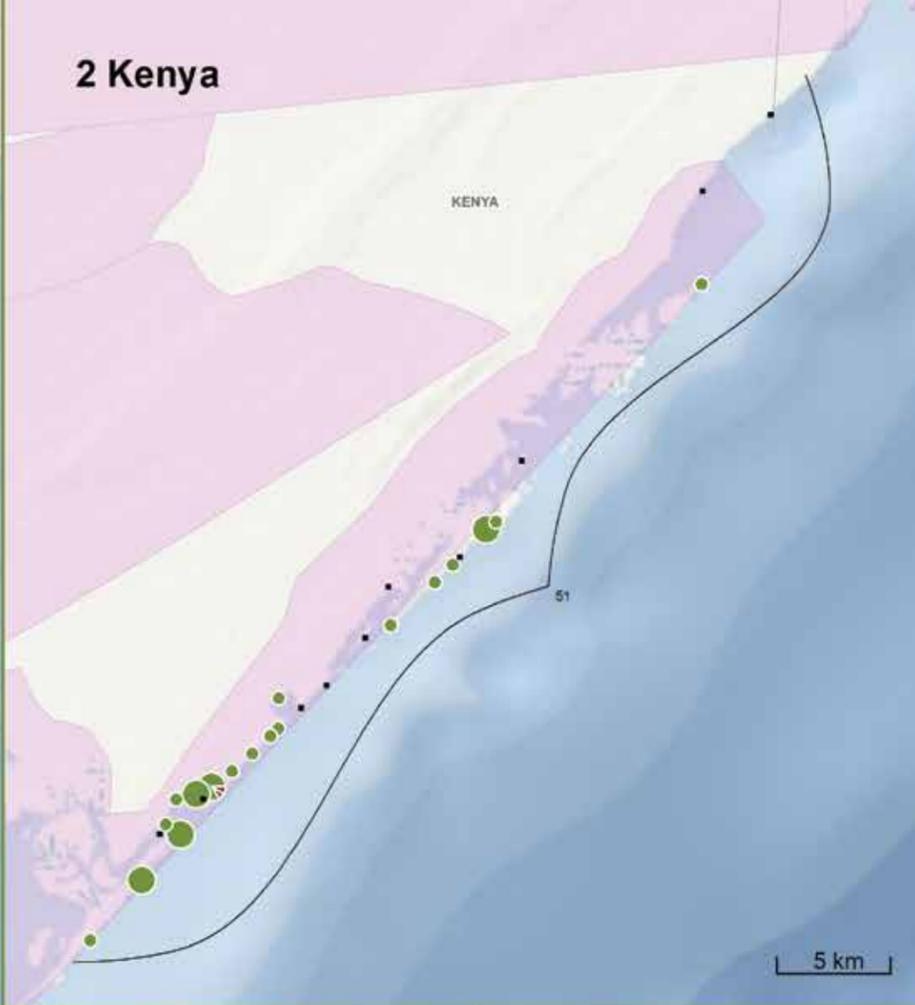


Telemetry Data and Regional Management Units for Individual Species

1 Mozambique and South Africa

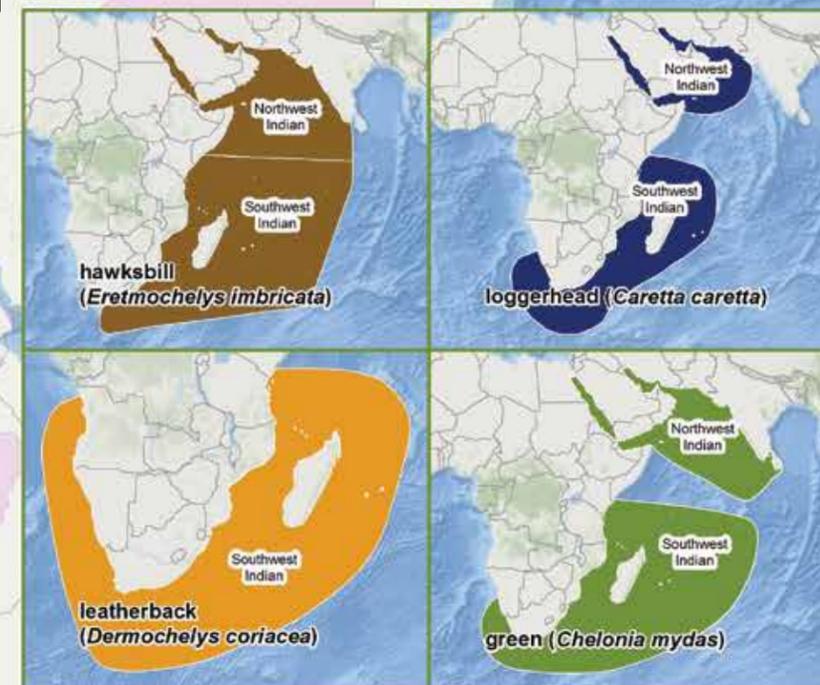


2 Kenya

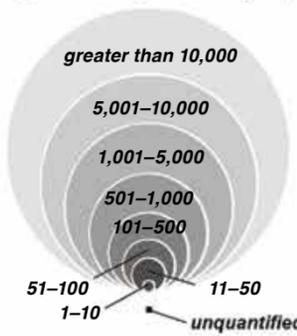


Nesting Biogeography of Sea Turtles in the Southwest Indian Ocean

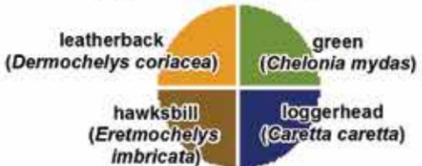
Regional Management Units [East Africa]



total clutches for all species combined (most recently available year)



proportion species composition*

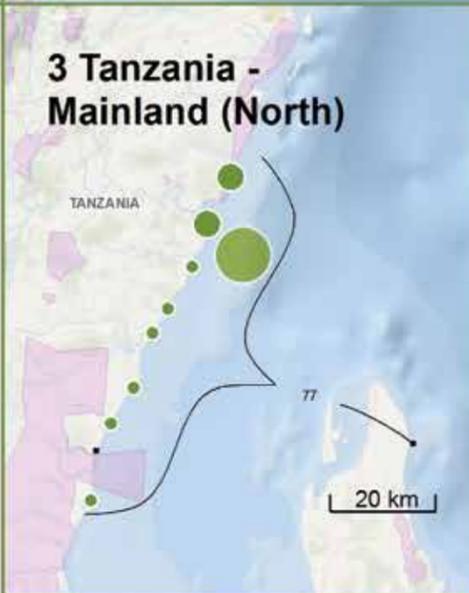


protected areas
country borders

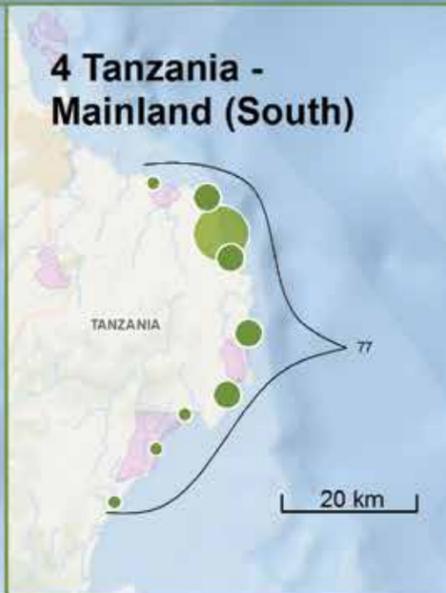
main map extents



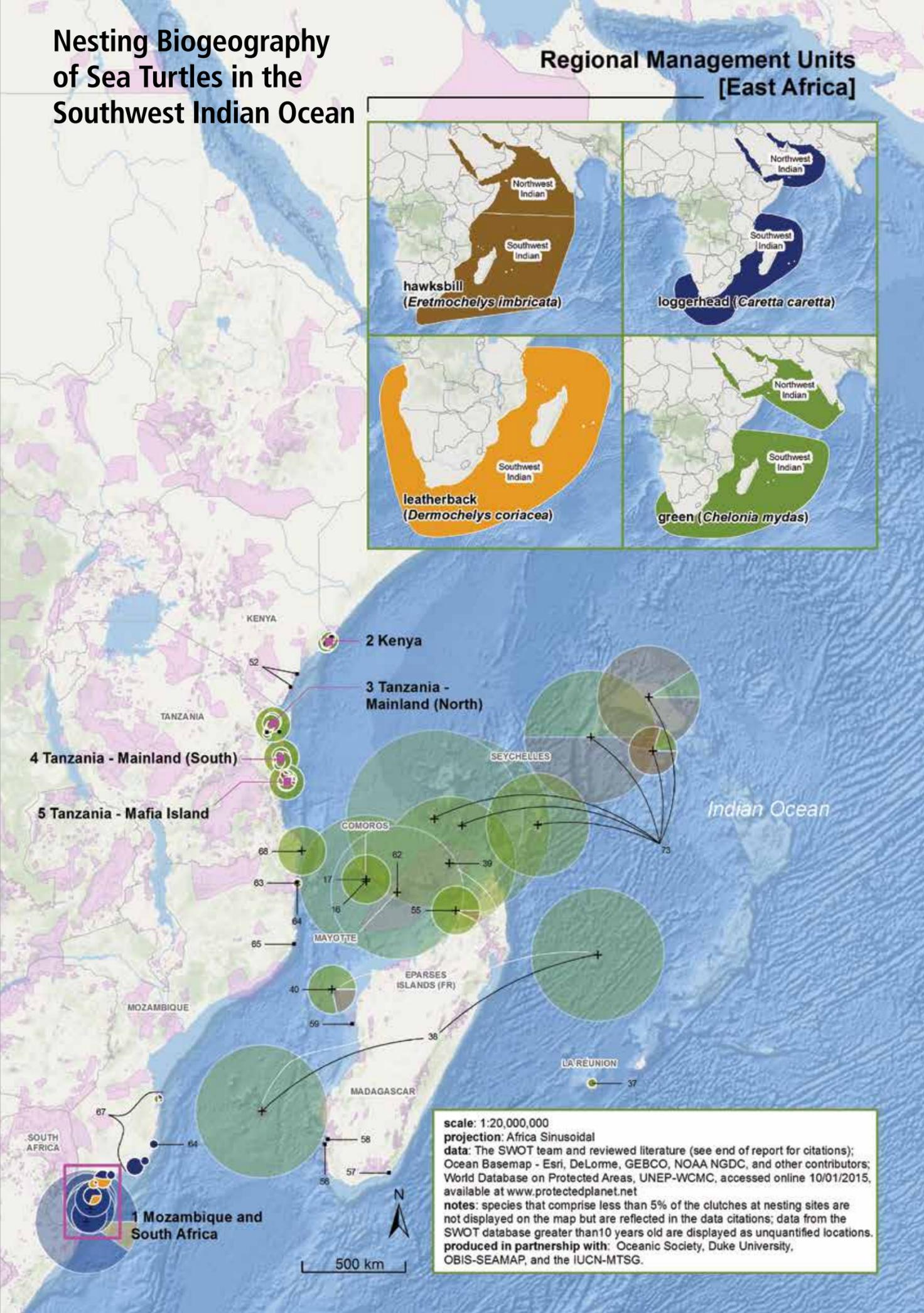
3 Tanzania - Mainland (North)



4 Tanzania - Mainland (South)



5 Tanzania - Mafia Island



scale: 1:20,000,000
 projection: Africa Sinusoidal
 data: The SWOT team and reviewed literature (see end of report for citations); Ocean Basemap - Esri, DeLorme, GEBCO, NOAA NGDC, and other contributors; World Database on Protected Areas, UNEP-WCMC, accessed online 10/01/2015, available at www.protectedplanet.net
 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 displayed as unquantified locations.
 produced in partnership with: Oceanic Society, Duke University, OBIS-SEAMAP, and the IUCN-MTSG.