

SWOT

report

Volume IX

The State of the World's Sea Turtles

are we **SUCCESSING?**

How Trends in Turtle Conservation
Are Shaping the Future



A leatherback dines on a pyrosome in calm water off the island of Pico in the Azores. © BRIAN SKERRY
FRONT COVER: Green turtles aggregate on the flats surrounding Raine Island, Australia, home to the largest nesting population of the species on Earth. © GARY BELL / OCEANWIDEIMAGES.COM





Editor's Note

On Measuring Success and the Search for Useful Trends

Ten years ago, SWOT, the State of the World's Sea Turtles Program, was launched in an attempt to point our movement toward its highest priority actions and, more important, to measure whether we were getting the job done. Were we succeeding at sea turtle conservation? We wanted better answers to some of the most basic questions about sea turtles: How many are there? Where are they? Are their numbers changing? Why? What are the most significant threats and the best ways to confront them?

Great work had been done since the 1950s at local and regional scales, but to definitively answer our questions about priorities and trends, we needed to look at the *global* scale using the best available tools of the day—geographic information systems, worldwide connectivity, and relational databases. A passionate international SWOT team network began to grow and to donate its hard-earned data to this common purpose. Together, we produced the first comprehensive, up-to-date global nesting maps for all sea turtles (see *SWOT Report, Vols. I–VI*). We have since developed guidelines (Minimum Data Standards for Nesting Beach Monitoring) to ensure that our data collection efforts are both efficient and fruitful, and we have expanded well beyond nesting beaches to compile genetic information and, more recently, satellite telemetry data. The SWOT database has been used to advance sea turtle research and conservation in many ways, from connecting researchers across borders or ocean basins, to defining subpopulations (regional management units), to predicting the impacts of climate change on nesting distribution.

Yet the question remains: Are we getting the job done? Or, as Wallace J. Nichols asks in our Special Feature (pp. 6–9), Are we winning? A decade of effort has taught the SWOT community that success in conservation is an elusive goal. It is not easily measured by simple metrics and is simultaneously undermined by lumbering threats like climate change and ocean acidification and by surprise affronts such as the Gulf of Mexico oil spill and the 2008 financial crisis. Furthermore, seeing trends in the nearly geological time scale of sea turtle evolution requires patience.

That said, progress is being made both in measuring our movement's success and in defining and understanding the trends that can influence it. This volume of *SWOT Report* is devoted to exploring some of those trends. We hope that the articles herein offer you food for thought about what to keep an eye on and where to head next as we seek to conserve the world's sea turtles and their ocean home.

Thanks for being part of the SWOT team as it winds down its inaugural decade and powers into the next.



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meet the turtles

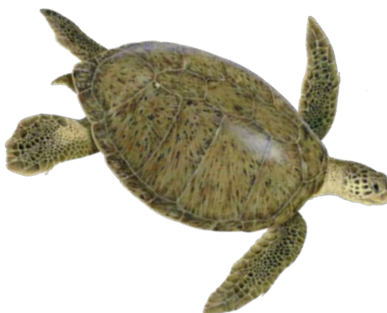
The seven sea turtle species that grace our oceans belong to a unique evolutionary lineage that dates back at least 110 million years. Sea turtles fall into two main subgroups: the unique family *Dermochelyidae*, which consists of a single species, the leatherback; and the family *Cheloniidae*, which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



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



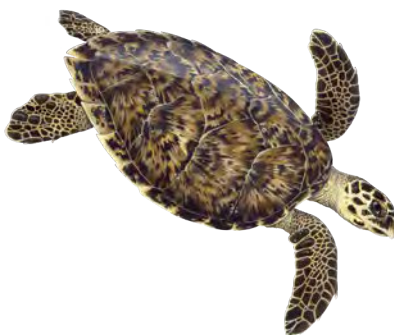
Kemp's ridley (*Lepidochelys kempii*)
IUCN Red List status: Critically Endangered



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



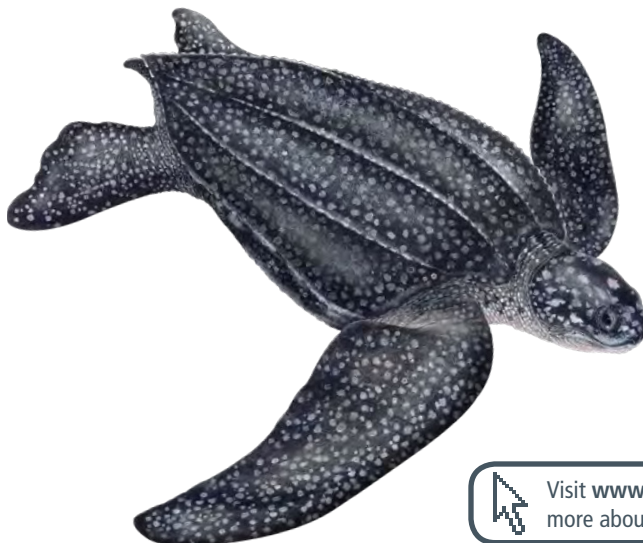
Loggerhead (*Caretta caretta*)
IUCN Red List status: Endangered



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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SPECIAL FEATURE



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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. © DAVID FLEETHAM ILLUSTRATIONS, AT LEFT: © DAWN WITHERINGTON

special feature

Are We in Tu



Winning Turtle Conservation?

By WALLACE J. NICHOLS



“Winning isn’t everything. It’s the only thing.”

— Vince Lombardi, considered by many to be one of the best and most successful coaches in American football history

I am not a very competitive person when it comes to sports. Neither are my daughters, which suggests the possibility of a genetic basis for such things. We prefer the personal enjoyment of athletic activities without the confines of “winners,” “losers,” speed records, or scoreboards. As spectators, we like a good game as much as we care about our team winning. That is not to say we do not strive to improve our skills and endeavor toward self-improvement. But process usually trumps outcome. We relish mistakes and learning for the sake of improving.

My philosophy is different when it comes to my chosen work—protecting oceans and restoring sea turtles: I like to win, and I know you do too. In the conservation game, losing means extinction. And although the phrase has become cliché, extinction *is* forever. Losing sea turtles is just not an option. We have devoted our lives to winning this game.

Some of our colleagues have been at this for over half a century. I have more than 20 years of work for sea turtles under my belt. Some among us are just getting started. What seems clear is that when you commit to fighting for sea turtles, you are in it for the long haul. This is a game of slow-motion chess, not downhill skiing or even four quarters of football.

A quick Web search for “sea turtle success stories” produces tens of thousands of results. But the query “Have we won?” has a more elusive response. For those engaging in sea turtle work, right off the mark things often get worse—sometimes much worse—before they get better. My sense is that the most interesting and useful information about winning comes from those low points, when our backs have been against the wall and the odds and the best science are against us. It is a fuzzy topic, winning, but here are five thoughts:

1. **Science and policy are far from enough.** Over and over again, we have seen the science pile up alongside poetically written laws and policies, international agreements, and treaties. Although we need science and policy, alone they certainly are

not enough, especially when resources for enforcement are thin or nonexistent.

2. **Winning is tenacity to the point of fanaticism.** Someone must take the guidelines provided by scientists and policymakers and put them into play. That would be us, the turtle-hugging, fanatical, ocean-loving members of this tribe of *tortugueros*. No one else cares enough to do what we do. Who else would stay up all night in the rain—with millions of mosquitoes—waiting to move some eggs? No one, that’s who.

3. **Winning is not the end, it is a process.** The honest truth—perhaps good news for those who love this game—is that there is no end for the foreseeable future. Even if you could define the ultimate win, emergent threats like climate change and plastic pollution lie just beyond those threats we are addressing now—bycatch and beach development.

4. **Winning is a state of mind.** There are plenty of signs that things are getting better. First, the sheer numbers of people of all kinds, grassroots organizations, and research institutions working for sea turtles globally are staggering. Second, over the past 20 years sea turtles have become much more popular, even cool. That really was not the case a few decades ago. Third, as you will read throughout this issue, at many locations around the globe the number of sea turtles is way up, and people are now dealing with



new questions related to legal use of turtle products and negative impacts of “too many turtles” (be still my heart). Neuroscience suggests that staying in a positive state of mind is a very useful, powerful tool.

5. **Winning is a feeling.** You have been there in the trenches, in the chaotic mix, and felt that what you were doing was right, good, and working. You could never quite put your finger on it, but your years of experience and study told you to “keep pushing right there.” So you did, and things continued to get better. That was your brain working together with other brains the way it has evolved to do so elegantly.

Sea turtle conservation is not a game, a campaign, or a battle. Sadly there are no starting guns, time clocks, or final whistles and no finish line, goalpost, or winner’s circle. Having more live turtles is better than having fewer, we know, but what metrics truly define success? Across a playing field or a chessboard, those questions are well defined. Across the globe’s coasts and oceans, they are less so.

Kemp’s ridley hatchlings make their way to the sea in Tecolutla, Veracruz, Mexico.
© VIDA MILENARIA

PREVIOUS PAGE: Green turtles bask on the Big Island of Hawaii. The Hawaiian green turtle population has grown so much in recent years that the population is under review for delisting from the Endangered Species List. © JEFF MONDRAGON / SEAPICS.COM

One thing I know with certainty
is that global sea turtle conservation
has the best team: smart,
innovative, tireless, and passionate.

One thing I know with certainty is that global sea turtle conservation has the best team: smart, innovative, tireless, and passionate. What we sometimes lack in funding resources we make up for in tenacity, grit, and camaraderie. Through relentless collaboration and sharing, world-class science, and creative communication, we are indeed driving down the field and keeping sea turtle extinctions at bay.

We are all part of a process that includes times for teamwork, times for fighting, times for loving, and no clear ending. And we have some remarkable stories and some deeply experienced conservationists among us to consult with as we proceed. The answers are elusive and, frankly, well beyond the scope of this essay, but the articles in this *SWOT Report* Special Feature offer a handful of ideas from different perspectives within our discipline—they mark a step toward defining how we know we have won. ■

The Importance of Setting Baselines for Assessing the Direct Take of Turtles





A Vezo turtle hunter adorns the bow of his canoe with turtle blood to honor his catch. © FRANS LANTING AT LEFT: Sea turtles have been traditionally hunted by Vezo tribesmen in southwestern Madagascar for centuries. © GARTH CRIPPS

By FRANCES HUMBER

The traditional turtle fishery in Madagascar is rooted in long-standing customs practiced by the Vezo coastal communities, and it represents thousands of turtles landed in southwest Madagascar since legislation was passed in the late 1980s. I have been studying the fishery since 2007, and while putting together the first estimates on the scale of the problem, I realized I could not really answer the following questions: Is this a lot of turtles by today's standards? How many turtles currently are taken directly? How many used to be taken?

Baseline data on direct takes of turtles are vital for conservationists to measure their projects' successes or failures and to help us avoid, or at least be aware of, *shifting* baselines, in which our perception of what is normal is influenced by what we have witnessed in our lifetimes. In addition, having baseline data enables us to assess the impact of management strategies, conservation programs, or new policies and allows us to say with confidence: this is working, we are winning.

As part of my doctorate degree program, I recently published an estimate of the current direct take of sea turtles from worldwide legal fisheries, a first attempt to comprehensively establish a baseline for such data. My coauthors and I estimated that current legal direct take stood at around 42,000 turtles per year, of which 80 percent were green turtles. Most of this number is spread around numerous small fisheries (< 1,000 turtles per year) throughout Caribbean and Pacific islands, with some larger fisheries in Papua New Guinea, Nicaragua, and Australia. We were also able to estimate that the legal take in these same countries had decreased by more than 60 percent in recent years.

This first estimate aims to provide conservationists and researchers with a number to work with and improve on. We know it is not perfect—much of the legal take is not regularly monitored, and data were not always easy to come by—but with this estimate we hope to take the first steps to achieve the following:

- Establish a baseline for present-day legal direct take that can be updated as new data from recent projects become available.
- Provide a way to assess relative threats to turtles, in particular direct take versus bycatch within fisheries.
- Provide the starting point to measure future success in further reducing these threats to turtles.

The relative impacts of bycatch and direct take, both legal and illegal, are of particular interest to me. Because I work with some of the

world's poorest coastal communities in Madagascar, I find it hard to argue that a turtle should not be a source of protein and income, when I am lucky enough in the United Kingdom to have sources of protein that are not in jeopardy. Those sources might even rely on unfair fishing access agreements that plunder African waters and potentially contribute to the decline of the marine resources of the very same people I work with.

Trying to work with communities to promote turtle conservation is particularly challenging, especially where illegal takes are ongoing and legislation is deemed unfair for not taking into account local traditions (and is therefore deliberately ignored).

Therefore, I believe the next challenge is to better understand the recent trends of these illegal turtle fisheries and to focus on where they have decreased, what has worked, and why. Turning an illegal fishery into a legal one does not make the fishery disappear, nor the underlying threats or drivers of that fishery, even if passing legislation seems like a part of the solution.

Through much of my research on turtle take, it was clear how many conservation groups now make coastal communities the center of their sea turtle conservation projects. The article by Jennifer Cruce and John Rulmal Jr. on the Ulithi Marine Turtle Program (pp. 14–15) illustrates perfectly the importance of striking the right balance between protecting turtle populations and involving key local stakeholders. No threat to marine turtles is linked as inextricably to human attitudes, perceptions, and daily needs as direct take.

So I believe we are moving in the right direction, not only with legal direct take declining around the world, but also with the majority of legal direct take now taking into account both traditional fishing rights and the impact on sea turtle populations. I also believe we are winning because we understand now more than ever the importance of working with communities, not against them. They can be the most powerful allies and advocates for sea turtle conservation. ■

How the U.S. Government Defines **RECOVERY OF ENDANGERED SPECIES**

By THERESE A. CONANT and SUSAN L. PULTZ



The United States Endangered Species Act (ESA), although a domestic statute, envisions protecting and conserving species wherever they occur if such species are considered in danger of extinction throughout all or a significant portion of their range (endangered) or are likely to become endangered within the foreseeable future (threatened). If a species occurs in a foreign nation, or crosses multiple jurisdictions, we work collaboratively with those nations through various international instruments. Currently, all sea turtles are listed under the ESA, except the Australian flatback.

An analogy to a species being listed under the ESA is a patient being taken to a hospital emergency room. The patient has become so ill or has been so critically injured that immediate and serious action is necessary to ensure his or her survival. Listing under the ESA has several implications. First and foremost, it is illegal for persons under U.S. jurisdiction to harm, harass, or kill any member of the species, or to harm its habitat, without going through a permitting process that seeks to avoid and minimize impacts. Federal agencies in the United States also must consult with either the National Marine Fisheries Service or the U.S. Fish and Wildlife Service if an action they are planning might affect a listed species. Special rules can be implemented to protect listed species, and a plan must be developed to guide species recovery. This recovery plan might be thought of as the treatment plan for the patient in the hospital.

The ESA defines recovery as “the process by which listed species and their ecosystems are restored and their future is safeguarded to the point that protections under the ESA are no longer needed.” The definition is deliberately vague because each species has unique life history traits and habitat needs and faces different threats. The point at which the species can be taken off the list of endangered or threatened species (that is, delisted) is spelled out in a series of recovery criteria that must address (1) biological or demographic parameters, such as number and arrangement of populations, abundance or trend within each population, or population structure that indicates the population will continue to increase or remain stable; and (2) threats-based parameters that indicate, when reached, that the threats to the species have been controlled or eliminated. Recovery plans then identify actions needed to achieve those criteria.

Ideally, we would like to see species recovered to historical levels and distribution. However, under the ESA, we delist a species when the protections provided by the ESA are no longer necessary, which often occurs before the species recovers to historical abundance. It is incumbent on experts who understand the species’ biological and habitat

needs to define recovery for that species. In general terms, the species will be considered for delisting only when it is self-sustaining, well represented in sufficient numbers and populations, and sufficiently widespread so it maintains its adaptive potential and will not become endangered again.

Although recovery goals address an entire species, recovery occurs in different places at different rates in a mosaic across the species’ range. Where and how quickly accomplishments occur depend on many factors, including the nature of the threats facing the populations, the societal situation in the area, and the conservation efforts. Under the ESA, we have the ability to list species, subspecies, and distinct population segments (DPSs) of vertebrate species. Recently, we have begun to list some sea turtles as multiple DPSs. This listing will allow us to tailor recovery actions and goals more finely for these widespread species.

Monitoring is key to understanding whether and where recovery is being accomplished for both the listed entity (whether species, subspecies, or DPS) and individual populations within it. Monitoring programs follow whether populations and threats are increasing or decreasing and also assess whether management actions are effective at achieving the goals for which they were designed. Effective monitoring measures recovery progress and provides a foundation for further recovery actions.

To date, no sea turtle species listed under the ESA have been determined to be “recovered” and subsequently delisted, and if a species were to be delisted, that would not be the last attention it would receive under the ESA. Just as a patient in a hospital emergency room would have follow-up monitoring and care after being released from the hospital, we are required to monitor a species for at least five years through the implementation of post-delisting monitoring plans. A post-delisting monitoring plan is developed in cooperation with affected states. Its primary goal is to monitor the species to ensure its status does not deteriorate. If either a substantial decline in the species or an increase in threats is detected, measures will be taken to reverse the situation, and relisting the population under an emergency listing is possible. Regardless of whether sea turtles remain listed under the ESA, they will continue to rely on our conservation efforts. ■

AT LEFT: The Kemp’s ridley sea turtle, pictured here, is listed under the U.S. Endangered Species Act and is the subject of a bi-national recovery plan prepared jointly between the U.S. and Mexico. © DOUG PERRINE / SEAPICS.COM



CONTINUITY IN A COMMUNITY SETTING

The Ulithi Marine Turtle Program

By JENNIFER CRUCE and JOHN RULMAL JR.

The Ulithi Marine Turtle Program is a community conservation project based in Ulithi Atoll, located 115 miles northeast of Yap, Federated States of Micronesia (FSM), and spanning an ocean area nearly 18 miles long and 9 miles wide. Green and hawksbill turtles forage and nest throughout FSM, and as elsewhere in the world they are highly vulnerable to fisheries, marine debris, and disease. Turtles are also an important part of the local culture, revered by the Ulithian people and carefully managed to this day by tribal law and age-old tradition.

Recognizing the mounting threats to turtles everywhere and their cultural importance locally, the program began community-based research there in 2005, aiming to learn more about the green turtle nesting population on Ulithi's uninhabited islands and to promote sea turtle conservation and management. In the ensuing decade, many lessons have been learned about what constitutes success in managing projects and monitoring turtles in an extremely remote, local community setting.

Sea turtles live a long time and reproduce late in life; therefore, to study a population effectively and to ultimately define trends requires

many years of consistent monitoring. With this in mind, the Ulithi Marine Turtle Program has set goals aimed at achieving success through long-term continuity. Keeping a project staffed, funded, and robust over the time it takes to produce significant results continues to be one of the greatest challenges, and the project's existence today is a strong testament to its success in this regard.

Since 2005, the Ulithi Marine Turtle Program has worked with the local community of Falalop to tag and monitor nearly 3,000 green turtles nesting on the remote and uninhabited islands of Gielop and Loosiep. In addition, 12 female green turtles were fitted with satellite transmitters and successfully tracked to their foraging grounds in the Philippines, Malaysia, and Japan. Data generated by the project have been published and used by SWOT, the National Oceanic and Atmospheric Administration (NOAA), and other institutions to broaden understanding of local and global trends in turtle abundance.

Ensuring success in the eyes of the local community has perhaps been more challenging. In Ulithi, and in most remote island communities, sea turtles are a main source of protein in an area where food is



scarce, and turtles have been taken regularly as a food source for centuries. Local tradition dictates that no matter where a turtle is caught in Ulithi, it must be taken to the island of Mogmog for slaughter, after which the meat is shared among the community, with a portion going to the fisher. However, the turtle islands are owned and managed by leaders from Falalop and are accessed only by those who have traditional rights to the islands.

With the support of a few strong leaders, the project began in 2005. The field crew since its inception consisted completely of local men, who were trained in tagging, collecting morphometric data, and taking tissue samples for DNA analysis. Many of the original crew members are still working on the project and training new field assistants. After several years, the community began to see the value in the information that was being gathered and how this could help leaders and landowners make better management decisions. Almost 10 years later, the community now takes great pride in the project, and it has become something they look forward to each year. The turtle work has also laid the foundation for other conservation projects in Ulithi, such as the establishment of a reef monitoring program, support

for conservation-based volunteer work on the islands, and creation of venues for eco-based tourism. Furthermore, in 2011 the Ulithi island leaders met and created locally managed marine areas, which were based on traditional management systems.

In moving forward with the work in Ulithi, the goal is to continue to broaden the program by expanding to other islands and working more closely with partners. The project has been sponsored by the Oceanic Society since 2007 and largely funded by NOAA. This support made possible a continuous monitoring program spanning nine years and put Ulithi on the map for sea turtle conservation. Given the remoteness of the islands and the area's susceptibility to outside threats, the Ulithi Marine Turtle Program recognizes the importance of continuing to support the community in its efforts to conserve their valuable marine resources. ■

THIS PAGE: An aerial view of the Crab Islands near Falalop Island in Ulithi Atoll, Federated States of Micronesia, is shown. © WAYNE SENTMAN

trend: changing ranges



Managing Moving Targets

IDENTIFYING AND RESPONDING TO SEA TURTLE NESTING RANGE SHIFTS

By BRIAN K. MEYER, R. KELLY VANCE, and GALE A. BISHOP

Change is nothing new to sea turtles. They have inhabited the Earth for many millions of years, persisting and evolving through the continuous changes in distribution of land and sea, climate, ocean currents, and sea level that have defined their world. First appearing in the fossil record 110 million years ago during the Early Cretaceous, sea turtles have shown remarkable resilience in adapting to environmental changes throughout their history.

Today we are living in a time of accelerated global change. Coastlines, which are dynamic environments to begin with, are being particularly influenced by the extreme weather events and rising seas brought on by climate change. Many sandy beaches are eroding, moving, or disappearing entirely, particularly in the case of low lying atolls and barrier islands. In some areas, sea turtles seem to be moving too. Whether in response to changing habitats, population dynamics, or simply natural patterns in nesting behavior, shifts in sea turtle nesting ranges are being observed. Such shifts bring new challenges for conservationists and resource managers. In cases of habitat loss, we must decide whether and when to intervene. When nesting ranges shift, we are faced with protecting new areas and engaging new stakeholders.

In spite of their adaptability, today's sea turtles face increasing competition for nesting habitat along the changing coastlines that human interests now dominate. In many cases, their populations have also been decimated by human predation, fisheries bycatch, habitat loss, and other threats that could impede their natural adaptability. Climate change further complicates the situation, as sea level rise against the continents (called transgression by geologists) and warming air and ocean temperatures are expected to influence sea turtles in ways that are largely still unknown. The bottom line is that today's sea turtle conservationists must learn to identify and respond to change; indeed, it is already happening.

We present here three case studies that document emerging shifts in sea turtle nesting habitat and distribution in Georgia (U.S.A.), Peru, and Hawaii (U.S.A.), and offer them as examples of the challenges faced by conservationists in these times of accelerated change. ■

AT LEFT: Green turtles nest on low-lying islets like this one in the French Frigate Shoals in the northwestern Hawaiian Islands. As sea levels rise, turtles may seek new nesting beaches. © JONATHAN BLAIR



Rising Seas

ADDRESSING ERODING HABITATS ON
ST. CATHERINES ISLAND, GEORGIA (U.S.A.)

By BRIAN K. MEYER, R. KELLY VANCE, and GALE A. BISHOP



An aerial view of the coastline of St. Catherines Island, Georgia, where sea level rise is already impacting turtle nesting. The area shown here is experiencing shoreline retreat of greater than three meters per year.
© BRIAN K. MEYER

FIGURE: A satellite image of St. Catherines Island with areas of erosion and accretion labeled in color, and arrows indicating locations of newly formed inlets.
© SCISTP, 2014

On St. Catherines Island, Georgia (U.S.A.), we—three geologists involved in sea turtle conservation—have been documenting the deterioration of sea turtle nesting habitat caused by sea-level rise since 1998. The geographic position of this barrier island and its limited sand supply have resulted in rapid erosion of back-beach nesting habitat at an average rate of 3 meters per year. As a result, adequate nesting habitat has declined from 25 percent to 12 percent of the total beach within a decade. Additional impacts from sea-level rise include fragmentation of three beaches into eight discrete beaches from 1990 to 2014, the formation of wash-over fans and wash-in fans of beach sand over back-beach marsh meadows and into the maritime forest, the formation of nearly continuous tree “boneyards” or scarps, and the exposure of relict marsh mud along nearly the entire beachfront.

The extreme shoreline changes on St. Catherines Island produce difficult conditions for nesting loggerhead sea turtles and challenge conservation efforts; however, these conditions also create an opportunity to develop, evaluate, and optimize conservation methods on this sentinel island. These erosional effects are expected to intensify as the rise of sea level accelerates, leading to further deterioration of loggerhead nesting habitat on St. Catherines Island.

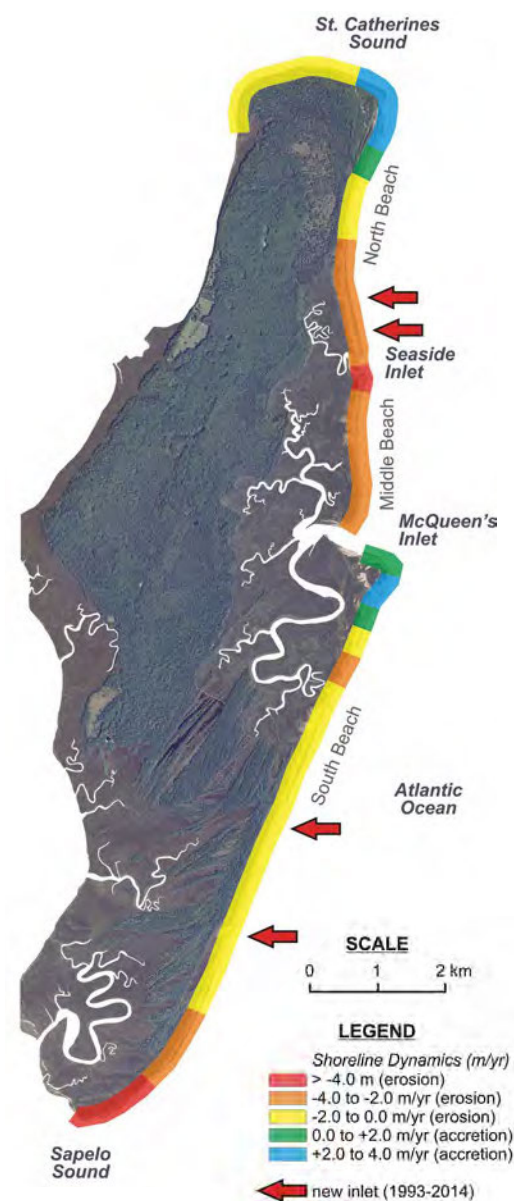
As erosion continues and nesting habitat continues to diminish, we may see the turtles begin to shift their nesting patterns in response. So far, such adaptations have not been observed. We do know that the loggerhead population here and throughout the southeastern United States has already experienced significant decline as a result of human actions, which could impede the turtles’ ability to adapt. We have therefore decided to take a proactive approach to give the turtles their best chance at surviving and adapting to change.

Because Georgia has a large tidal range, many, if not most, turtles that nest during neap tides deposit clutches too low on the beach. Spring tides and storms can cause successive inundation of these “low nests,” which has been shown to reduce hatching success by as much as 77 percent. Our response has been to relocate a large portion of at-risk or “doomed” loggerhead nests.

Relocated nests are moved into “nurturies” on areas of the beach that are better suited to hatching clutches of eggs and are still being

used by the loggerheads as natural nesting habitat. The original sites of relocated nests are staked, labeled, and monitored through the summer. We note whether they are washed out, as well as the number of times they are overwashed, and use this information to evaluate our relocation decisions. We have also used thermologger data to determine that our relocation of nests does not bias gender ratios, and we have actively managed predators to protect nests within the nurseries from predation.

We believe that such proactive measures are necessary until population levels reach the targeted management benchmark of 2,800 nests per year in Georgia set by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service. The St. Catherines Island Sea Turtle Program will continue to monitor and evaluate the efficacy of our relocation efforts. We present the program as one possible model for sea turtle conservation by addressing nesting habitat threatened by the modern transgression. ■



SEA TURTLE NESTING EXPANSION INTO PERU BRINGS NEW MANAGEMENT CHALLENGES

By SHALEYLA KELEZ and XIMENA VELEZ-ZUAZO



Olive ridleys are nesting in increasing numbers in northern Peru, extending their nesting range south in the American Pacific. © RODERIC MAST

AT RIGHT: Shaleyla Kelez interviews a local resident about the presence of sea turtles during a survey of Peru's coastline. © ecOCEANICA

Five sea turtle species are known to occur regularly in Peru's waters and, rightfully, it is in the water that most Peruvian sea turtle research has taken place. For the most part, sea turtle nesting in Peru has been considered an extremely rare event. Before 2000, there had been only a single published account of sea turtle nesting in Peru; in 1979, one olive ridley nest was recorded in the northernmost tip of the country, in Tumbes, just a few meters south of the border with Ecuador. The prevailing notion was that Peru is too far south—too cold—for successful sea turtle nesting. But with only one nesting event on record, very little was truly known about sea turtle nesting in Peru.

In 2000, ecOceanica decided that to effectively study and conserve sea turtles in Peru, we needed to know for certain whether they nest, or used to nest, along our shores. So, traveling by truck, by motorcycle, and on foot, we visited 57 sites scattered along the entire 3,000-kilometer (1,864-mile) Peruvian coastline to gather information about the presence of sea turtles. In 47 places, we interviewed local residents, and in five of those places we were told that sea turtles used to nest nearby, though no further evidence was provided. That same year, a Peruvian fisherman brought olive ridley hatchlings to a nearby crocodile farm, but the origin of the hatchlings was unclear. So we continued to believe that Peru was not a regular nesting site for sea turtles, but rather was home to only rare nesting events.

It was not until 2007 that another sea turtle nest was reported, again an olive ridley, this time in the northwestern region of Piura, just south of the location of the 1979 record. This nest was followed in 2008 by another olive ridley nest in Tumbes, making us, and other organizations, start paying closer attention to nesting activity in Tumbes and Piura. By 2010 a few more nests were recorded in sites even farther south, indicating southward expansion of olive ridley nesting distribution limits in the eastern Pacific Ocean. But it is only in the past three years (2011–2013) that sea turtle nests have begun to occur more frequently, always in these two northernmost departments of Peru (with the exception of one green turtle nest in 2013 found even farther south in Lambayeque). The olive ridley has been, by far, the most commonly reported species nesting in Peru, but green turtle nests have also been observed with increasing frequency.

A total of about 70 nests and nesting emergences were recorded from January 2010 through February 2014, providing needed information about the reproductive biology and ecology of sea turtles in Peru. We are beginning to identify the most popular nesting beaches and to gain a better understanding of breeding seasons, average numbers of eggs per clutch, incubation times, and hatching and emergence success.

There are a few theories as to why sea turtle nesting is on the rise in Peru, and, in fact, the cause may be a combination of several factors. First, we are monitoring sea turtle nesting much more closely now than even a few years ago, which may be resulting in higher reporting. Second, eastern Pacific populations of olive ridleys have recovered substantially in recent years, and green turtles also appear to



be increasing, which may be resulting in a higher number of “fringe” nesting events. It is also possible that a loss of suitable nesting habitat in other areas is causing the turtles to seek new nesting sites. Finally, warming land and sea temperatures may be allowing the turtles to expand farther south into habitats now suitable for nesting.

At this point, not enough evidence has been collected to determine the precise causes of the increase in sea turtle nesting in Peru. What we do know is that with the rise in nesting comes a new and difficult challenge—to manage the northern coast of Peru, which used to be relatively uninhabited but is now an almost continuous development of beachfront houses and hotels. Because the presence of nesting turtles was not previously known, coastal development has not taken into account the impact on sea turtle nests and hatchlings. Many beachfront houses and hotels have been or are being built over the dunes, or where the dunes used to be before they were removed, as well as very close to the water. These practices are causing erosion that, when combined with future scenarios of rising sea level, may cause the reduction or complete loss of some beaches. At the same time, critical attention is needed to address artificial lighting on the beaches, which can deter nesting females and disorient emerging hatchlings.

In 2000, we knew almost nothing about sea turtle nesting in Peru. We now know not only that turtles regularly nest in Peru, but also that nesting appears to be on the rise. Although the causes of this welcome increase still remain uncertain, we know that it brings new management challenges that must be addressed. Greater awareness, citizen participation in science, and revised legislation are all urgently needed. Now that we know Peru is home to the southernmost nesting of sea turtles in the eastern Pacific, we need to respond responsibly. ■

Hawaiian Nesting Range Shift Offers Rare Learning Opportunity

By PETER H. DUTTON, GEORGE H. BALAZS, and AMY FREY





Green turtles are among the most iconic species in the Hawaiian Islands, and they have been the subject of scientific study for more than four decades. Extensive research on the Hawaiian green turtle population has shown that it is genetically isolated from other sea turtle populations. This demographic isolation, combined with its confinement to limited available habitats, offers a relatively controlled environment for studies of population dynamics and trends that would be more complex in other areas. These conditions have enabled us to observe and document recent changes in Hawaiian green turtle nesting distribution that may suggest the foundation of a new, distinct nesting population, thus offering a unique learning opportunity. While the drivers of this range expansion are undetermined, we hypothesize that the new population could offer an evolutionary “buffer” that would protect against prospective loss of low-lying nesting habitat at the current primary nesting grounds.

More than 90 percent of all green turtle nesting in Hawaii occurs at French Frigate Shoals (FFS), a low-lying cluster of islands in the remote Northwestern Hawaiian Islands. The nesting population has been monitored since 1973 and has steadily increased in size over that time. Nesting has been almost nonexistent around the main Hawaiian Islands in the southern part of the archipelago, despite the many suitable beaches that are available. Recently, sporadic nesting scattered around these southern beaches has also been on the rise, but the origin of these nesting turtles has been unclear. Nests are almost always discovered after being laid at remote locations, so the mothers’ identities are unknown. Is it just one female that is responsible for all the nests at a given beach? Are they turtles that also nest at FFS? Are they related to captive-born turtles that were released on Oahu? Or do they represent a new “founder” population, made up of the offspring of a few pioneers colonizing this unclaimed nesting habitat? Using genetic analysis, we set out to solve this mystery in hopes that we might explain this rise in nesting in the main Hawaiian Islands.

More than 90 percent of all sea turtle nesting in Hawaii occurs at French Frigate Shoals, seen here. Recently, nesting has been increasing in the main Hawaiian Islands, where it was formerly nonexistent.

© MARK SULLIVAN, NOAA AFFILIATE

Using samples from 55 clutches laid by unknown females on the main Hawaiian Islands between 2000 and 2010, and from 15 clutches by a known female, we analyzed genetic information (from mtDNA and nDNA microsatellite markers) to deduce the genetic fingerprints of the mothers and determine relatedness to each other and to turtles from FFS. We were able to determine that at least 15 different females are nesting on the main Hawaiian Islands and that, based on their mtDNA haplotype frequencies, they are a breeding population that is demographically distinct from the FFS population. Finally, our analysis revealed that the main Hawaiian Islands females are closely related to one another, and suggests that these turtles are recent founders of a new population and not adults that also nested at FFS and switched beaches. But where did they come from? (For details of our analysis see our April 2013 article in the *Journal of Experimental Marine Biology and Ecology*).

One possible origin of the main Hawaiian Islands founders is Sea Life Park on Oahu, where several hundred captive-reared juvenile green turtles and about 14,000 newly emerged hatchlings from the park’s artificial nesting beach have been released into local waters since 1976. Although some of the available evidence makes this a likely explanation, inadequate records and absence of historical samples make interpretation difficult. It is also possible that the colonization is a natural consequence of (1) the steady nesting population growth at FFS and (2) a corresponding increase in the foraging population around the main Hawaiian Islands.

Regardless of its source, the new nesting colony in the main Hawaiian Islands may provide a buffer against the effects of climate change on Hawaiian green turtles. With most of the islands in FFS rising no more than 2 meters (6.6 feet) above sea level, they are especially vulnerable to sea level rise. This increase may lead to a reduction of available nesting habitat in FFS, making the turtles’ colonization of new nesting areas advantageous for the population’s future viability. Whatever the future may bring, this emerging case study allows us to gain new insight into how new nesting habitats are colonized, a topic of great relevance in many sea turtle nesting areas where populations are growing, nesting habitat is shrinking, or both. ■



In the 1950s, Dr. Archie Carr used the technology of his day in an attempt to track green turtle inter-nesting movements at Tortuguero, Costa Rica. © COURTESY OF SEA TURTLE CONSERVANCY

AT RIGHT: A far cry from early methods, modern technology has enabled scientists to study sea turtles' "lost years" using solar powered tracking devices. © PROJETO TAMAR / NOAA / UNIVERSITY OF CENTRAL FLORIDA



Bold Innovations Set the Pace for Research and Conservation

By NICOLAS PILCHER

The very word *innovation* excites some people and simultaneously imparts fear of the unknown in others. Throughout history, innovators have constantly been met with resistance, but those who innovate ultimately achieve success far beyond the dreams of others, and they set the stage for worldwide changes. “Television is just a passing fad,” said some, and “Color photographs will never be practical.” Yet, while revolutionary in their early days, those innovations led to today’s wall-size plasma and LED screens and to digital imagery comparable to the acuity of the human eye. Innovation is the future, and without it our lives would not be what they are today. The same is true for sea turtle conservation.

The creators of the American television series *CSI* might bend the truth a little, yet the innovative technology they portray actually exists to solve forensic mysteries. DNA analysis used in laboratories to identify villains is the very same technology used to determine where turtles nest and forage and to reveal details of their ancestral origin. Sea turtle biologists who study DNA are today’s *CSI* teams, and the science of genetics that was considered revolutionary in Mendel’s day has been augmented by DNA extraction and an ever-expanding array of gene sequencing tools to the point that we can practically identify a turtle by name.

Early space programs paved the way for orbiting satellites that today enable instantaneous contact with vehicles and airplanes anywhere in the world. That technology, coupled with advances in electronic miniaturization, allows us to attach a tiny tracking device to a sea turtle and unravel the mysteries of its migrations and life habits. We have

come a long way. Looking back to the original forays into turtle tracking by innovators such as Archie Carr in the 1950s, the height of innovation then was to attach a helium balloon to a turtle’s shell and watch its movements from the nearest beach (pictured at left). Taking tracking one step further, man has even learned to harness the power of the sun, and miniature solar-powered transmitters are helping to solve the mystery of sea turtles’ “lost years” (pictured above).

Reducing the entanglement of turtles in the world’s fisheries is a constant challenge as well, and who would have thought innovations from the world of optics and electronics, coupled with some clever thinking and experimental rigor, would provide solutions to the problem? Ultraviolet LED technology, as you will see in the article that follows, is a shining star lighting the path to solving one of sea turtles’ largest threats. And biological sciences, coupled with nuclear technology, practically allow scientists to know what a turtle was eating for breakfast. Stable isotopes, as you will also see, are helping us understand feeding patterns and habitat use, and even point us in the direction of the next conservation hotspots. As shown later, social science innovations are happening as well, including a strategy in Central America that cleverly engages local communities with turtle conservation through sports.

Innovation of all types bubbles up from thinkers and doers and challengers and people who seek to make a difference and help sea turtles. Innovation is about not necessarily knowing what the solution is or looks like, but being willing to gamble on a new idea, to look forward, and to dream, do, and create—things that mankind is well versed at and for which turtles are grateful. ■

Illuminating Innovations in Fisheries Technology Reduce Bycatch

By JOHN H. WANG, JOEL BARKAN, SHARA FISLER, and YONAT SWIMMER



Coastal gillnet fisheries are some of the most common fisheries throughout the world, and they play an important role in the food security, economics, and culture of coastal communities. Yet gillnet fisheries are often problematic because of their nonselective impact on the marine environment; they incidentally capture many nontarget species. Recent studies have shown that sea turtles, in particular, are often caught at high rates in coastal gillnet fisheries. For example, gillnet fisheries along the Pacific coast of Baja California, Mexico, inadvertently kill hundreds of loggerhead turtles each year, and off the coast of northern Peru, gillnets catch hundreds of green sea turtles each year.

Such bycatch can be a severe barrier to the recovery of sea turtle populations. Yet recent experiments with net illumination are yielding encouraging results in reducing sea turtle interactions without affecting target catch species. For the past several years, we have been working in collaboration with Mexican fishers, conservation nongovernmental organizations (NGOs), and the Mexican government to develop various technological solutions that gillnet fishers could adopt to reduce sea turtle bycatch. Because we know that visual cues play important roles in sea turtle ecology and behaviors, we focused on developing visually based bycatch reduction strategies by adapting the fishing lights that are commonly used in longline fisheries, such as chemical lightsticks and battery-powered LED lightsticks, to illuminate gillnets.

In our experiments with gillnet illumination, the average rates of green sea turtle interactions with the nets were reduced by up to 65 percent. The most important finding, however, has been that net illumination *did not* significantly affect total target catch rates or the total catch value of gillnet fisheries that employ this bycatch reduction technology. This finding is critical, because for any bycatch reduction technology to have a chance of being successfully implemented, it must have limited impact on the market value of the fisheries.

Targeted fish species and bycatch species such as elasmobranchs (sharks and rays), sea turtles, and others all have different visual sensitivities that can translate to different behavioral responses to different types of light and, ultimately, to different catch rates. For example, many pelagic and coastal fish species have eye structures that prevent ultraviolet (UV) vision, whereas sea turtles' eyes are sensitive to UV light (wavelengths less than 400 nm). This difference suggests that UV light may be used selectively to communicate with sea turtles.

To examine how various wavelengths of light might affect the overall catch composition of gillnets, we have begun to test the effects of net illumination with short, medium, and longer wavelengths using UV, green, and orange lightsticks, respectively. Experiments with UV-illuminated nets showed that sea turtle interactions were reduced without changing total target catch rates. More interesting, these nets decreased the catch rates of some fish species while increasing the catch rates of others. They also decreased the catch rates of some elasmobranchs—scalped hammerhead sharks (*Sphyrna lewini*) in particular. Green- and orange-illuminated nets had different effects on these fish and elasmobranch species. These findings suggest that using different wavelengths of illumination can change the selectivity of the net to fit



the needs of a fishery by reducing selected bycatch species, and thereby address specific conservation goals.

We have now begun to transfer this technology to other gillnet fisheries. Experiments are ongoing in Peru, Baja California Sur (Mexico), Brazil, Chile, and Indonesia. Exciting results from Peru suggest that net illumination may reduce bycatch of sea turtles and other species. Early results from experiments in Baja California Sur are equally promising with regard to reducing loggerhead bycatch. Experiments in Brazil, however, suggest that net illumination may not work in some fisheries, which underscores the fact that incidental capture of sea turtles in gillnet fisheries is complex, and solving the problem may require a multitude of mitigation measures and strategies. Nonetheless, bycatch reduction technologies will be important tools in the growing toolkit available to resource managers as they work to improve the balance between species protection and fishing interests. ■

THIS PAGE: Researchers and fishermen collaborate in Mexico to test the use of lightsticks on gillnets to reduce turtle bycatch. © JOHN WANG

AT LEFT: A leatherback entangled in a gillnet off of Trinidad. © BRIAN SKERRY

INVISIBLE RECORDS REVEAL New Understandings

By HANNAH VANDER ZANDEN

Sea turtles, like all other organisms in the natural world, carry invisible records of their biological history. Researchers simply need to know where and how to look for these records. Stable isotopes are among a growing number of intrinsic markers biologists use to extract information about organisms' environments without having to observe their actions directly. Considering that sea turtles use a variety of diet and habitat resources throughout their lives, make regular migrations, and can be difficult to encounter (apart from the small fraction of the life cycle during which females come ashore to nest), this methodology has been useful for ecologists and conservationists to make discoveries about the diet and habitats of these sometimes elusive creatures.

Naturally occurring stable isotopes are forms of elements that have differing numbers of neutrons and do not decay through time like radioactive forms. The difference in mass between the light (common) and heavy (rare) forms of the elements can lead to predictable patterns in isotope distributions, which is precisely what gives rise to their utility as a natural biological tracer. In the marine realm, the most commonly used isotopes in ecological studies are carbon and nitrogen, and the otherwise unobservable differences in heavy and light forms of these elements can be measured in small tissue samples using mass spectrometry techniques that are relatively inexpensive. Both carbon and nitrogen are incorporated by primary producers at the base of the food web and then transferred through trophic levels by consumers that assimilate the stable isotopes into their tissues, thus acting as indicators of diet. Because of baseline differences in the isotope signals from different regions in the ocean, stable isotope concentrations can also reflect location. Although these two components may be inextricably linked, this article focuses first on the advances in research on sea turtle diet and habitat use that are gained from stable isotope analysis. In addition, these data can be useful for informing habitat protection and conservation measures. The article then discusses gathering location information.

You are what you eat

One of the most basic interactions an organism can have with its environment occurs through foraging. Organisms are an isotopic representation of what they eat, often with some measurable offset that can be useful in determining trophic level (such as herbivory, omnivory, or carnivory) or the baseline primary producer the organisms use in the food web (such as seagrass or algae). Depending on the tissue sample used (blood, skin, or

egg yolk), the record may reflect short or long periods, and in some cases, when the tissue can be subsectioned, such as scute or bone, the sample provides a chronological record through time.

Stable isotope results have been used to document ontogenetic diet shifts (and the lack thereof) in sea turtles. These data have been critical in altering the assumptions regarding green turtles' diet, specifically by demonstrating that the only herbivorous sea turtle species is not always so. In some cases, green turtles continue feeding carnivorously past the oceanic juvenile stage and even in coastal areas as large juveniles and adults, thus revealing a previously unrecognized trophic role of green turtles in the marine environment.

In habitats where two or more sea turtle species may overlap, stable isotope analysis can be used to define potential dietary competition between species. For example, hawksbill aggregations have been observed to co-occur with green turtles in seagrass habitat, likely as a result of the decline of coral reef habitat, yet the stable isotope values of these two species in the same location indicated that they do not have similar diets, thus eliminating the likelihood of competition in the shared habitat.

In the future, stable isotope sampling also may be able to identify shifts in sea turtles' diets caused by factors such as habitat decline, oil spills, food availability, and so on. However, recognizing those shifts in sea turtle populations requires first establishing a baseline and then continuing regular monitoring.

Where wert thou?

The geographic variability in stable isotope values within ocean basins has made this approach useful for tracking animal movements in the marine environment. Determining the geographic location where a sea turtle (or its tissues) may have originated relies on understanding isotopic distributions across space, yet large-scale isotopic maps of the oceans have thus far been very limited. Instead, relating sea turtle isotope values with geographic location has been accomplished primarily using the combined approaches of satellite telemetry and stable isotope sampling to identify regions that are isotopically distinct. After these relationships have been validated, then stable isotope analysis alone can be applied to a large number of individuals to track their movements.

For example, stable isotope samples from nesting females have been studied to identify population-level patterns in the different coastal areas or coastal versus oceanic habitats the turtles used. This is



A green turtle grazes on seagrass off of Mexico's Yucatan Peninsula. © LUIS JAVIER SANDOVAL

an exciting direction for sea turtle research, because the stable isotope approach holds great promise as an inexpensive way of monitoring sea turtle foraging aggregations from the nesting beach, where sea turtles are more easily accessed.

In addition, the sequential records that can be obtained from subsections of scute tissue from the carapace have revealed changes in foraging location through time (such as juvenile green turtles changing from oceanic to coastal habitat) as well as long-term consistency in foraging location used by adult loggerheads and green turtles. Similarly, sea turtle bone exhibits growth rings, and the study of these growth marks (skeletochronology), in combination with stable isotope analysis of the bone sections, has been used to detect the timing of ontogenetic shifts in juveniles to estimate the duration of the oceanic stage and differences in growth rates before and after the habitat shift.

Despite the benefits of stable isotope data, there are limits in classifying turtle movements or origin. First, the period represented in the tissue sample is finite, but the approximate period needs to be known for the sample to be useful. Unlike fish otoliths, which contain a whole life history, sea turtle tissue does not provide a record of the turtle's entire lifespan. Life history also cannot be obtained in bone from nonliving turtles. Second, only broad regions of habitat use can generally be identified; precise locations of origin cannot be pinpointed. Nevertheless, stable isotope samples from satellite-tracked turtles are very valuable, and the paired data from these two methods may lead to higher resolution maps, or isoscapes, to make finer scale assumptions

of likely origin in the future. Stable isotopes in combination with other types of data, such as trace elements or genetics, may also contribute to an increased ability to assess movements and connectivity between nesting and foraging aggregations.

The bigger picture

Stable isotope analysis avoids some of the logistic challenges of working with sea turtles in the otherwise vast and opaque ocean environment. Moreover, sea turtle research using stable isotope analysis has contributed to increasing our knowledge of sea turtle habitat and diet, which can ultimately improve conservation measures. For example, monitoring population trends in foraging aggregations from the nesting beach would allow researchers to know whether particular foraging areas are at risk and to geographically prioritize conservation efforts. Likewise, several studies have used stable isotopes to identify foraging locations of sea turtles and link habitat use to reproductive output, revealing that where turtles forage can contribute to differences in demographic parameters. Having a better handle on what influences these parameters allows us to improve population models.

Above all, these invisible records that sea turtles carry can provide insight into their behavior and ecology. Knowing where we can find them and what they might be consuming in these places can help us to better protect them. Given the advantages of using this method, perhaps one day stable isotope sampling of sea turtles will become as common as applying flipper tags, thus bringing the invisible to light. ■

The Hawksbill Cup

A SOCIAL INNOVATION HELPS SAVE TURTLES THROUGH SPORT

By MICHAEL LILES, VELKISS GADEA, ANA HENRIQUEZ, EDUARDO ALTAMIRANO, DAVID MELERO, JOSE URTEAGA, PERLA TORRES, INGRID YAÑEZ, and ALEXANDER GAOS

The vast majority of the world's biological wealth is found in areas with high human poverty. This juxtaposition has led many governments, nongovernmental organizations (NGOs), and the private sector to develop conservation interventions that attempt to curb the destruction of biodiversity while simultaneously improving human livelihoods in low-income regions. Scenarios that benefit wildlife and alleviate poverty are extremely attractive and can be highly effective. However, although economic incentives for conservation can motivate behavioral change, such change can be ephemeral if the incentives are not permanent. This is particularly true in areas such as El Salvador and Nicaragua, where the livelihoods of impoverished residents depend on the extraction of natural resources from their local environment, including eggs from critically endangered hawksbill turtles. Human consumption of sea turtle eggs is illegal in both countries, but limited enforcement by authorities, scarce employment options, and high-density human populations located near hawksbill nesting beaches result in coastal residents commercially collecting nearly 100 percent of eggs.

Economically based conservation initiatives must offer egg collectors an equivalent or higher incentive to protect the eggs than they would receive for the sale of eggs on illegal local markets for human consumption. The purchase of hawksbill eggs from coastal residents for protection, however, can be financially burdensome, but more important, that approach does little to foment a local conservation ethic. Conservationists must seek new ways to increase the noneconomic values of biodiversity, such as hawksbills, in low-income regions to improve the effectiveness and durability of hard-won conservation outcomes.

We embraced this challenge by developing an innovative, culturally based competition that draws from a deep-rooted passion, the soccer World Cup, which is an unrivaled cultural phenomenon in Latin America that has the ability to destroy division, create relationships, and fuel excitement. In an attempt to harness Central

Americans' soccer passion for conservation purposes, we developed the Hawksbill Cup as a tool to shift the way coastal residents view hawksbills. The Hawksbill Cup emulates the soccer World Cup such that the hawksbill nesting season (May–October) represents the championship match between the two most important nesting sites in the eastern Pacific Ocean—Bahía de Jiquilisco in El Salvador and Estero Padre Ramos in Nicaragua. The winner is determined by which team, Team Bahía or Team Estero Padre Ramos, can score more hawksbill conservation goals at their respective sites.

We designed the scoring system together with local egg collectors and NGOs to encompass research and conservation objectives, while simultaneously ensuring that each team would have an equal chance of winning. Seven categories were established by which teams could score hawksbill conservation goals: (1) total number of nesting events recorded, (2) percentage of nesting females that were observed, (3) number of nests protected, (4) percentage of nests that were protected, (5) number of hatchlings released, (6) hatching success of protected nests, and (7) number of local egg collectors who participated in the protection of nests. Each category was worth one goal per month for a total of seven goals per month for six months, totaling a minimum of 42 goals during the competition. The team that had the highest number or percentage in a given category for a given month received one goal, and the team with a lower number or percentage for that same category received zero goals. If both teams had equal scores for a category, one goal was awarded to each team. Teams reported their results at the end of each month, the goals were awarded, and publicly displayed scoreboards were updated at both sites to show the status of the competition for members of local communities.

In 2012 and 2013, the Hawksbill Cup contributed to the achievement of record-breaking results at Bahía de Jiquilisco and Estero Padre Ramos, including 166 individual hawksbills tagged, 775 nests protected (96 percent protection rate), 77,686 hatchlings produced, and more



THE FINAL SCORE IS 21-25 IN FAVOR OF THE WINNER OF THE 2013 HAWKSBILL CUP...

TEAM ESTERO PADRE RAMOS

CONGRATULATIONS!!!

THE 2013 CUP WAS EXTREMELY CLOSE. EACH CONSERVATION GOAL WAS KEY THROUGHOUT THE ENTIRE NESTING SEASON.

BAHIA JIQUILISCO & ESTERO PADRE RAMOS TOGETHER ACHIEVED THE FOLLOWING AMAZING RESULTS:



BEACH PATROLLERS, EGG COLLECTORS, HATCHERY MANAGERS, COMMUNITY MEMBERS, VOLUNTEERS



than 200 local egg collectors participating directly in research and nest protection. These results are even more impressive given that before 2008 so few adult hawksbills were sighted in the eastern Pacific Ocean that they were considered virtually extirpated and that few, if any, hawksbill eggs escaped the dinner plate.

Perhaps as important as the nest protection results themselves is the impact the Hawksbill Cup has had on the way coastal residents view hawksbills. Because the way we communicate about the environment influences our relationships with the natural world, how coastal residents, and especially local egg collectors, speak about hawksbills can give insights into the values they place on them. Using pre- and postcompetition interviews, we saw a shift in how local egg collectors valued hawksbills and in their attitudes toward hawksbill conservation. Before their participation in the Hawksbill Cup, the primary value placed on hawksbills by local egg collectors was the economic value attached to egg sales, not a surprising view given the lack of employment opportunities at both sites and the reliance of coastal residents on the direct use of natural resources.

The Hawksbill Cup, however, has transformed the relationships that local egg collectors have with hawksbills by instilling passion and motivating them to participate in research and conservation initiatives for reasons other than personal economics. Now they are rising to the challenge of protecting more hawksbills than their neighbors, a challenge that has begun to change their views toward the turtles. Postcompetition interviews revealed that although local egg collectors still spoke of economics, their words were now in terms of reciprocal well-being. Turtles provide economic assistance to coastal residents, and coastal residents provide protection to turtles.

Furthermore, residents now associated other values with hawksbills, speaking of them in terms of patriotism, natural heritage, and pride in being able to share their homes with the last remaining hawksbills. Local egg collectors highlighted the need to protect hawksbills because of their ecological role and their highly endangered status. And at both sites, they spoke enthusiastically about the human connection generated by the Hawksbill Cup—the camaraderie within and between competing teams, the relationships of trust replacing previously high levels of distrust, and the excitement of uniting around a common goal infused with passion. The shared passion exhibited by both teams is exemplified in the videos they created to build the spirit of competition (see the videos at www.hawksbill.org). The Hawksbill Cup slogan of “We are one team!” that rings throughout the videos of both teams makes it clear that no matter which team wins the competition in a given year, all participating local egg collectors form one team in the fight to protect hawksbills in the eastern Pacific Ocean.

Most of the successes of the Hawksbill Cup have come from its ability to directly engage coastal residents in research and conservation in a way that recognizes their interests and motivates them to participate. By harnessing local egg collectors’ passion for soccer and competition, the Hawksbill Cup has begun to increase the non-economic values of hawksbills for coastal residents at both sites and has enhanced local interest and participation in nest protection activities, facilitated information exchange and experience sharing among egg collectors, positioned hawksbills as an emblematic species at both sites, and shifted local discourse on hawksbill conservation away from purely economic terms. Moreover, the Hawksbill Cup has contributed to record numbers of hawksbill nests protected and hatchlings produced in El Salvador and Nicaragua, demonstrating the ability of culturally based competitions to garner local support for conservation in low-income regions. ■

LEFT: The Hawksbill Cup (Copa Carey) was awarded to Team Estero Padre Ramos for scoring the most “hawksbill conservation goals.” © VELKISS GADEA / FFI RIGHT: A flyer celebrating the winners and their achievements in turtle conservation. © CLEIDE CEA & INGRID YAÑEZ / ICAPO



New Model Mends Conservation, Community, and Business Gains in Mexico

By CHRIS PESENTI

In the realm of sea turtle conservation, private enterprise is rarely considered a lead player. At best, it fills a supporting role through corporate financing of conservation projects, but more often it plays the villain. Mexico's tourism industry, in particular, has earned a bad reputation for the destruction of vital nesting habitats through coastal development, and the relationship between the tourism and conservation sectors is sometimes toxic. But with tourism being one of the country's largest sources of revenue, Mexico needs tangible efforts that seek common ground between tourism and conservation sectors.

RED Sustainable Travel (RED) has developed an innovative and positive role for the tourism sector in sea turtle conservation by combining a for-profit tour operator with a conservation nonprofit to create a hybrid social enterprise that is achieving both community development and conservation objectives. RED uses tourism as a tool to address many of the challenges that conservation projects face, including raising funds, pursuing communication and awareness goals, building community support and alliances, and engaging local stewards of natural resources. We believe that RED can serve as an innovative model that can be replicated in other sites around the world.

The nonprofit component of RED implements an array of community development and conservation activities, including community business incubation, training, and environmental education projects—all of which are standard activities for a nonprofit. What makes RED different, however, is that the nonprofit is directly linked to a sister corporation that shares the same community development and conservation objectives but uses a for-profit business model.

The for-profit entity develops, markets, and operates Conservation Adventures; partners with community enterprises; and directly employs individuals in rural communities. RED's hybrid model generates both social and economic benefits, often (and ideally) blurring the lines between the two.

In an average five- to six-month season, RED's trip fees finance 100 percent of more than a dozen in-water sea turtle monitoring projects, including the costs of equipment, operations, and staffing. Funds raised through RED trips also finance Academic Adventures for about 50 youth from rural communities each year, which generates local awareness of the importance of sea turtles, mangrove and dune ecosystems, and sustainable fisheries. RED also engages hundreds of Mexican and international travelers each year in hands-on sea turtle research and conservation. These travelers become project ambassadors, spreading the word as storytellers of their personal experience and of the important work performed by RED and its partners such as Grupo Tortuguero.

These travelers become project ambassadors, spreading the word as storytellers of their personal experience and of the important work performed by RED and its partners such as Grupo Tortuguero.

RED's conservation results are bolstered by important social and economic influences as well. In a typical season, RED sea turtle monitoring trips generate more than 375 person-days of nonextractive employment and close to \$40,000 in income for local residents. To maximize these impacts, RED targets key actors, such as fishermen and poachers who directly interact with natural resources. For example, RED's camp in Magdalena Bay employs a chef once renowned for his *caguamada* (sea turtle stew), a practice he has now willingly abandoned. After his experience with RED, he even took it upon himself to recruit an individual known as the *mega-guatero*, or "big-time sea turtle poacher," as a new RED staff member. In effect, fishermen are recruiting fishermen.

The interactions that take place in RED Conservation Adventures create a two-way street. Travelers originally drawn to the sea turtle experience often walk away having been deeply affected by the human experience and the bonds they form with local fishermen. Conversely, fishermen's interactions with travelers—Mexicans and internationals alike—fill them with a sense of pride in their work and in their unique knowledge of nature.

Although RED's non-profit vehicle generates its own important impacts and the hybrid nature of RED contributes to cross-pollination between the two entities, the results described are, for the most part, products of the *for-profit* vehicle. To understand what makes RED an innovator, one should look beyond the results to the nature of the model.

RED provides nontraditional funding for conservation activities. Trip fees support conservation activities, in particular sea turtle monitoring performed by Grupo Tortuguero. This structure helps to diversify revenue so that the projects can better weather the inevitable changes in funding streams, such as shifts in foundation priorities. Moreover, RED donations are unrestricted and can be used where they are most needed. For example, RED can support activities such as exploratory research and monitoring, which an organization with restricted donations might find difficult to fund.

RED furthers conservation goals by aiding local residents. Employment opportunities are hard to come by in rural communities, typically for coastal fishermen, and family economic unease consistently trumps concern over natural resources. RED provides training, attractive wages, benefits such as social security and insurance, and dignified employment in a positive environment. Dedication to conservation is never a requirement for employment, but rather RED seeks in its staff members a willingness to be part of the team and to perform given tasks while keeping an open mind. This means that RED is able to attract a broader range of participants than a typical conservation project. After working with others in a positive environment, interacting with travelers, and finding a place to grow and express their own knowledge, staff members' perspectives change, and the conservation mind-set follows. The contract is based on economics, but the experience builds stewardship, one fisherman at a time.

RED builds multisector alliances. Partnerships are pursued with any and all willing actors, including government agencies such as CONANP (Natural Protected Area Commission), SEDESOL (Secretary for Social Development), and SECTUR (Secretary of Tourism). Although economic development is the responsibility of all these

agencies, they often lack the resources and technical capacity to implement economic development projects. The possibility of participating in self-driven projects with capable partners presents an attractive opportunity for collaborations that lead to tangible results. For instance, in Cabo Pulmo, home to foraging hawksbill turtles, RED is currently working with CONANP to develop a program that will involve tourists in coral reef monitoring, generating both funding and free labor for a program in need of resources. RED also partners with regional tour operators that seek innovative tourism products that promote social and conservation objectives.

RED uses a business approach. Although many nonprofit conservation groups identify tourism as a way to achieve their goals, few have the technical skills, experience, and professional networks to implement tourism businesses in a highly competitive market. RED leverages its marketing and operational experience to work with conservation partners to source and carry products to market and, along the way, transfer skills to its partners. As a for-profit tour operator with a growing client base, RED is constantly driven to develop new products. RED's business know-how closes the gap between conservation and market-based tools by creating innovative products out of projects. For example, in the region between La Paz and Loreto in Baja California Sur, RED is developing products that will involve travelers in conservation programs such as fish counts and tracking of bighorn sheep and mountain cats. Other tour operators will seek these new products, thereby amplifying RED's impact and strengthening the financial viability of the conservation efforts.

Building community support and momentum is one of the greatest challenges faced by conservation NGOs. Social change in communities takes years, sometimes generations, and it can stall, leaving conservationists with no clear path forward. Although RED's nonprofit entity faces the same challenge, RED's business vehicle competitively forges ahead to provide products and services. In 2013 in Magdalena Bay, social conflict between fishermen and conservation interests forced much of the sea turtle work in the zone to cease; but as a business and economic driver in the community, RED was able to maintain its operations in spite of this conflict. Therefore, it was able to continue financing and carrying out sea turtle monitoring in conjunction with Grupo Tortuguero.

Mexico is just the beginning. RED has real potential for replication and adaptation in other parts of the world that face similar challenges. We recognize that every situation is unique and that conservation-focused tourism forms just one part of an integrated conservation strategy. But considering the scale of the tourism industry and its direct ties to environmental health (for better and for worse), we believe this model holds great promise as a tool for sea turtle conservation. ■

AT LEFT: Tourists watch in Baja California, Mexico, as a fisherman conducts in-water sea turtle monitoring. © KAREN DELANEY WOLVERTON

trend: coastal development





Crowded Coastlines

By BRIAN J. HUTCHINSON

Increasing development of coastlines is a growing global trend. According to the United Nations, 60 percent of the world's population already lives within 37 miles (60 km) of the coast, and this is expected to increase to 75 percent within the next two decades.

Yet the rising coastal population is only part of the story. In many places, coastal development is also consuming increasing amounts of land per person because of changes in lifestyles and development models, such as more sprawling residential development and greater use of cars.

Meanwhile, coastlines are shrinking as a result of sea level rise. Scientists project that by 2100 global sea level will rise by between 7 inches (0.18 meters) and 79 inches (2 meters). In some areas, beaches are already experiencing more frequent inundation and accelerated erosion, or they are becoming wholly submerged. Low-lying island states are particularly vulnerable, as evidenced by the Maldives' recent decision to set aside funding for a "new homeland." As demand for space along the coast grows and supply dwindles, the value of coastal property, which is already some of the most valuable in the world, is only expected to rise. These trends present formidable challenges to sea turtles, which must come ashore to nest and can be greatly affected by disturbance of their nesting beaches.

Coastal development has always been a key threat to sea turtle conservation, but development pressures are now intensifying, and in some places the conflicts are becoming more acute. The following reports from the Mediterranean, Mexico, Cape Verde, and Brazil describe situations in which coastal development and the well-being of sea turtles are increasingly at odds. In some cases, development and conservation interests are finding common ground and, in others, the solutions have remained elusive.

Although the impacts of growing coastal development on sea turtles are still being determined, the trend is clear, and approaches that seek common ground between conservation and development goals are greatly needed. We hope that the stories that follow will bring greater awareness to this growing concern, and will inspire conservationists to seek mutually beneficial solutions to save the world's diminishing coastlines. ■

A loggerhead hatchling makes its way to the sea along a densely developed shoreline in Palm Beach County, Florida.
© MARILYN & MARIS KAZMERS / SEAPICS.COM



Economic Recovery Takes Its Toll on Mediterranean Loggerheads

By LIZA BOURA, KOSTIS GRIMANIS, and ELLI SFYROERAS

Over the past six years, coastal tourism and real estate development in the Mediterranean have gained new momentum as drivers for economic recovery among countries hit by the economic crisis. The governments of Greece, Cyprus, and Turkey are reshaping policies to attract investments. As a consequence, laws regulating land use and environmental impact assessments (EIAs) have been watered down. Greece and Turkey have drafted laws to open up protected areas to development, and environmental authorities have suffered staff cuts or reforms that weaken their powers. The European Union (EU), far from shouldering its green leadership role, is encouraging this trend toward deregulation and plans to revise legislation to remove “green tape” barriers to growth. The resurgence in coastal development is affecting loggerhead nesting sites in the Mediterranean, as shown in the following examples:

- **Greece – Kyparissia:** The second most important loggerhead nesting site in the Mediterranean is protected by law but lacks a management plan. It has, nonetheless, been earmarked for a major vacation home development. Given the lack of political will to implement environmental regulations, developers have not been

required to carry out an EIA and have already destroyed sand dunes and coastal forest to make way for the real estate project.

- **Turkey – Fethiye:** With no management plan in place in this protected area, businesses are encroaching on the turtle nesting habitat and building along the shoreline, which has resulted in severe nesting declines. Uncontrolled development increased as Turkish institutional reforms led to weaker law enforcement and protected areas management.
- **Cyprus – Limni:** Despite being a protected area, Limni beach is soon to be the site of the largest golf resort in the Mediterranean. Notwithstanding objections from nongovernmental organizations (NGOs) and scientists, authorities approved the project as part of the national development agenda. A 500-meter buffer zone was required between the planned 800 villas and the nesting beach, but authorities recently decided to reduce this zone to 20 meters with no justification.

The massive rollback in environmental agendas and lack of official control of development in Mediterranean countries must be met by the



active involvement of civil society to help safeguard sea turtle nesting beaches. It is crucial that stakeholders, such as citizens, experts, and NGOs, monitor and react to legislative reforms and illegal or unsustainable investments on the ground in sensitive and high-priority areas for sea turtles. Scientific impact monitoring and the dissemination of results are essential ingredients of any advocacy effort. Raising awareness, especially about coastal ecosystem services and climate change, can also help change practices among business developers and the public.

To ensure a reasonable level of planning and consultation before development, getting protected status for nesting beaches is a critical step. As the southern Mediterranean begins to join this growth surge following the Arab spring, we must have nesting beaches adequately protected before they are earmarked for development. The need for functional rather than “paper” protected areas cannot be overstated.

At the policy level, efforts have been stepped up to ratify and implement the Integrated Coastal Zone Management Protocol developed at the 1976 Barcelona Convention. The 100-meter setback zone is undeniably one of the Protocol’s flagship provisions. Similarly, the EU is also in the process of adopting a new Directive on Maritime Spatial Planning and Integrated Coastal Management. Both are promising tools that can commit states to improving interagency and intersectoral coordination, enhancing stakeholder participation in management processes, and improving livelihoods through development that ensures biodiversity conservation. The ongoing review of the

... tourism statistics predict that the number of visitors will increase from 200 million to more than 300 million by 2030.

EU’s EIA Directive is far from being as ambitious as NGOs campaigned for, but its provisions in relation to biodiversity conservation were recently strengthened by the European Parliament, despite resistance by some European ministers.

The great leap forward is to ensure that these commitments and tools are put into practice and not shelved in times of financial crisis. Regardless, coastal development will continue to expand in the Mediterranean with more impacts on biodiversity. For example, tourism statistics predict that the number of visitors will increase from 200 million to more than 300 million by 2030. Part of the tourism sector is meeting this challenge by applying sustainable tourism best practices, which is positive but perhaps not enough to safeguard the natural capital on which tourism relies. Supported by NGOs and scientists, citizen action is also a promising ally against the coastal squeeze. Unlike the 20th-century coastal development trend, citizens are now better educated, have easier access to information, and have better tools to directly expose unsustainable development and put change-making pressure on developers and policymakers. We still have a long way to go to put our preaching into practice; hence, we must continue challenging the coastal development paradigms applied to date. ■

THIS PAGE: With no management plan in place, beachfront businesses at Calis Beach, Fethiye, Turkey, are encroaching on valuable turtle nesting habitat. © MEDASSET (2013)

AT LEFT: Volunteers measure a loggerhead nesting on Kyparissia beach in Greece. © RODERIC MAST

Research Results Guide Turtle in Baja California Sur, Mexico

By STEPHANIE ROUSSO and CARLA SANCHEZ

At the southern tip of the Baja California peninsula, Los Cabos is one of the fastest growing coastal tourism destination centers in Mexico. It is also home to the northernmost primary nesting beach for olive ridleys in the eastern Pacific, and hosts some leatherback and green turtle nesting too. The coastline of Los Cabos is already highly developed, and coastal hotels and resorts have grown an additional 15 percent since 2009. While poaching and bycatch are significant threats to sea turtles in the region, coastal development and its impact on nesting beaches pose the greatest threats.

The coastal development taking place in Los Cabos consists predominantly of multi-use megaresorts and residential neighborhoods with multiple single-family lots. One such megaresort, the 610-hectare luxury Diamante Beach and Golf Resort, is a perfect example of the potential impact of coastal development on sea turtle nesting habitat. Located on the beach approximately 10 kilometers north of Cabo San Lucas, Diamante Resort, which is currently under development, boasts 40 one-acre beach estate sites. These homes will bring new artificial lighting, desalination plants, and human activity to the beach, ranging from all-terrain vehicle and horseback-riding tours to shore-fishing, all of which have the potential to adversely impact sea turtle habitat and nesting activity. The cumulative effects from multiple single-family lots can be just as great as from a megaresort.

The typical method of coastal development has been to level the coastal dunes to construct the infrastructure. But such dune removal essentially eliminates the sediment reservoir needed to replenish nesting beaches after the storm season. In response to concerns about the unregulated coastal development promoted by the Mexican Secretary of Tourism (FONATUR) and generally poor habitat management practices in the region, environmental organizations held multiple public workshops about the future conservation of coastal dunes and wetlands of northwest Mexico. Building on the workshops, the Federal

Secretary of Environment (SEMARNAT) published a management plan for coastal dunes in 2013. In the plan they specifically cite two federal regulations protecting sea turtles, which detail the importance of healthy dune habitats in supporting successful sea turtle nesting.

For more than 19 years, our organization, ASUPMATOMA A.C., has monitored 21 kilometers of coastline in the Pacific region of Los Cabos. Over the past two years we began evaluating olive ridley nest distribution and density in relation to dune-backed beach profiles. By comparing developed areas with undisturbed areas, we analyzed the impacts of dune removal and related erosion on sea turtle nesting. We found that over the past 18 years, nest density has been on average 43 percent greater in the undisturbed nesting area than in the developed area. Results from the 2013 nesting season ($N = 438$) also show that more than 52 percent of olive ridley nests occur between 60 and 90 meters from the shore, although the Federal Maritime Protection Zone (ZOFEMAT) extends only 20 meters from the shore. These findings are allowing us to create region-specific scientific recommendations for balancing conservation with tourism development, such as a recommendation to extend the ZOFEMAT. While coastal development poses a significant threat to sea turtles in Los Cabos, we are hopeful that our research will be used to guide improved development practices here and that our experiences can serve as an example for other coastal areas. ■

Sprawling beachfront development in Cabo San Lucas, Mexico, leaves little undisturbed habitat for nesting turtles. © PHILLIP COLLA

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Can Turtle Conservation and Tourism Development Coexist in Cabo Verde?

By JACQUIE COZENS

Cabo Verde is in many ways one of the most advanced African countries, with a reputation for financial security and a stable and democratic government. However, the island nation has few resources beyond its excellent climate and incredible natural beauty. Given these attributes, tourism is an obvious choice for economic development, and plans have already been drawn up for each of the islands, focusing on sectors such as cultural, sun and sea, or nature-based tourism. In the early part of this century, Cabo Verde Investimentos, the government's investment agency, began to attract large tour operators such as TUI to the island of Sal, because that area seemed to be a natural target for mass tourism development. It was then that the authorized construction of large beachfront hotels, apartment complexes, and resorts began.



At the same time, it became clear that Cabo Verde had a significant number of nesting loggerhead turtles; indeed, it has recently been documented that the archipelago is home to the third largest loggerhead rookery in the world. Recognizing the need to protect this valuable natural asset, in 2008 the government created a National Plan for the Protection of Marine Turtles, becoming the first West African country to do so. Soon after, a United Nations project began to create a network of protected areas across the country, and several important nesting beaches on the island of Sal were included. However, the balance between preserving Sal's natural areas and creating economic benefits for the population through tourism development has recently tipped in favor of the latter.

Algodoeiro is the nesting area on Sal that has suffered the most, having seen three resorts open since 2009, with another under construction. The effect has been dramatic, with a reduction in nests from 19 percent of the island's total in 2009 to less than 1 percent in

2013. Beaches have also been degraded as the free flow of sand has been impeded, leading to more exposed rocks on the shoreline. Other areas on the island have also been devastated by illegal sand mining for construction.

ADTMA SOS Tartarugas ("Turtle SOS"), an NGO that has been working on the island since 2008, expects to see a further decline in nesting on Algodoeiro in the years ahead as more land is developed. This development threatens not only turtles but also other species such as plants, birds, and lizards. Indeed, it threatens the very reason that tourists visit the island—the natural, unspoiled beaches.

Tourism development on Sal is certainly a necessity for economic growth, but unfortunately the development plan for the island was drawn up before the conservation plan, which now causes a conundrum for the government because many parts of the tourism development zone lie inside newly created protected areas. Although a legal process for environmental impact assessments (EIAs) exists, these



studies are not always robust, and the decisionmaking process lacks transparency.

ADTMA SOS Tartarugas believes that both conservation and development interests can be served by instituting small mitigation measures that minimize disturbance to turtles, such as shading lights and building resorts farther from the shore. There must also be a stronger commitment from government to uphold the country's constitution as it applies to protecting natural areas and endangered species.

Meanwhile, development continues unabated. Although many resorts and apartment buildings have been unfinished and abandoned since the 2008 financial crash and two established hotels have closed and fallen into disrepair, two new projects appear to be moving ahead. The first of these two projects is the construction of a concrete breakwater on the nesting beach of Algodoeiro, which is intended to improve the swimming conditions for the hotel's guests. Neither the negative environmental impacts seen as a result of projects of this kind in other

countries, nor the 7,000 signatures from tourists and residents on a petition opposing the breakwater, have deterred the government from proceeding. The second project, still in the planning stages, is a hotel in the buffer zone of the Ponta Sinó Protected Area, where the developer's EIA claims that there are "no significant natural habitats." The government's own Protected Areas Management Plan contradicts that statement. The plan lists many important species in the area, including nesting turtles and breeding birds.

Time will tell if this seemingly unsustainable development model will kill the goose that lays the golden eggs. Tourists may very well turn their backs on Cabo Verde when the lure of unspoiled golden sands and natural vistas are gone. ■

THIS PAGE: A lone loggerhead comes ashore to nest in Cabo Verde. © JULIET TEN WOLDE / TURTLE SOS CABO VERDE

Pursuing Coastal Conservation in Northeastern Brazil as a Shared Responsibility

By GUSTAVE G. LOPEZ, PAULO H. LARA, and EDUARDO SALIÉS

Sea turtle conservation in Brazil began in 1980 with the creation of Projeto Tamar, the Brazilian Sea Turtle Conservation Program. The work started with an extensive survey that identified the different turtle species and areas of occurrence along the entire Brazilian coast. Threats also were documented as part of this survey, which at the time were egg collection, the killing of nesting females for food and for shell used in handmade crafts, and the capture of turtles at sea.

At the time, nesting beaches were distant from major urban areas, and Tamar's main conservation strategy was to promote local community participation. Tamar hired fishermen to locate and protect turtles and nests, promoted environmental education, and developed economic activities that generated employment for local residents. Ultimately, this strategy supported the concept that turtles are more valuable alive than dead. Currently, 80 percent of all nests are kept at their original sites without any human-induced disturbance. Nests are relocated to protected open-air hatcheries only when they have been laid on highly erosive areas or on beaches with high levels of human use.

Early on, the northern coast of Bahia State was identified as an important nesting ground, at first for the loggerhead turtles and later for hawksbills and olive ridleys. Green turtles can also be found nesting in small numbers but are mostly seen swimming and feeding on the reef fringes along the coast. The nesting season runs from September through March, and in the 2012–2013 season nearly 8,000 nests were recorded, representing 4 out of 10 nests recorded for all of Brazil during that period. Research published in 2007 shows increasing trends in nesting numbers for loggerheads, hawksbills, and olive ridleys in northern Bahia, and data collected in following years uphold those findings and demonstrate that long-term conservation efforts have had positive results.

During the past three decades of Tamar's work in Bahia, the socioeconomics of northern Bahia have changed drastically. Historically, coconut farms predominated throughout the entire region. Coastal fishing villages were isolated and connected only by unmaintained and tortuous roads. It was only in the mid-1990s that transportation infrastructure was improved with the construction

of a major road. Tourism gradually became a strong economic activity in northern Bahia, owing to the beauty of its deserted beaches, and the old coconut plantations started to give way to hotels and condominiums, thereby raising new challenges to sea turtle conservation. In 10 years, the region's availability of tourist rooms grew by 300 percent, not including condominiums. Development projects were undergoing separate environmental evaluations but were not being looked at for their broader impacts on the region.

As these new threats emerged, Tamar needed to inform government agencies and developers that a long-standing turtle population also occupied the beach. But merely informing government would not be enough to prevent damaging development projects from affecting this high-value 200-kilometer stretch of pristine coastline. Sustainable solutions had to be proposed or there would be very little room for dialogue.

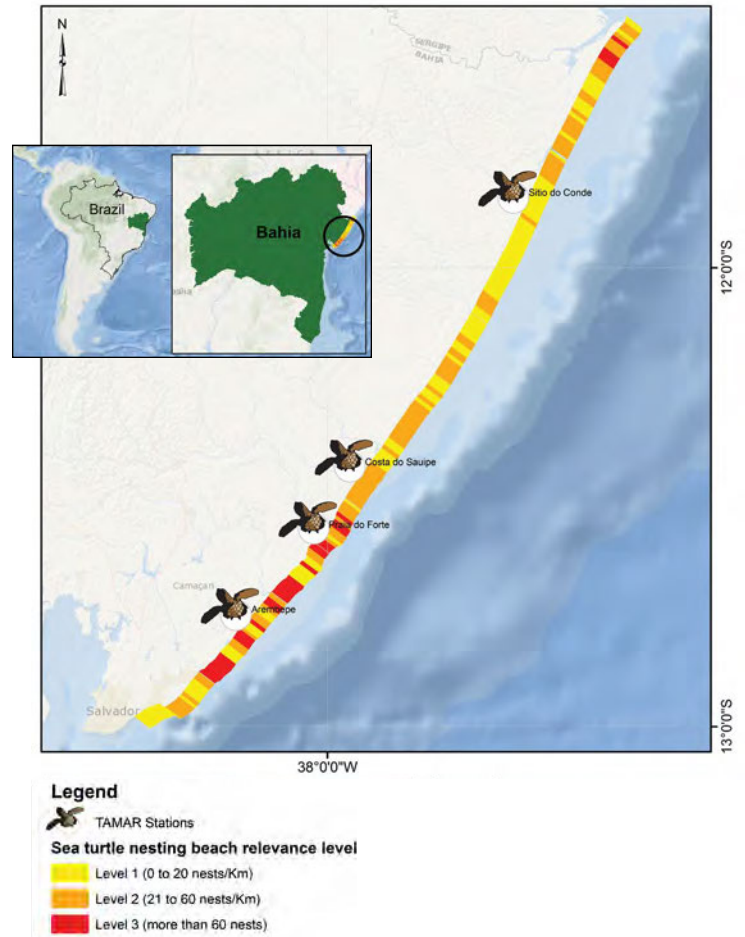
Using a geospatial tool and data collected over 30 years allowed Tamar to demonstrate sea turtle nesting patterns and fidelity in the region, highlighting key hotspots important for turtles. A detailed map



was produced with turtle nesting activity, graded by colors representing numbers of nests per kilometer for all three species found in the region. The map showed three sensitivity categories and suggested land use strategies for each. These suggestions included guidelines on safe forms of beach access, safe distances from the beach for construction, as well as suggestions on beach lighting and use by tourists. The content of the maps and guidelines was published as a booklet called Sensitivity Maps and Guidelines for Sea Turtle Conservation in Bahia.

Gradually, experience has shown that a single group, institution, or program does not achieve conservation goals. Rather, conservation is a shared responsibility among all stakeholders, and only through collective participation will sea turtles be protected long term. As a body of conservationists, Tamar's main challenge is to educate and promote the best available environmental practices using information gathered through years of research and continuous presence in the field. The user-friendly format of the sensitivity maps helps everyone, from government to investors and builders, understand the situation of northern Bahia's sensitive turtle beaches. Businesses can now better evaluate their plans and include the necessary costs of environmental protection, government environmental agencies have the information needed to conduct permitting processes, and decisionmaking processes become clearer for all stakeholders. As a result of Tamar's contributions, fewer conflicts arise, and there is more room for conciliation between urban development and environmental conservation.

Brazil has other important nesting areas, and most of them are targeted for tourism and industrial development as well. Lessons learned from the production of this guide are now being used to create similar documents for important rookeries in the states of Rio de Janeiro, Espírito Santo, Sergipe, and Rio Grande do Norte. ■



MAP: A map of Bahia, Brazil, with areas of coastline color-coded to reflect their level of nesting activity. Land use strategies that correspond to each level were developed to help safeguard sea turtles in one of Brazil's most abundant nesting areas. © PROJETO TAMAR

BELOW: Aerial images of the coastline of northern Bahia, Brazil, in 2000 and 2008 show how the coastline has been developed over time from coconut plantations to resort tourism. © PROJETO TAMAR IMAGE BANK



THE STATE OF SWOT

Ten Years and Counting

By BRYAN P. WALLACE

When the first global SWOT map was compiled using data collected at leatherback nesting beaches in 2004, the result showed broad geographical representation, with more than 150 unique sites from 47 countries. Although this impressive display of breadth came at the expense of depth—only a single year of data from each site was included—the initial approach encouraged wide participation by data providers in this volunteer effort. With each subsequent year from 2005 to 2010, a new species was added to the SWOT database, with both ridley species joining in 2009. This one-step-at-a-time approach worked well to develop a global team of data providers—members of the SWOT team—and in 2008, SWOT began to invite contributions of multiple years and multiple species at the same time to add depth to the dataset.

Fast forward a decade to 2014, and SWOT has not only diversified the number of nesting sites in the database but also, as the maps on the following pages show, added several new data layers that aid our understanding of marine turtle distribution, biogeography, and status. In the example of leatherbacks, the numbers of unique records, nesting sites, sites with multiple years of data, and data providers have all increased by more than 70 percent since the first SWOT map was published (see graph and table, p. 47). Overall, the number of records has increased from fewer than 200 to nearly 7,000. The SWOT database has not only grown year by year since that first leatherback map, but also expanded its reach backward in time, adding nesting data going back as far as the 1930s.

Besides including data from nesting beaches, SWOT now also includes maps of global distributions, genetic stocks, and regional management units. SWOT has even taken to the sea by unveiling the Sea Turtle Tracking Initiative, which is collating and displaying satellite telemetry data for future identification of important turtle areas worldwide. All of these additional resources help to put individual sites and datasets in a global context, thereby aiding researchers working on questions of distribution, status, and threats relevant to turtle conservation. For example, SWOT nesting data formed the basis for nesting habitat suitability maps for all species (see maps, and *SWOT Report* Vol. VIII), which are used to evaluate resilience and vulnerability of turtle populations to potential climate change impacts on nesting beaches.

SWOT continues to expand in breadth as well as in depth. To broaden the database, SWOT (with partial support from the National Fish and Wildlife Foundation) is currently collecting time series data for nesting sites already contributed to SWOT and is also identifying gaps in SWOT's global data coverage. Our evaluation of the "State of SWOT" also is revealing regional and population scales on which SWOT's future outreach to data providers should be focused. This work, particularly when combined with SWOT's globally applicable Minimum Data Standards for Nesting Beach Monitoring, will enable researchers to perform abundance and trend estimates for conservation

planning. This is the natural next step for SWOT to fulfill its long-term science goal of being the go-to resource for display and assessment of marine turtle distribution and population status.

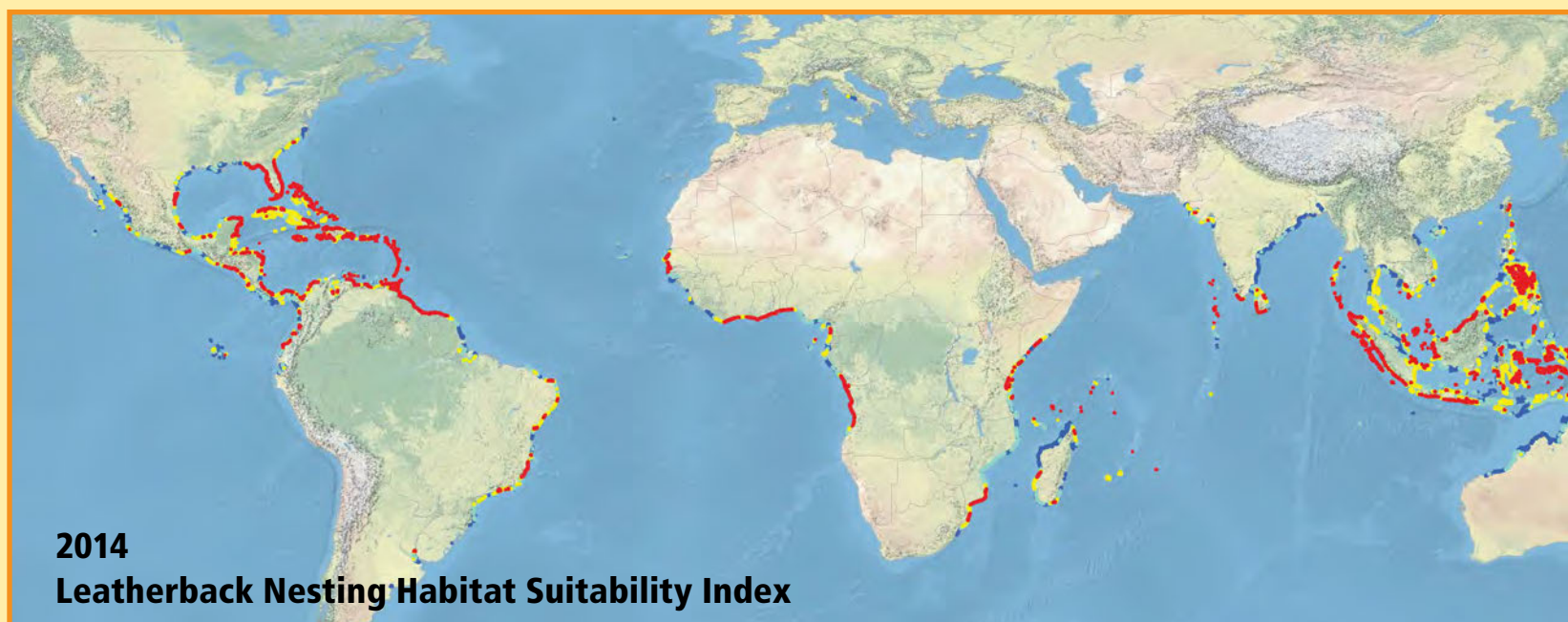
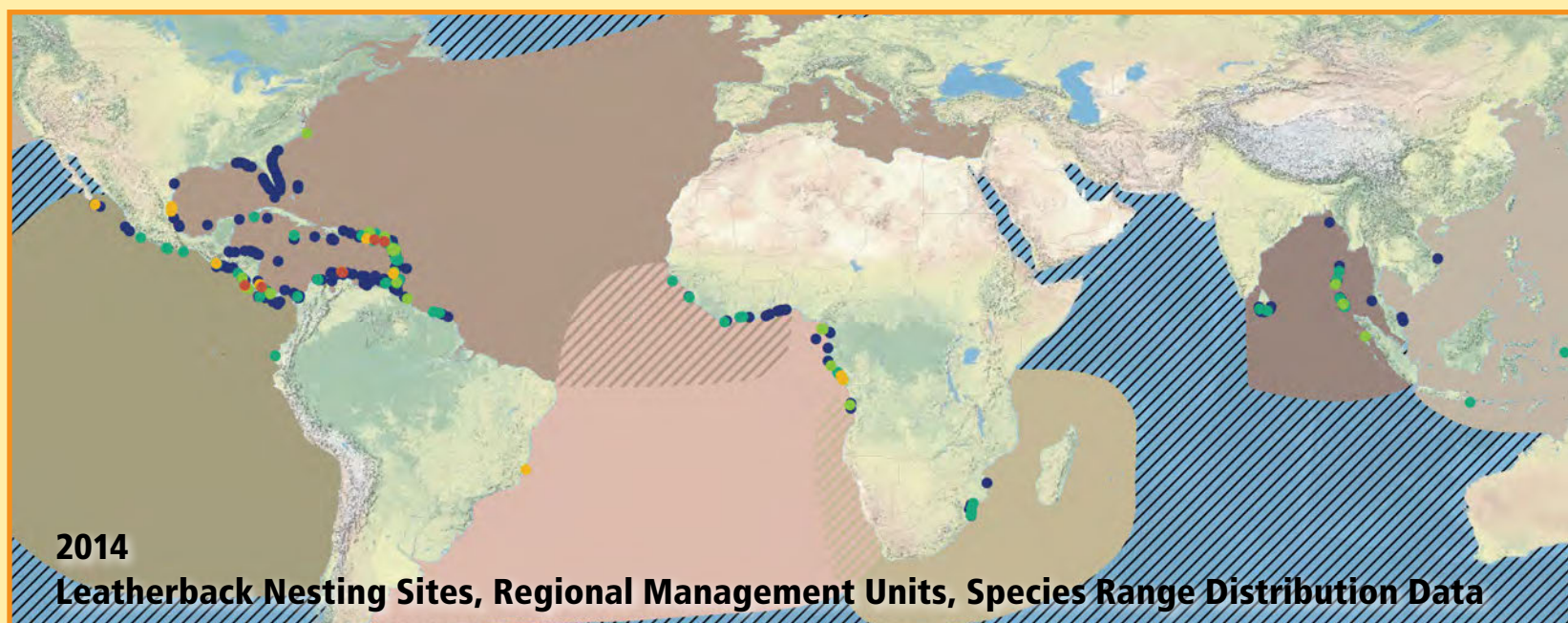
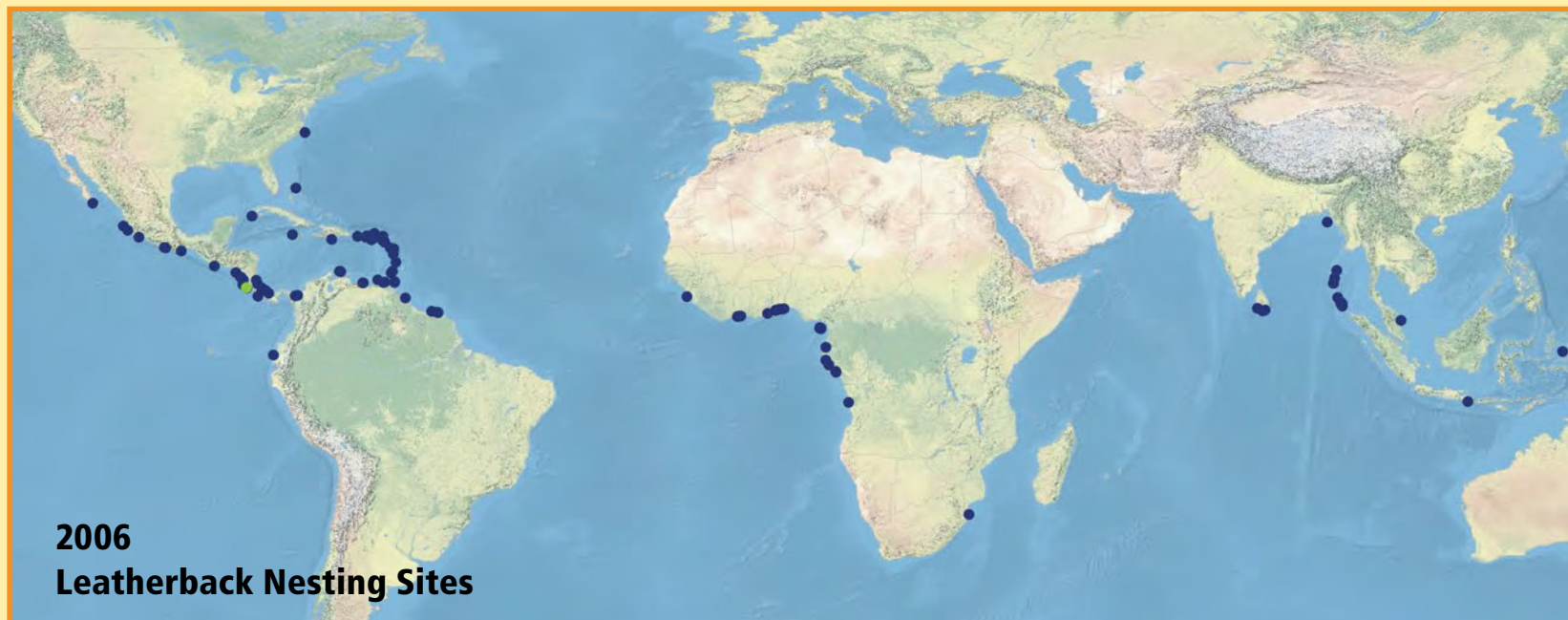
SWOT's online application also just received a significant upgrade that enhances the user experience of interacting with available data. OBIS-SEAMAP, SWOT's partner initiative, recently completed an overhaul of the site's user interface, which now allows site visitors broad latitude to visualize all data for all species, to define specific data layers and regions, and even to draw unique polygons for viewing available data within a specific area (see maps, pp. 46–47). The new site also offers several types of basic data analyses, such as temporal trends in data records that can be filtered by year, season, and spatial extent. All of these improvements permit site users to get a much richer understanding of marine turtle distribution data and, we hope, to stimulate ideas about how those data could be used to improve management of marine turtle populations around the world.

Now that we have seen how far SWOT has come in 10 years, what might SWOT look like 10 years from now? Expansion into areas of turtle distribution data beyond nesting beaches will no doubt continue, as the Sea Turtle Tracking Initiative keeps gaining steam. Also other candidate data types could be added, such as locations and severity of fisheries bycatch, strandings data, and beach and nest temperatures for tracking hatchling production and possible effects of climate change. Going hand in hand with this expansion of the data contributed to SWOT, we envision an expanded SWOT team, in terms of more data providers from underrepresented countries and regions, as well as of the sheer number of data providers. But most important, we hope that 10 years from now SWOT will have provided a data foundation—one that is both broad and deep—on which sound conservation decision-making can be made to ensure a healthy future for marine turtle populations around the world. ■

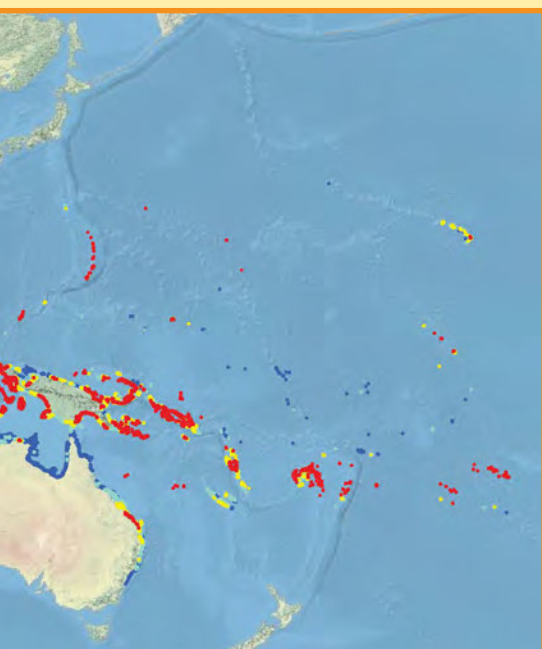
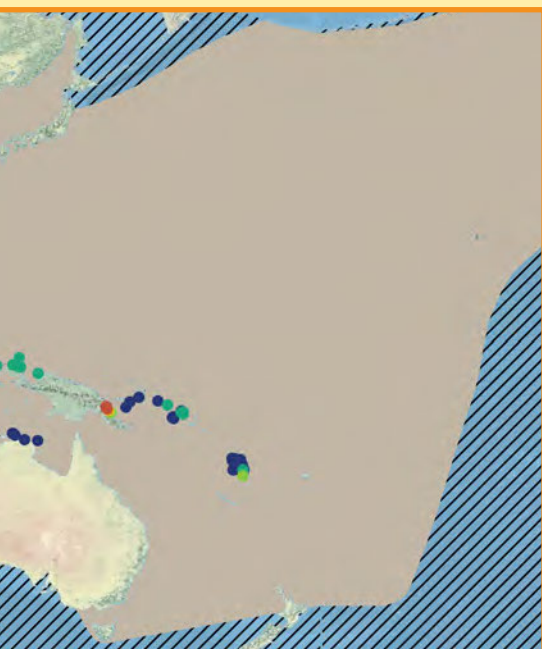
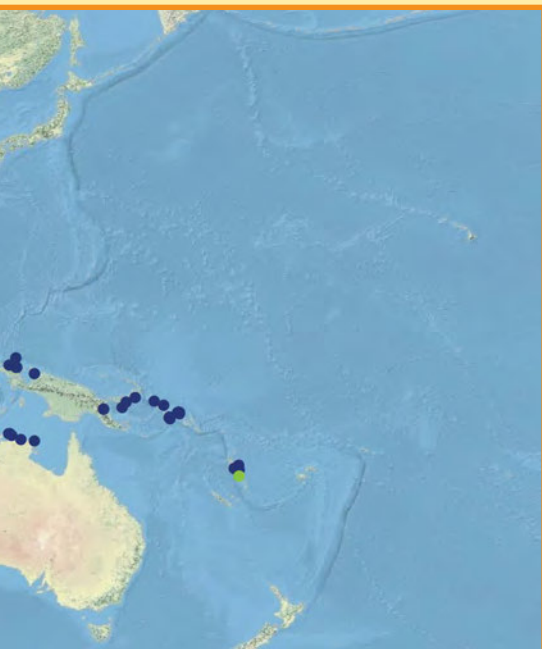
AT RIGHT: Fishermen in Baja California, Mexico, watch the release of a green turtle captured as part of Grupo Tortuguero's monitoring efforts. © JASON HOUSTON / WWW.JASONHOUSTON.COM



Global Leatherback Biogeography:

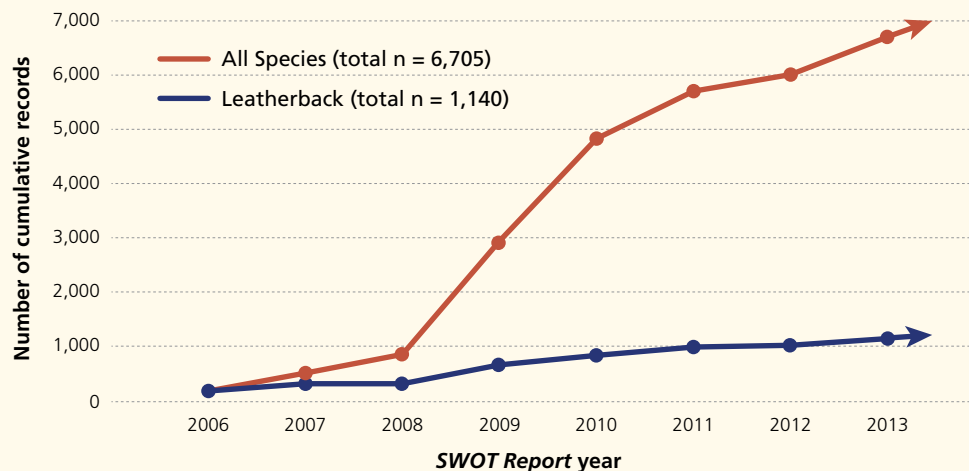


Then and Now



These maps illustrate how much SWOT has grown in a decade. Building on the first global leatherback map (top panel), SWOT has added thousands of new sites and records, as well as several new data layers, to describe marine turtle biogeography (middle panel). New data products using SWOT data have also been generated, such as nesting habitat suitability (bottom map), with more to come in the future.

SWOT Data Collection Trend



SWOT Leatherback Data Summary Statistics

	2006	2014	Increase (%)
Data Records	173	1,140	85
Nesting Sites	169	768	78
Nesting sites with > one year of data	2	170	99
Countries	47	65	28
Data Providers	71	246	71

Map Legend

Years of data for all nesting sites <ul style="list-style-type: none"> ● 1 (n = 598) ● 2 (n = 105) ● 3-4 (n = 40) ● 5-6 (n = 15) ● >6 (n = 10) 	Leatherback Regional Management Units <ul style="list-style-type: none"> ■ Northwest Atlantic ■ Southeast Atlantic ■ Southwest Atlantic ■ Northeast Indian ■ Southwest Indian ■ East Pacific ■ West Pacific
Nesting habitat suitability <ul style="list-style-type: none"> — Marginal — Moderate — Good — Excellent 	Species range <ul style="list-style-type: none"> ▨

Data Sources

Nesting data: The SWOT Team and reviewed literature (see complete citations on pp. 51-52)

Species range and Regional Management Unit data: Wallace, B. P., et al. 2010. Regional management units for marine turtles: A novel framework for prioritizing conservation and research across multiple scales. *PLoS ONE* 5(12): e15465. doi:10.1371/journal.pone.0015465.

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Land and ocean features: Natural Earth, U.S. National Park Service

Country borders: VMap0, National Geospatial Intelligence Agency

Projection: Plate Carree, central meridian 40° east

© 2014 Connie Kot, Marine Geospatial Ecology Lab, Duke University

Acting Globally

SWOT Small Grants 2013

Since 2006, SWOT small grants have helped field-based partners around the world realize their research and conservation goals. To date, we have given 43 grants to partners in 27 countries. SWOT grants are awarded annually to projects in each of SWOT's three areas of focus: networking and capacity building, science, and education and outreach. The following are updates from each of our five grantees in 2013.

ECUADOR

Equilibrio Azul

Equilibrio Azul (EA) is a grassroots marine conservation group based in Puerto Lopez, a fishing town located within Ecuador's Machalilla National Park. EA conducts research on nesting and in-water activity of hawksbill and green turtles. EA launched Ecoclub to provide opportunities for local children to interact with and learn about the biodiversity that their shores boast. Most club members are children of fishermen, who are crucial stakeholders in marine and turtle conservation. In weekly meetings, Ecoclub enables participants to discover and appreciate local marine life. The 2013 SWOT grant will fund turtle nesting and hatching fieldtrips, as well as in-water observation trips. EA hopes to inspire its *guardianes de la naturaleza* (nature guardians) to lead conservation initiatives in the future.



© EQUILIBRIO AZUL



INTERNATIONAL

Indian Ocean Turtle Newsletter

A 2013 SWOT grant is covering a portion of the printing and mailing costs for the 2014 issues of the Indian Ocean Turtle Newsletter (IOTN), a semiannual publication distributed to an international network of biologists, conservationists, government officials, NGOs, and academics. In circulation since 2005, IOTN covers the biology, conservation, and management of the five sea turtle species found in the Indian Ocean and Southeast Asia (loggerhead, olive ridley, green, hawksbill, and leatherback sea turtles). Major threats to these populations are unsustainable hunting and egg collection, habitat destruction, and fishing operations. IOTN reports on research, advocacy, and education programs that address these issues, including coastal zone and fisheries management.

© INDIAN OCEAN TURTLE NEWSLETTER

GRENADA

Ocean Spirits

Levera, at the north end of Grenada, boasts a beautiful beach that serves as a primary nesting ground for leatherback sea turtles. The beauty makes it a tourist destination, but development threatens the natural habitat, and egg poaching is common in the local communities. Ocean Spirits, a conservation nonprofit based in Grenada, is teaching local children to be environmental stewards. A 2013 SWOT grant sponsors an afterschool environmental science club, which meets once a week and includes an evening field trip to watch nesting leatherbacks. The grant also covers summer camp sessions, each a full week of activities that focus on local conservation topics, including nest excavation and hatchling release.



© OCEAN SPIRITS

COOK ISLANDS

Dr. Michael White

Michael White, who leads a research team working on various atolls of the Cook Islands, has designed a community-based sea turtle conservation project in two villages of the remote northern islands. A 2013 SWOT grant is supporting the launch of an education and training component of the project. *Rahui* is the centuries-old traditional practice of selective harvest closures (*tapu*) that locals use to regulate seasons for food resources, from seabirds and clams to sea turtles and their eggs. White's initiative will present sea turtle conservation practices to the subsistence-based coastal communities. By encouraging islanders to report turtle sightings and takes, White hopes to improve research and raise local awareness regarding nesting green turtles and offshore populations of green, hawksbill, and leatherback turtles.



© MICHAEL WHITE

CABO VERDE

ADTMA SOS Tartarugas

Cabo Verde, a remote 10-island archipelago off the coast of West Africa, provides a crucial nesting area for loggerhead sea turtle populations. Major threats are hunting and sand removal tied to unregulated development. ADTMA SOS Tartarugas, a sea turtle conservation organization based on the main nesting island of Sal, has created a summer internship program for marine science students from the University of Cabo Verde, located two islands away. Their 2013 SWOT grant will help offset program and travel costs for two local interns who will gain theoretical and field training during the nesting season. ADTMA SOS Tartarugas hopes that the experience of working with research scientists and international volunteers will inspire future leaders in sea turtle research and conservation.



© ADTMA SOS TARTARUGAS

MEXICO

Vida Milenaria

Vida Milenaria is a research nonprofit organization based in Tecolutla, Veracruz, Mexico, a nesting site for Kemp's ridley sea turtles. Fernando "Papa Tortuga" Manzano has made it his life's work over the past four decades to help bring this turtle population back from the brink of extinction. Manzano has now launched a project to tag and track Tecolutla's nesting females. The initiative promises to improve scientific understanding of the population and provide vital information for future conservation efforts. With a 2013 SWOT grant, the nonprofit has purchased flipper tags and applicators, as well as calipers to apply tags to adult females during the 2014 nesting season. Long term, the mark-recapture study should inform understanding of population dynamics and size, nesting site fidelity, and connectivity between populations.



© VIDA MILENARIA



Visit www.SeaTurtleStatus.org to apply for a 2014 SWOT small grant!

SWOT Team Member Spotlight



Gale Bishop (U.S.A.). In 1990, Nancy Marsh and I cofounded the St. Catherines Island, Georgia, Sea Turtle Program (SCISTP) while I taught geology at Georgia Southern University. Then I became director of the Museum of Geology and Paleontology at the South Dakota School of Mines and Technology, and now I codirect the SCISTP through GeoTrec LLC in Fayette, Iowa. SCISTP has taught 326 interns, many of whom were K–12 teachers. We protected 2,992 nests, released 168,165 hatchlings, and shared our experiences through talks, publications, and websites. SCISTP merges conservation, research, and education to maximize public impact, leading to enhanced stewardship and appreciation for coastal environments. I am happy to have been a part of the SWOT team for the past several years and to have contributed to this and other volumes of *SWOT Report*.



Frances Humber (United Kingdom). I have been working for Blue Ventures Conservation since 2005. As conservation programs manager, since 2011, I help to coordinate our diverse research and conservation projects in Madagascar and Belize. I also manage our endangered species program in Madagascar, with a focus on the status of the artisanal shark and turtle fisheries (also the subject of my PhD dissertation). Working with the Vezo coastal communities in Madagascar is the most rewarding part of my role, developing projects that help to both improve livelihoods and conserve marine resources. *SWOT Report* is a great resource for reading about new initiatives and projects in one place and for finding like-minded projects for inspiration.



Gordon Moore (U.S.A.). SWOT thanks Dr. Gordon Moore, his wife Betty, and their children for many years of steadfast commitment to our work. An icon in microchip design and technology, Gordon co-founded Intel in 1968 and is widely known for “Moore’s Law” (1965) that accurately predicted the rate at which computing speed would grow. Among his countless awards is the Presidential Medal of Freedom, the USA’s highest civilian honor. Gordon was raised near the sea and is a lifelong fisherman and lover of the ocean. The Moore Family Foundation and the Gordon and Betty Moore Foundation seek to improve the quality of life for future generations through nature conservation, patient care, and science. We are proud and grateful to count Gordon and his family among our SWOT Team since the beginning.



Kathy Moran (U.S.A.). I am a 33-year veteran at National Geographic, and a senior editor for natural history. I have worked on over 200 NGM stories on ecosystems, including Nick Nichols’ story on the Serengeti lion, Tim Laman’s Birds of Paradise adventure, and the award-winning work of photographer Nick Nichols and Michael Fay that resulted in the creation of Gabon’s national park system. My book editing credits include *Women Photographers at National Geographic*, *The Africa Diaries: An Illustrated Memoir of Life in the Bush*, *National Geographic Cat Shots*, and *Tigers Forever*. As a founder of the International League of Conservation Photographers and a director of Wildscreen USA, I am deeply involved in telling stories through images. Being photography adviser for *SWOT Report* has offered me a great opportunity to use my skills in support of global sea turtle conservation.

© DAVID L. GRIFFIN



Dawn Witherington (U.S.A.). My graphic design and biological illustration work draws on first-hand experience with the subjects I portray and input from many experts who help me achieve accurate depictions of species and ecological relationships. I trained at the Art Institutes of Colorado and Ft. Lauderdale, and studied biology at the University of Central Florida. My work is in natural history books, posters, exhibits, and greeting cards, and I co-authored *Florida’s Living Beaches*, *Florida’s Seashells*, *Living Beaches of Georgia and the Carolinas*, and *Seashells of Georgia and the Carolinas*. With my husband, Blair, I produced several sea turtle posters and a folding sea turtle guide. We are now completing a book entitled *Our Sea Turtles—A Practical Guide for the Atlantic and Gulf, from Canada to Mexico*. I am proud that my work has been used in the “meet the turtles” section of several volumes of *SWOT Report*.

SWOT Data Contributors

A growing, global movement

The following individuals and organizations generously contributed the leatherback nesting data displayed in the maps and figures on pages 46–47. Complete data records, detailed citations, and terms of use are available online at <http://seamap.env.duke.edu/swot>.

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In Memoriam



Creusa Hitipeuw.

Creusa “Tetha” Hitipeuw was an accomplished marine conservationist in Indonesia. After earning a Master of Marine Ecology from Vrije Universiteit in Belgium, she went on to an illustrious 17-year career with World Wildlife Fund, most recently as the marine program development and partnership leader. Her efforts led to a groundbreaking research partnership with the National Oceanic and Atmospheric Administration, in which the extensive migratory patterns of leatherback turtles were documented using remote sensing tools. She led a similar study using satellite transmitters to describe the migration habits of whale sharks and the impact of human tourism on these populations. Tetha was a vocal activist and social media user, noting on her Twitter profile that she was “obsessed with endangered marine mega fauna.” Tetha’s enthusiasm and leadership are deeply missed by her colleagues in Indonesia and worldwide.



George Petro.

George Petro was a noted turtle conservation officer with Wan Smolbag, a dynamic theater group and nongovernmental organization focused on community engagement and cultural education in Vanuatu. George’s 15-year conservation career earned him the prestigious Turtle Champion Award in 2012 from the International Sea Turtle Society and recognition from SWOT. He conducted surveys on previously undocumented nesting areas for leatherback, green, and hawksbill turtles and led negotiations with local communities, culminating in a force of more than 500 village monitors across Vanuatu. Through the efforts of George and his team of monitors, annual turtle harvest was reduced by more than 80 percent in the Maskelyne Islands. George helped expand the work of these monitors to include coral reef and marine resource conservation, and he exported the monitor model to Fiji, which has implemented a similar program. George leaves behind a community that is inspired by his creativity, ambition, and passion for marine conservation.



Jairo Mora Sandoval.

On May 30, 26-year-old Costa Rican sea turtle biologist Jairo Mora Sandoval was killed while protecting turtles from poachers. Since the age of 15, he volunteered with sea turtle nesting patrols near his village, and in his short career he was responsible for the protection of thousands of sea turtles in Costa Rica. Jairo’s murder attracted international attention including statements from the UN and a host of international conservation groups, and vigils were held across Costa Rica. Under the leadership of WIDECAS, money was raised and 150,000 people pled for justice with Costa Rica’s president. SWOT and others made gifts to support Jairo’s family, and in his memory Sea Shepherd added a fifth ship to their fleet—the M/Y Jairo Mora Sandoval. Our global community laments this terrible loss, and we promise to keep Jairo’s sacrifice always in our thoughts.

Thank You

This volume of *SWOT Report*, along with all the other accomplishments of SWOT over the past decade, would not have been possible without the contributions of an ever-growing network of generous and dedicated people who contribute their time, talent, skills, data, resources, and enthusiasm to the pursuit of our vision. We are particularly grateful to the authors (their names appear below) and photographers (credited with their photos) who have contributed to *SWOT Report, Vol. 9*, to our Scientific Advisory Board (see masthead), and to Kathy Moran, our photographic advisor. Our deepest gratitude also goes out to the many donors upon whom we depend: the Andrew Sabin Family Foundation, the Anderson-Rogers Foundation, the Ann-Eve Hazen Family Fund, the Balkanski family, the Betlach Family Foundation, the Comer Family Foundation, the Frances and Benjamin Benenson Foundation, the Goldring Family Foundation, IUCN, the Moore Family Foundation, the National Fish and Wildlife Foundation, the Panaphil Foundation, Perseus Telecom, and the U.S. State Department. And of course, thanks to our host institution, Oceanic Society, and all of the *Waves on a Healthy Ocean*, and to Duke University's Marine Geospatial Ecology Lab.

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