SWOT report

Volume IV

The State of the World's Sea Turtles

INSIDE:

CONFRONTING CLIMATE CHANGE

STUDYING HAWKSBILLS IN THE DEEP

MINIMIZING LOGGERHEAD AND LONGLINE INTERACTIONS

AND MORE …

Discovering the Flatback

AUSTRALIA'S OWN SEA TURTLE


A remarkably large aggregation of green turtles gathers during breeding season off the coast of Raine Island, Queensland, Australia.

Foreword

Be a Legend

No matter who you are or what you do, you can be a rock star when it comes to conserving Nature. I am a musician, and have found ways to put my skills to use for the Earth. My band, Pearl Jam, offset its carbon emissions by protecting a forest in Madagascar. I have also recently written a song and teamed up with Chad Smith of the Red Hot Chili Peppers to produce a music video to benefit sea turtle and marine conservation.

Through my involvement with music and conservation, I have come to know all kinds of amazing people. But it wasn't until I met Mr. Leatherback, a shy guy doing some pretty un-shy things to save his kind, that I truly understood the essence of being a legend. I look at the world through a rock-and-roll lens, and the way I see it, Mr. Leatherback is pure rock genius. He embodies the qualities of great rock legends like the ones who have inspired me all my life; it's these same qualities that can make any of us a conservation legend.

The fate of sea turtles, the global marine environment, and humanity are all inextricably tied to the choices we make today.

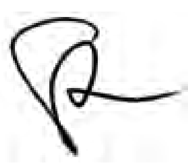
The first quality is a **mad desperation for success.** True legends do whatever it takes, pushing beyond the constraints of social norms and personal inhibitions, to get the job done and have their message heard.

Moreover, legends aren't afraid to **flaunt their special talents** for the cause. Whether showcasing their hot dance moves like Mr. Leatherback or donning costumes and face paint like KISS, legends use their talents to get audiences on their feet. This kind of boldness and audacity can make the difference between big and mega-huge.

Legends also have a **relentless work ethic.** Like the band that spends years in smoky clubs honing its sound, conservationists also pay their dues with sweat, blood, and the occasional tear.

Finally, the most important quality of all is what I like to call **rock passion.** It's big, and it is the key ingredient of legendary success. Passion is that spark that keeps legends going, keeps them dreaming, and keeps them from accepting good as good enough.

The fate of sea turtles, the global marine environment, and humanity are all inextricably tied to the choices we make today. Discover the rock legend inside yourself; choose to join SWOT; and put your gifts, your voice, and your talent into the glorious spotlight for conservation.



Stone Gossard
Guitarist, Pearl Jam

THIS PAGE: Stone Gossard (right) of Pearl Jam and Chad Smith (left) of the Red Hot Chili Peppers pose with Mr. Leatherback at the recording of the new song, "Stubborn Insane." Stay tuned to www.SeaTurtleStatus.org to learn about downloading the song and music video in March 2009. © TERRILL A. MAST AT LEFT: A snorkeler enjoys a close encounter with a green turtle a few miles off the coast of Makena Bay, Maui, Hawaii, U.S.A. © NEIL EVER OSBORNE / WWW.NEILEVEROSBORNE.COM

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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:
Critically Endangered

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

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FROM TOP TO BOTTOM: © CALEN OFFIELD, © CARPENTARIA GHOST NETS PROGRAMME, © DAVID DOUBILET FRONT COVER: A flatback emerges to nest at sunset on Eighty Mile Beach in Western Australia. © CALEN OFFIELD AT LEFT: © DAWN WITHERINGTON

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

&research status

The Ocean World through Turtles' Eyes

One of the great difficulties in studying marine animals is that they spend most of their lives in places where humans can't go. In 1986, biologist Greg Marshall had an idea, a new way to reveal this hidden world. This idea resulted in Crittercam—an animal-borne camera and data-logging device that records behavioral and ecological observations from the unique perspective of the creature wearing the device.

Since their creation, Crittercams have been deployed more than 600 times on 50 species around the globe, providing National Geographic Remote Imaging (NGRI) researchers and their collaborators with unparalleled insights. Green, loggerhead, hawksbill, olive ridley, and leatherback sea turtles have been among the subjects of Crittercam studies that are helping to solve some long-standing mysteries of sea turtle biology. Crittercams have observed some never-before-seen behaviors such as leatherback mating occurring just off the nesting beaches, adult greens frequently eating invertebrates in some foraging locations, and female hawksbills spending a lot of time "hiding" from amorous males.

Images provide a wealth of detail that is simply unavailable through other types of instrumentation data. Researchers can finally see exactly what an animal was doing in a particular location or circumstance, rather than inferring that behavior from indirect means. Crittercam has provided new insights into foraging, habitat use, physiology, and inter- and intra-specific interactions of sea turtles and many other marine species.

THIS PAGE, FROM TOP TO BOTTOM: Sea turtles inhabit a wide variety of ocean ecosystems, such as this coral reef in the North Red Sea. © DAVID DOUBILET Crittercam recorded this unique turtle-eye view of a male leatherback courting a female. Crittercam has been deployed on more than 50 species using a variety of creative attachment techniques including suction cups on leatherbacks and whales and custom-fitted backpacks on emperor penguins. PHOTO COURTESY OF NATIONAL GEOGRAPHIC REMOTE IMAGING AT LEFT: Members of the Sea Turtle Research and Conservation Programme look for signs of nesting green turtles in Cuba, where the Ministry of Fisheries recently passed a resolution banning sea turtle harvesting. © STR / AFP / GETTY IMAGES

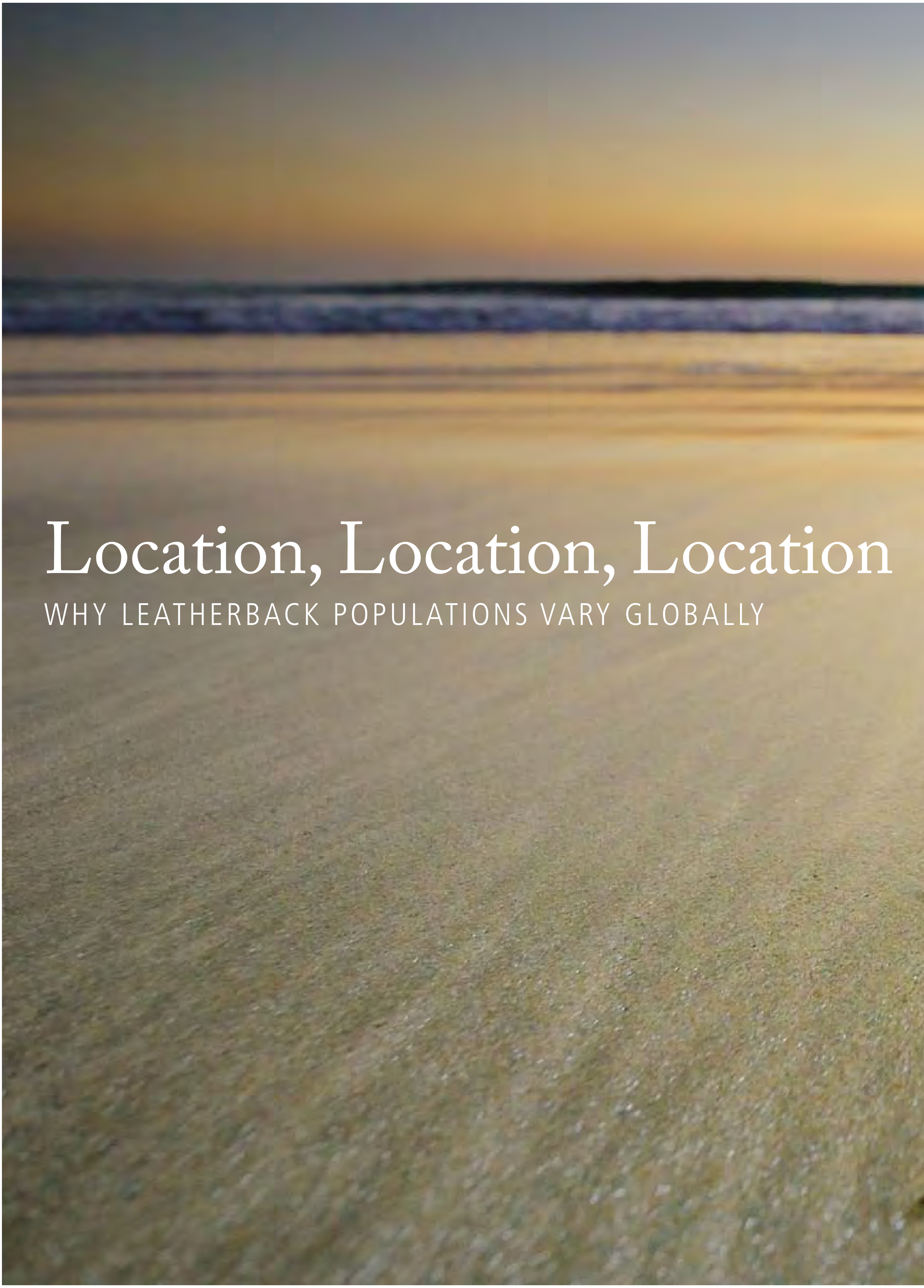
Science is always at the core of Crittercam projects, but visual data also have uniquely inherent value for outreach. Crittercam's amazing views of the lives of wild animals are unfailingly fascinating to non-scientists as well. Through use of this footage on TV, the Web, and other media outlets, NGRI is able to connect people to the natural world in ways that inspire them to care about and conserve it.

Kyler Abernathy *is the director of research for National Geographic Remote Imaging.*

Visit **www.SeaTurtleStatus.org** to watch actual Crittercam video!

Location, Location, Location

WHY LEATHERBACK POPULATIONS VARY GLOBALLY



Sea turtle researchers are often asked seemingly simple questions: How much do leatherbacks weigh? How many eggs do they lay? Are their numbers declining, and will they become extinct? Research has revealed that the answer to each of those age-old queries for leatherbacks is consistent: *it depends.*

It turns out that the answers to many questions about sea turtle biology depend on your location in the world. For example, leatherbacks are Critically Endangered globally according to the *2008 IUCN [International Union for Conservation of Nature] Red List of Threatened Species*™. However, populations in some regions appear stable and are even growing, while in other regions they have crashed. Sea turtle researchers must continue to focus their work at more specific scales that will provide insight into the geographic differences among turtle populations to help guide and prioritize global conservation efforts.

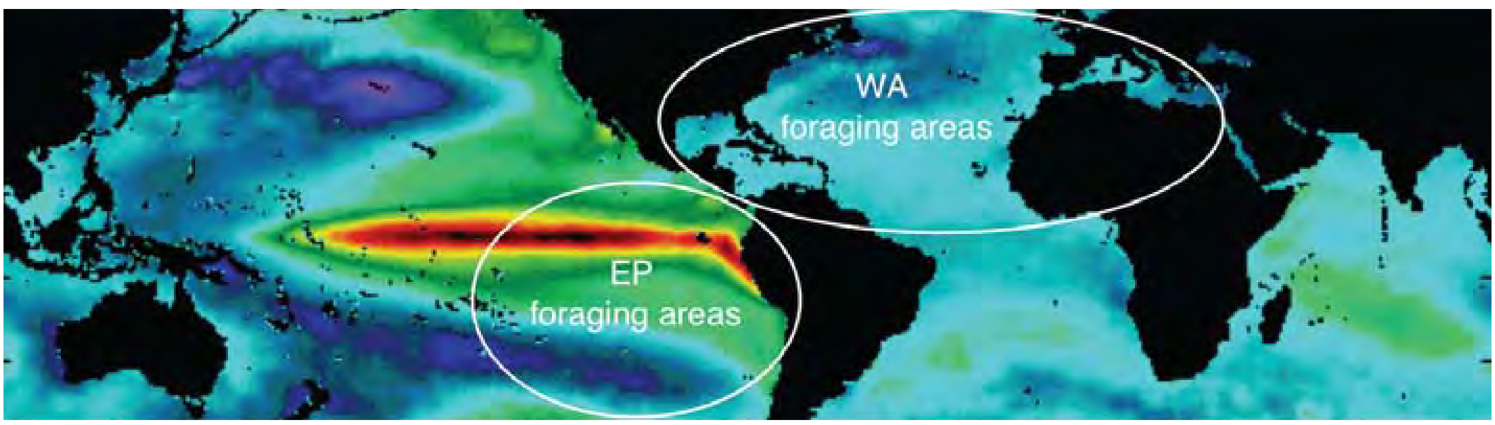
Although leatherbacks worldwide belong to a single species genetically, individuals and populations can vary remarkably in morphological, reproductive, and behavioral traits. Leatherbacks in the eastern Pacific Ocean (EP) have the smallest body sizes, lowest number of eggs per clutch, and longest interval between nesting seasons of any leatherback population globally. In addition to those life history differences, EP nesting numbers have declined by more than 90 percent in the past two decades, whereas leatherback populations in other ocean basins are stable or are increasing (see graphic at right). The fact that populations in different ocean basins show such marked differences in both life history and population trends hints at important, large-scale differences in leatherback habitats around the world.

Analyses of energy requirements for egg-laying indicate that EP leatherbacks appear to be resource limited with respect to their counterparts in the western Atlantic Ocean (WA). Despite having higher energy requirements than EP leatherbacks, WA leatherbacks remigrate to their nesting beaches twice as frequently, suggesting that leatherback food (jellies) is more consistently available and is in higher abundance in WA foraging areas than in EP foraging areas. If more food energy is available to WA leatherbacks, they should have bigger bodies, more eggs, and more frequent reproduction than do resource-limited EP leatherbacks.

To investigate this idea further, scientists analyzed net primary productivity (NPP) in leatherback foraging areas worldwide. Those analyses revealed that the amount and predictability of resources is indeed related to the average body size and reproductive output of leatherbacks from different populations. The highest variability in resource availability occurs in the EP, meaning that EP leatherbacks must forage for longer periods of time and probably over longer distances to meet their energy requirements, which most likely results in smaller body sizes and lower reproductive output. In contrast, leatherback populations with the largest body sizes and highest reproductive outputs tend to forage in areas characterized by stable, high levels of NPP, such as in the north Atlantic Ocean (see figure below).

Imagine foraging areas as leatherback “restaurants.” Restaurants in the WA are generally plentiful, are open at the same locations every year, and serve lots of good food. However, restaurants in the EP tend to change location frequently, they are far apart, and the menu quite often is limited to daily specials. Thus, it’s tougher for leatherbacks to find a good meal in the EP, and they spend a lot of fuel searching for a place that’s open.

In addition to ecosystem factors, anthropogenic pressures can also impact the number of turtles in the oceans. Leatherbacks in the WA have shown clear signs of stability and even exponential increase, owing to beach conservation as well as high survival rates of adult turtles. Leatherback rookeries in the EP, however, have not yet shown signs of recovery, although conservation programs have been in place for more than 20 years at the major nesting beaches. Researchers now think that resource limitation not only renders EP leatherbacks unable



Ecosystem stability (based on variability in sea-surface temperatures) in leatherback foraging areas worldwide varies from very stable areas (cool colors; e.g., the western Atlantic Ocean) to highly unstable areas (warm colors; e.g., the eastern Pacific Ocean). General foraging areas of the respective leatherback populations are highlighted on the basis of satellite tracking studies. © VINCENT SABA to match the size and reproductive abilities of other leatherbacks, but also makes the EP population less resilient to high levels of human-induced mortality from hazards such as fisheries bycatch and egg collection. It is likely that the combined effects of high variation in NPP and human pressures in the EP have caused drastic population declines in recent decades.

Changes in ocean conditions over multiple decades also appear to influence leatherback feeding areas. Ocean temperatures shift in response to changing climate conditions over periods of 20 to 30 years. When the surface waters of the EP are cooler than usual, NPP is higher and favors good leatherback foraging. However, the opposite is true when surface waters are warm. The limited reproduction and the declining trend in nesting leatherbacks in the EP over the past 20 to 30 years have coincided with an unusually warm regime in the EP. Therefore, it is possible that when the EP is in a cool regime lasting multiple decades, leatherbacks may also become larger and more productive like their WA counterparts because foraging areas would be highly and more consistently productive. In addition, the EP leatherback population's vulnerability to anthropogenic hazards would probably be lower during a cool phase in the EP, which would help the population to grow. Many aspects of the links between environmental variability and leatherback biology remain speculative, which further highlights the importance of long-term monitoring of both leatherback populations, and of changes in ocean conditions.

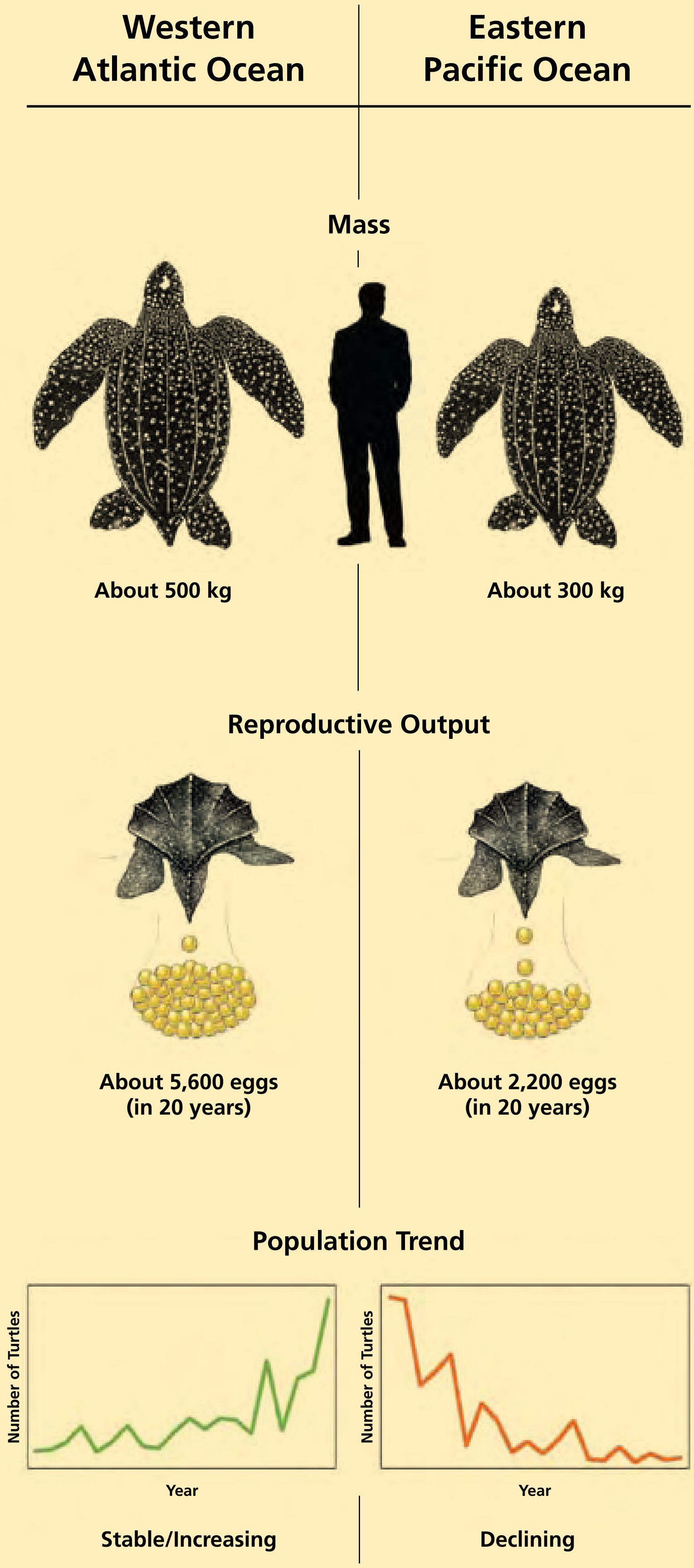
Understanding these links is important for setting conservation priorities for globally distributed sea turtle species. Until now, sea turtle status has been assessed for each species at the global level using IUCN Red List criteria that recommend projecting recent population trends into the past to estimate the degree of population change over three generations. However, sea turtle researchers have long recognized that global assessments fail to capture the idiosyncrasies of different populations of the same species and, thus, are unable to provide solid recommendations for regional conservation strategies. Considering the observed differences among leatherback populations described here, the IUCN will use a different approach in its forthcoming leatherback Red List assessment that will determine the conservation status of leatherback populations on regional and global scales.

Although it is unclear whether any new leatherback restaurants can be opened in the EP to help hungry turtles find more reliable meals, such improvements in the assessment procedure will help to target conservation actions to address the different scenarios that leatherback populations face around the world.

Vincent Saba *is a research associate marine scientist at the Virginia Institute of Marine Science in Gloucester Point, Virginia, U.S.A.* ***Bryan Wallace*** *is the science advisor in the Sea Turtle Flagship Program at Conservation International.*

PREVIOUS SPREAD: A leatherback hatchling will swim for nearly a week upon entering the ocean for the first time.

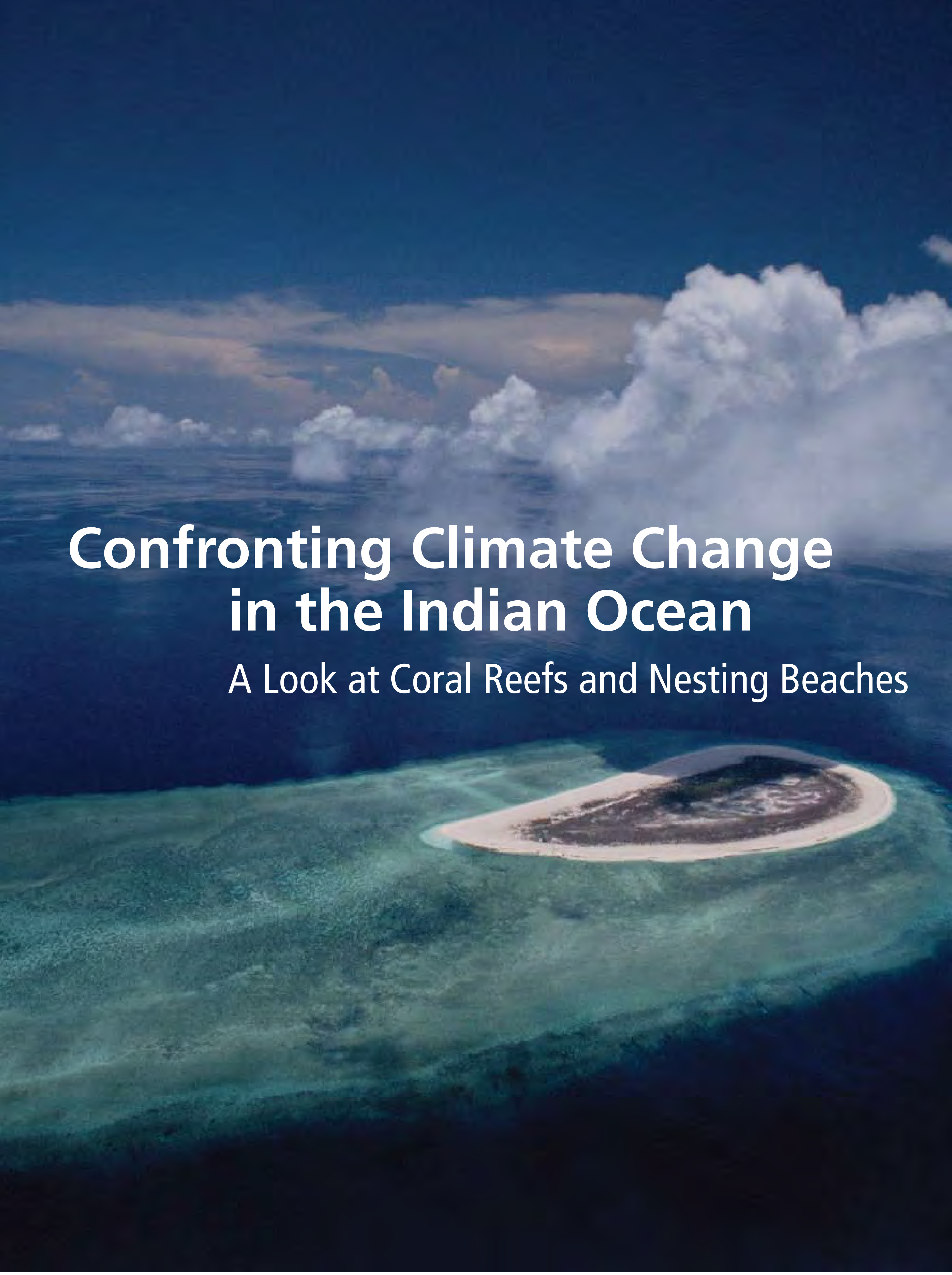
A Tale of Two Oceans



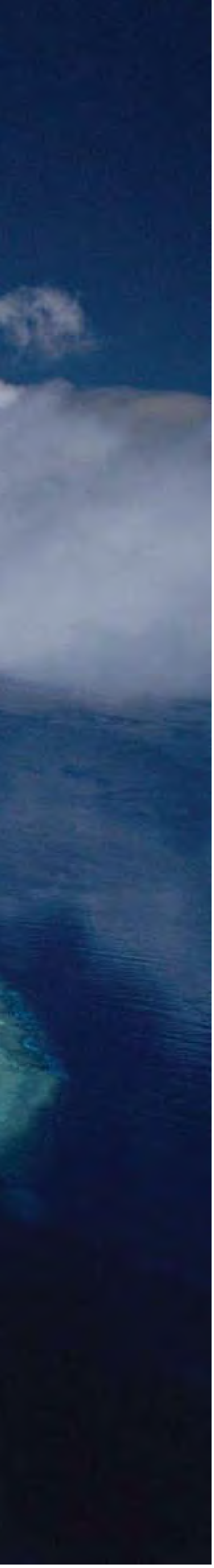
Biological traits of leatherback turtles vary according to where they are in the world. Leatherbacks that feed and breed in the eastern Pacific Ocean are smaller in body size and lay fewer eggs over time (through smaller clutch sizes and longer intervals between nesting seasons) than leatherbacks in the western Atlantic Ocean. Leatherback nesting populations in the EP have declined precipitously in recent years, while many WA nesting populations are stable or increasing. Differences in resource availability between leatherback feeding areas in the western Atlantic Ocean versus the eastern Pacific Ocean appear to be driving this distinct pattern. ILLUSTRATIONS BY STEPHEN NASH AND TOM McFARLAND. GRAPHIC BY BRIAN J. HUTCHINSON.

Confronting Climate Change in the Indian Ocean

A Look at Coral Reefs and Nesting Beaches



Raine Island, a 32-hectare (79-acre) coral cay, is one of the largest and most important green turtle nesting grounds in the world. Like many atolls, Raine Island's low-lying beaches are particularly susceptible to rising sea levels. © DAVID DOUBILET AT RIGHT: Now widespread, coral bleaching is one of the most poignant signs of climate change in the marine realm. © PASCAL KOBEH



In recent years, the issue of climate change has received a good deal of attention from media, governments, and communities around the world. But what does climate change mean for sea turtles and their habitats?

Climate change can affect coastal and marine habitats in far-reaching and complicated ways. For sea turtles, humans, and many other species, coral bleaching and sea-level rise are recognized as significant phenomena related to climate change whose effects are being observed throughout the Indian Ocean.

Coral health directly affects sea turtles that inhabit coral reefs, particularly hawksbills in the case of the Indian Ocean. Hawksbills don't eat coral, but they do forage on sponges and other invertebrates that live in reef crevices. After a coral reef dies, hawksbills are still able to forage among the dead branches. However, erosion eventually turns the dead coral into a smooth bed of sand that is relatively devoid of life and, thus, of food for hawksbills.

Coral reefs host the highest levels of biodiversity on the planet, but their stability is threatened because they are sensitive to increases in ocean temperature. A coral reef depends on the symbiosis between reef-building coral polyps and algae (known as zooxanthellae) that reside within the tissue of the polyps. When the water temperature rises too high, corals expel their algae, causing the corals to "bleach" and eventually die unless the temperature drops in time to allow for their recovery.

Ocean temperature in a given location tends to change seasonally and in response to climate-related phenomena such as El Niño. These changes can be dramatic. In fact, the El Niño of 1998 was the most devastating global coral-bleaching event on record, and it did significant damage to corals in the Indian Ocean. Although some sites recovered quickly, others have yet to do so. Unfortunately, coral-damaging events such as that in 1998 might become more frequent as Earth's climate warms; indeed, several smaller events have occurred since 1998. Studies have shown that background sea-surface temperatures are rising and will reach new highs in the coming decades, which may endanger the health of reefs in the Indian Ocean and elsewhere.

The death of corals also affects tropical beaches that are so important to both nesting turtles and human tourism. Corals are critical to the persistence of beaches for two main reasons: they produce sand, and they protect the beach from erosion. Although massive coral mortality can produce a pulse of sand for beaches, this activity lasts just a few years and is soon followed by sand starvation and sand loss that can expose sharp rock beneath. Furthermore, when corals on reef flats die, they lose some of their breakwater function that naturally reduces beach erosion by decreasing wave energy.

Sea-level rise is another major concern for sea turtles and people throughout the world and in the Indian

Ocean in particular. As polar ice melts at unprecedented rates, rising sea levels take their toll on beaches everywhere. On average, the global rise caused by polar ice cap melting is around 2.5 millimeters (.098 inches) per year. However, at coral atolls that develop as their underlying land mass sinks, the relative rise in sea level can be greater than the global average. This circumstance is why the Chagos Islands in the mid-Indian Ocean and the entire nation of Maldives (comprising some 1,200 islands) are both experiencing a relative sea-level rise of nearly 1 centimeter (cm), or .39 inches, per year—four times faster than the global average! In general, a typical beach experiences about 150 units of horizontal erosion for every 1 unit of vertical rise. Therefore, a 1-cm (.39-inch) rise in sea level in the Maldives could remove 150 cm (59.06 inches) of beach platform each year. As a result, some scientists predict that the Maldives may be submerged within 100 years. As a precaution, the Maldivian government is currently procuring parcels of high ground on the Asian continent to provide a long-term refuge for its 380,000 citizens.

In response to the challenges posed by climate change, efforts are being made around the world to reduce human-induced greenhouse gas emissions—a main driver of climate change—and to prepare coastal communities for the impending effects, as in the case of the Maldives. If we each do our part individually and work toward broader solutions collectively, there is still hope on the horizon for turtles and humans alike. But we must act urgently to address this important challenge.

Dr. Jeanne A. Mortimer *is an ecologist and conservationist interested in turtles and coastal and marine habitats. She has worked in some 20 countries during the past 30 years and currently resides in the Seychelles.* ***Professor Charles Sheppard*** *of the Department of Biological Sciences, University of Warwick, United Kingdom, is a marine ecologist with a special interest in the response of coral reef communities to natural and human-induced stresses, including climate change. He has worked extensively in the Indian Ocean.*

Filling in the Gaps

NEW INSIGHTS INTO OLD QUESTIONS ABOUT SEA TURTLE BIOLOGY

"Despite growing interest, our ignorance of the biology and ecology of the world's sea turtles still seems the most fundamental obstacle to their survival."

—Archie Carr, March 1984

It has been more than 50 years since renowned sea turtle researcher Archie Carr published his landmark book, *The Windward Road: Adventures of a Naturalist on Remote Caribbean Shores.* In it, he recounted stories of his early exploits roving the Caribbean, studying sea turtles throughout the region, and pondering and exploring many basic questions about their life history: Where are the primary nesting beaches? Where are the foraging areas for turtles originating from those beaches? How do turtles migrate between those areas? Incredibly, the gaps in our understanding of sea turtle biology that Archie highlighted more than half a century ago continue to drive much of today's sea turtle research worldwide.

Over the past several decades, conservation and research on sea turtle nesting beaches has thrived, and the development of novel tools such as genetic analysis and satellite telemetry have yielded an ever-increasing wealth of knowledge from around the world. Through those approaches, we've learned about important management issues such as genetic stock structure, hotspots of sea turtle habitat, and when and where sea turtles migrate. However, numerous insights have also been gained during this time that remind us of the tremendous value of "low-tech" approaches to studying sea turtles. Gadgetry aside, simple methods such as beach reconnaissance and good, old-fashioned, word-of-mouth networking are still among the most valuable techniques for successfully studying sea turtles.

In the following anecdotes, which are reminiscent of the globetrotting days of Archie Carr, we relay stories of nesting beach discoveries for three species on three continents. Unraveling those sea turtle mysteries did not happen in the 1950s or 1960s, but rather over the past couple of decades, during a time when sea turtle research had seemingly moved on from the fundamental task of cataloguing nesting beaches.

AT RIGHT: Green turtle tracks cover the beach at Ras Al Jinz, Oman. Many sea turtle nesting beaches are still being "discovered" by science, including some that host large nesting populations. Turtle tracks like these are often the first clue of nesting activity. © NICOLAS J. PILCHER

Members of the Eastern Pacific Hawksbill Initiative prepare to attach a satellite transmitter to an adult female hawksbill for the first time in the region. © MICHAEL LILES

Rediscovery of Eastern Pacific Hawksbills

It just didn't make sense. Historical records revealed considerable numbers of small juvenile hawksbills in Mexican Pacific waters, but the scant reports of nesting simply couldn't account for all of the little turtles. The only explanation was the existence of undiscovered nesting sites from which the turtles were originating. But how could this be? How could science miss those sites? In view of the army of dedicated biologists and turtle enthusiasts who have been combing beaches for decades and are armed with the Internet, digital cameras, and aerial surveys, common sense has suggested that someone had to have seen appreciable numbers of hawksbills nesting somewhere in the eastern Pacific.

The mystery began to unfold early in 2008. In January, Andres Baquero provided the first account of hawksbill nesting activity in Ecuador, at Parque Nacional Machalilla, a site where Baquero and his colleagues had just initiated a sea turtle monitoring program. A month later, researchers Mike Liles and Mauricio Vásquez reported at least 80 hawksbill nests being laid annually on secluded beaches in El Salvador. When all the data were analyzed, this number eventually climbed to an estimated 200 nests. It is unclear whether the near-simultaneous accounts were an accident of history or a so-called alignment of the sea turtle stars. Nonetheless, those discoveries gave the first inkling that eastern Pacific hawksbills—a population thought to be long extinct—might still have a chance for recovery. Since then, regional experts have compiled records of more than 300 nests annually throughout the American Pacific, thereby bringing the connectivity of hawksbill nesting and feeding areas in the region into better focus. These findings are fueling hope that conservation may someday be able to restore eastern Pacific hawksbills to their former glory.

Unexpected Find in Syria

Similar to the serendipitous hawksbill story, researchers recently stumbled upon—almost literally—a major nesting population of green turtles in the Mediterranean. This discovery stemmed from the interest by Ph.D. student (and article co-author), ALan F. Rees, to update information on the nesting activity of loggerhead turtles—not greens. Beginning with the first description in 1991, Syrian beaches had been shown to host a small nesting population of loggerhead turtles. However, since that time, information had essentially ceased to flow from Syria, and the importance of Syria for sea turtles slipped into relative obscurity. Because of this lack of new information, the search for answers began with a partnership between Rees and Dr. Adib Saad, a Syrian scientist working on sea turtle bycatch issues. Together, Rees and Dr. Saad agreed to cooperate on a two-month reconnaissance survey of the Syrian coast.

This loggerhead survey in Syria occurred during summer 2004 and was made possible by grants from the Marine Conservation Society and the British Chelonian Group. Dr. Saad and Rees were joined by Mohammad Jony, who became a surveying expert by the end of the summer. The first day of surveying took place in the middle of the nesting season, and the team was expecting to see a handful of old turtle tracks and maybe one or two fresh crawls. They were not prepared for what they found: in their first 300 meters (984 feet) of walking, they identified what they thought were numerous, odd-looking loggerhead tracks. Further along, they located a nest from the previous night, and it became clear that these weren't tracks from loggerheads at all, rather they were from green turtles!

The first survey by Dr. Saad and Rees in 2004 recorded more than 80 tracks, almost all of them attributed to green turtles, a species not previously known to nest in the country. Soon thereafter, tracks were corroborated by confirmed green turtle sightings, and Rees recorded greens doing what the species has likely been doing—unseen by the outside world—on the beaches of Syria for centuries: nesting. Ultimately, more than 100 green turtle nests were recorded, making the previously unknown Syrian population one of the 10 largest in the Mediterranean region.

Local Knowledge Goes Global in Gabon

The so-called discovery of the Gabonese leatherback rookeries is remarkable in that it went unnoticed by the international community for decades, despite what turned out to be a staggering volume of nesting activity. Until the early 1980s, knowledge of leatherback nesting in Gabon existed in local communities, but it was virtually nonexistent in the outside world. This paradigm shifted when French biologist Jacques Fretey—a long-time sea turtle researcher in Africa—was forwarded a letter from

Nicole Girardin describing the "bulldozer tracks" at Pongara Point in Gabon that neither she nor her students could identify. That letter set into motion a series of beach surveys by Girardin and Fretey, the results of which were soon shared with the rest of the world. However, even Fretey underestimated the enormous leatherback population in Gabon on the basis of his initial surveys.

In the 1990s, the local nongovernmental organization titled Aventures Sans Frontières and the European Union program titled Protection des Tortues Marines d'Afrique Centrale (PROTOMAC) started more thorough surveys of the Gabonese beaches. They recorded an astonishing number of leatherback nests—an estimated 6,000 to 7,000 females nesting in southern Gabon each year! As a result, Gabon came to the world's attention not simply as home to important nesting sites for leatherbacks in western Africa, but also as one of the largest leatherback nesting populations in the world. By 2005, several groups involved in leatherback conservation in Gabon had formed the Gabon Sea Turtle Partnership. Over the past few years, members of this partnership have flown over the entire coastline of Gabon three times per season, and their nest counts and abundance estimates continue to refine our understanding about the extraordinary number of leatherbacks nesting in Gabon.

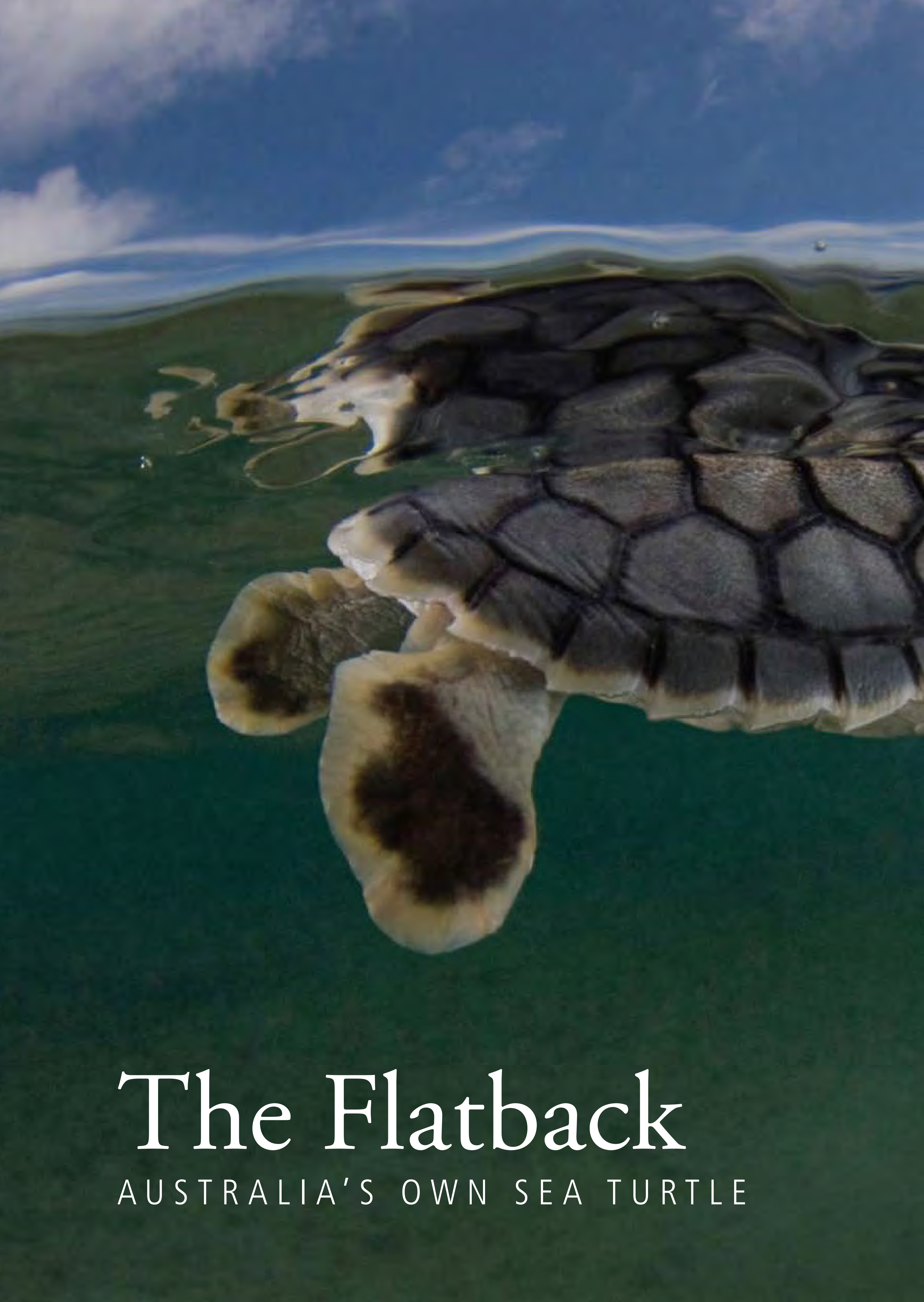
Why did it take so long to make these discoveries?

The stories of hawksbills, green turtles, and leatherbacks described here reflect the many unfilled gaps in our knowledge of sea turtles, including fundamental questions such as where and how many sea turtles nest around the world. When one considers the technological advances of the past few decades, it is hard to understand how major nesting populations can go unnoticed for so long by a global cadre of sea turtle researchers. This mystery may relate to the elusiveness of nocturnally nesting turtles, which tend to appear on secluded beaches rather than populated coastal areas. More important, the persistence of those mysteries within the scientific community also arises from a fundamental disconnect between so-called local knowledge and scientific knowledge. Indeed, the stories spelled out here are clearly discoveries to science, but not necessarily to the local communities near those sites. On the contrary, each of the nesting populations has most certainly been known to local inhabitants for decades, if not generations. Nevertheless, the discoveries provide a sobering reminder that the scientific community has much to learn about the whereabouts and wanderings of sea turtles.

So, where do we go from here? Clearly, the scientific community's understanding of sea turtle ecology and of the conservation strategies necessary for turtles' survival has advanced substantially over the years. Although our high-tech gizmos and remote observations can reveal clues about some of the remaining mysteries, we must remember the equal or greater value of low-tech strategies that fill the gaps in our basic knowledge; the questions of how many, where, and when sea turtles exist continue to be among the most important advances that can be made for sea turtle conservation worldwide.

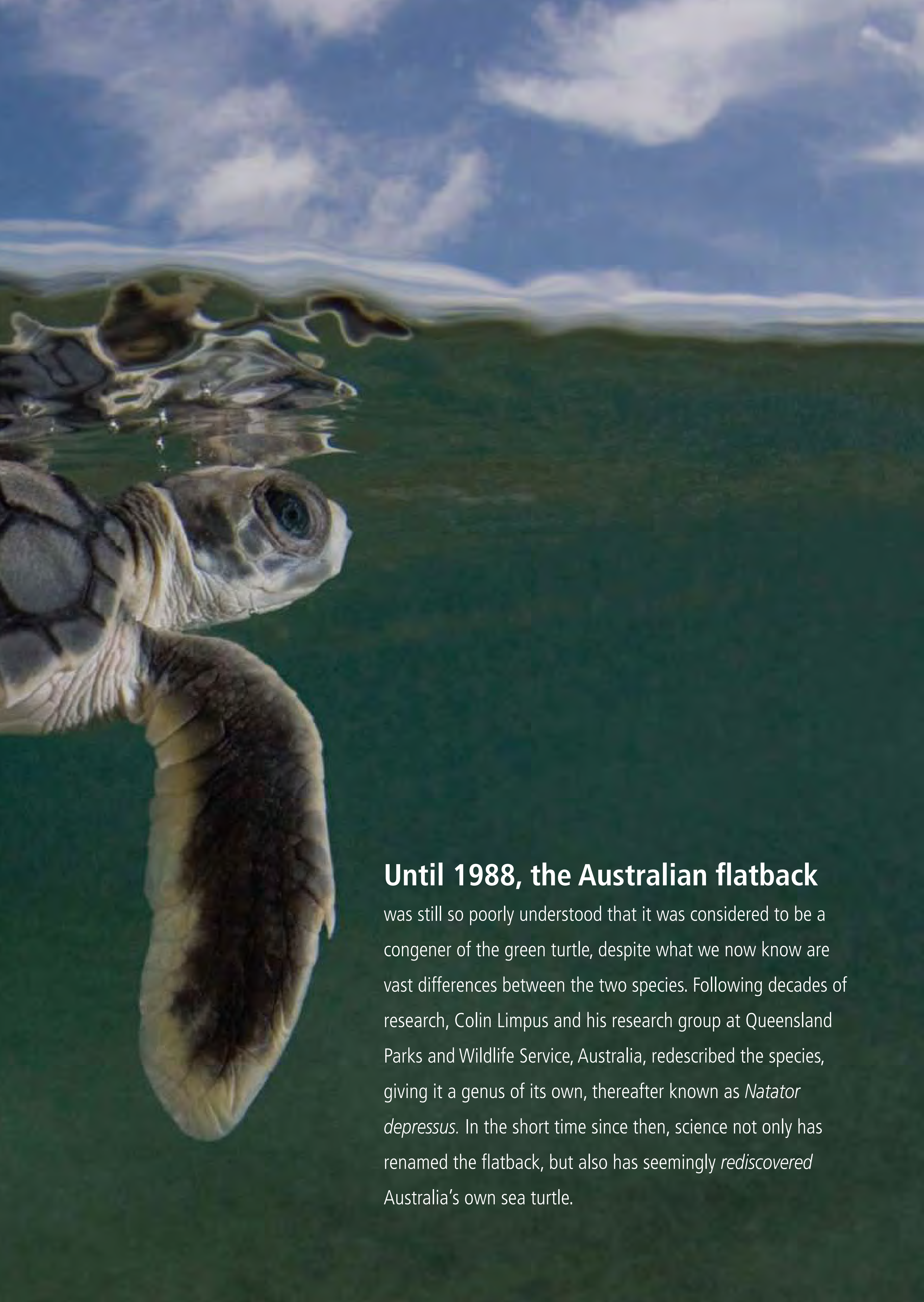
Dr. Jeffrey Seminoff *is a marine ecologist and leader of the Marine Turtle Ecology and Assessment Program for the National Marine Fisheries Service, Southwest Fisheries Science Center. He has been active in marine turtle research and conservation in the eastern Pacific for nearly 20 years.* ***ALan F. Rees*** *is a Ph.D. student and member of the Marine Turtle Research Group based at the University of Exeter, Cornwall, U.K. His current research examines the migration patterns of the sea turtles nesting on Masirah Island, Oman.* ***Dr. Manjula Tiwari*** *is a research scientist at the National Marine Fisheries Service, Southwest Fisheries Science Center, and has been involved in sea turtle research and conservation in West Africa for almost a decade.*

A leatherback nests in Loango National Park, Gabon. © MICHAEL NICHOLS / NATIONAL GEOGRAPHIC STOCK



The Flatback

AUSTRALIA'S OWN SEA TURTLE



Until 1988, the Australian flatback

was still so poorly understood that it was considered to be a congener of the green turtle, despite what we now know are vast differences between the two species. Following decades of research, Colin Limpus and his research group at Queensland Parks and Wildlife Service, Australia, redescribed the species, giving it a genus of its own, thereafter known as *Natator depressus.* In the short time since then, science not only has renamed the flatback, but also has seemingly *rediscovered* Australia's own sea turtle.

Flatbacks are unique among sea turtles in form and function, in life cycle, and in life history. In morphological terms, their pancaked bodies and flared carapace margins—like hydrofoils—are not observed in any other sea turtle species. Flatback shells are covered with only lightly keratinized scutes that tend to be softer and more susceptible to injury than are those of other hard-shelled turtle species. Thus, the sensitive flatbacks rarely nest at beaches that are fringed with coral reefs, preferring open mainland beaches or inshore continental islands where they are less likely to collide with obstructions or to be scraped by an abrasive substrate. Although they nest on a very diverse range of beach types, many of the largest flatback rookeries occur on low-energy beaches that are often sheltered behind broad intertidal zones.

Flatbacks are unique among sea turtles in form and function, in life cycle, and in life history.

Though flatback turtles forage across the northern Australian continental shelf and into the territorial waters of Papua New Guinea and southern Indonesia, the species nests *only* in Australia, making it a truly Australian animal. Indeed, it is the only sea turtle species able to claim endemism to a single country. Because of their Australia-centric life history, flatbacks have one of the most restricted breeding distributions of all sea turtles, second only to the Kemp's ridley that nests solely in northeastern Mexico and in Texas, U.S.A. Although small in global terms, flatback distribution still spans three enormous states in northern Australia, with nesting scattered across numerous beaches from Mon Repos in southeast Queensland across the Northern Territory to the Pilbara region of Western Australia (see map, pages 24–25).

Large segments of the northwestern Australia coastline remain unsurveyed, but major rookeries have been confirmed recently. Among those rookeries, the east coast of Barrow Island has 1,700 nesting females per year, Mundabullangana Beach on the mainland coast has 1,600 nesting females per year, Eighty Mile Beach has hundreds to thousands of nesting females per year, and Cape Dommett has hundreds to thousands of nesting females per year. Furthermore, the Montebello Island group, the Dampier Archipelago island group, and the island chains between Dampier Archipelago and Exmouth Gulf each host flatback breeding populations in the same hundreds to thousands range (see map, pages 24–25).

Despite being intermediate-sized sea turtles as adults, flatbacks lay eggs that match the size of those laid by the mighty leatherback, giving flatbacks the honor of laying the largest eggs and having the largest hatchlings per adult female body size. Genetic and tagging studies have shown that the species comprises at least six genetic stocks, each roughly tied to a distinct nesting area. Across genetic stocks, there are some differences in flatback morphology and in the timing of their breeding. For example, adults from the eastern coast of Queensland (the East Australia Stock) breed through the Australian summer, are larger, lay fewer eggs per clutch, lay larger eggs, and produce larger hatchlings than do those adults in the neighboring Gulf of Carpentaria Stock, which breed in the winter (dry season) months. Across their nesting range, it is not uncommon to observe flatbacks nesting under the blaze of the Australian sun, unlike other large-bodied, nesting sea turtles that typically avoid the burn by nesting under the cover of darkness.

Although there are a few longer-term studies in the Northern Territory and Western Australia, most information about flatback population dynamics comes from Queensland sites. Using long-term tagging studies at Peak Island in central Queensland, we can estimate that adult female flatbacks breed, on average, every two to three years and have a mean reproductive life of 10 years. In addition, new first-time breeding females account for approximately 14 percent of the annual nesting population each year. Similar to other sea turtle species, female flatbacks also show strong fidelity to nesting sites, and data from several long-term studies show that only a small percentage of nesting females change nesting beaches within a breeding season or between breeding seasons.

Flatback nesting beaches are not adjacent to major ocean currents that would disperse hatchlings, as occurs with other species. Indeed, in the 1980s, Terry Walker and John Parmenter found that flatback turtle hatchlings lack an oceanic dispersal phase altogether and, instead, disperse through the inshore waters. Thus, hatchling flatbacks may have evolved a swimming behavior that differs markedly from other species that rely on currents for dispersal to open-ocean habitats. Little flatbacks swim consistently during the 24 hours after emergence, and then they gradually switch to a mostly diurnal swimming pattern. They dive frequently, spending little time at the surface, and they tend to spend more time submerged during dives as they age. This behavior suggests that flatback hatchlings, like green and leatherback hatchlings, might undergo physiological shifts (such as a decrease in residual yolk, an increase in blood volume and lung capacity, or a change in oxygen-carrying pigments) with increased size and age. Their dispersal patterns and residency in continental shelf waters near the Australian coast make flatbacks the ultimate "homebody" sea turtle.

Although we know that flatbacks spend their adolescent years in nearshore areas, an enormous knowledge gap exists regarding the locations and characteristics of habitats used by flatbacks at all life stages, across the entirety of the species' distribution. Flatback turtles do not form the highly visible nearshore mating aggregations that are commonly observed in other species. And in much of their distribution, flatbacks swim in the same waters as the saltwater crocodile *(Crocodylus porosus),* an aggressive and dangerous predator whose presence precludes sensible humans from diving and snorkeling nearby. Because of the crocodile threat, the study of the flatback's marine habitats and behaviors requires approaches that are creative, opportunistic, and nonlethal (to humans or turtles). In fact, most flatback in-water behavior information has come via satellite, with researchers collecting data from the safety of their offices.

In a satellite tracking program in the Pilbara region in 2005, 16 satellite tags were deployed on nesting flatback turtles at Barrow Island and at Mundabullangana Beach on the mainland (280 kilometers [174 miles] east of Barrow Island). The Pilbara satellite tracking program has shown that flatback turtles use shallow, nearshore (mainland coast), inter-nesting habitat—regardless of whether they nest on the mainland or offshore on Barrow Island.

AT RIGHT: A flatback turtle comes ashore to nest on Eighty Mile Beach in Western Australia. Although the flatback is a medium-sized sea turtle, its eggs are the size of the mighty leatherback. © CALEN OFFIELD PREVIOUS SPREAD: A flatback hatchling swims out to sea from a nesting beach near the Torres Strait in Queensland, Australia. © DOUG PERRINE / SEAPICS.COM

In addition, not all of the flatback turtles tracked showed strong foraging-site fidelity. Some traveled constantly along the Pilbara and Kimberley coastlines, stopping briefly for a few days over unidentified seabed features before moving on to other sites. Following the nesting season, satellite tracking results indicated that between 41 and 72 percent of the recorded locations for foraging flatback turtles were in waters 50 to 100 meters (54.5 to 109.0 yards) deep and between 100 and 1,000 kilometers (62 and 620 miles) from the nesting beaches. This range of distances is similar to those recorded in eastern Australia from tag recoveries, which also show migration distances up to 1,300 kilometers (806 miles).

Additional information on foraging flatback turtles has come from trawling bycatch records, limited mainly to eastern and northern Australia, which were collected by the Queensland Department of Primary Industries immediately before the introduction of bycatch reduction devices (the Australian equivalent of the turtle excluder devices of the 1990s). Those records of bycatch of flatback turtles in trawl nets brought to light another interesting observation: researchers working on turtles and bycatch issues in Queensland reported that flatbacks seemed to survive forced submersion better than other sea turtles—twice as well as loggerheads. This finding prompted questions about what makes flatbacks such successful survivors.

A study of flatback diving behavior and respiratory physiology was initiated between 2000 and 2002 to investigate whether flatbacks are particularly well adapted for long dives. The study found that adult flatbacks most frequently dove to the ocean bottom and that they spent 57 percent of their time submerged on the seafloor. During the dives, turtles presumably remained inactive because the dive records showed that they appeared to passively ride the up-and-down cycles of tides, requiring little time at the surface to breathe between prolonged dives. The inactive dives typically lasted nearly an hour (up to 98 minutes), which is unusually long for adult sea turtles; similarly inactive dives to the seafloor by loggerhead turtles typically last only 30 minutes, and rarely in excess of an hour.

The answers to this riddle of prolonged submergence appear to be in the flatback's blood. In general, air-breathing, diving animals must

Researchers attach a satellite tag to a flatback turtle on Cemetery Beach in Port Hedland, Western Australia. Satellite tracking studies are shedding new light on the marine habitat use of flatback turtles, the only sea turtle species whose entire life cycle occurs on the continental shelf. © CALEN OFFIELD

rely on oxygen that is stored in blood and muscles once the oxygen in their lungs either is consumed or becomes unavailable. However, the capacity for the flatbacks' blood to store oxygen and to buffer the potentially toxic buildup of carbon dioxide during breath-holding is at the high end of the range in diving reptiles. So, because flatback turtles are rarely found in waters deeper than 45 meters, their respiratory physiology may be suited particularly well to sustaining prolonged dives in shallow habitats. Researchers think that those traits could explain the flatback's ability to survive the stress of forced submergence in trawl nets better than the less-resilient loggerhead.

Although the scientific world has come to know the flatback only recently, the relationships between sea turtles and indigenous peoples in the region have spanned millennia. Many present-day flatback nesting sites are located on the lands of Aboriginal or Torres Strait Islander people, and partnerships among those indigenous communities, researchers, and government have been critical in improving knowledge of flatback distribution, biology, and conservation. The research and conservation programs have greatly benefited from the inclusion of traditional ecological knowledge and the enthusiastic participation of several indigenous communities in monitoring exercises. Successful management of flatback turtles in northern Australia will ultimately rely on those community collaborations.

The once mysterious flatback turtle has literally been drawn out of obscurity in the past few decades, has been researched and renamed, and has been brought to the attention of the world. In a country known for strange and superlative creatures—from egg-laying, poisonous mammals, such as the platypus, to man-eating crocodiles larger than any other reptile on Earth—the flatback turtle has entered the ranks of Australia's most amazing animals. Whether known for its smallest home-range, longest dives, biggest eggs, or any of the other unique natural history and physiological features highlighted here, the flatback is unquestionably an Australian original and an icon for the country's unique biodiversity.

Mark Hamann *is a research fellow at James Cook University in Townsville, Australia.* ***Colin Limpus*** *leads the Freshwater and Marine Ecology team within the Queensland Environmental Protection Agency in Brisbane, Australia.* ***Kellie Pendoley*** *is a marine conservation biology consultant based in Perth, Australia.* ***Chloe Schauble*** *is the monitoring and evaluation coordinator with Burdekin Dry Tropics NRM in Townsville, Australia.* ***Jannie Sperling*** *is a marine biologist from Brisbane, Australia.* ***Jeanette Wyneken*** *is an associate professor of biology at Florida Atlantic University, Florida, U.S.A.*

SWOT Feature Map

Global Biogeography of the Flatback *(Natator depressus)*

The SWOT feature map on the following pages displays the global biogeography of the flatback turtle *(Natator depressus)* and demonstrates, as described in the preceding article, that flatbacks are undeniably Australia's own sea turtle. In the map, the relative abundances of nesting rookeries are displayed by site over varying time periods; some rookery sizes are represented by averages over several years, and others are represented by the most recent available year of data at that site (2006, 2007, or 2008). Nesting abundances are indicated by number of clutches. In areas where abundance data were reported as numbers of crawls or numbers of nesting females, conversion factors were used of 70 percent nesting success (numbers of crawls that resulted in successful clutches) and 2.8 clutches per female, respectively (Limpus, C. J. 2007. *A biological review of Australian marine turtle species. 5. Flatback turtle, Natator depressus (Garman).* The State of Queensland. Environmental Protection Agency, 2007). Altogether, the map displays 290 flatback nesting sites from nine different data providers. Please see the SWOT Data Contributors section on pages 47–48 for complete citations of all data points.

This map represents the "next generation" of SWOT spatial displays of biological information on sea turtles and is an exciting step forward. In addition to the nesting abundance estimates shown in previous *SWOT Report* centerpiece maps, the flatback map incorporates, for the first time, data on in-water distribution and known genetic stocks. A special thanks goes to Dr. Nancy FitzSimmons (University of Canberra) for providing the most current genetic stock information (see Data Contributors section for more information on genetic stocks, pp. 47–48).

Visit **www.SeaTurtleStatus.org** to see SWOT's interactive map with leatherback, loggerhead, hawksbill, and flatback nesting data!

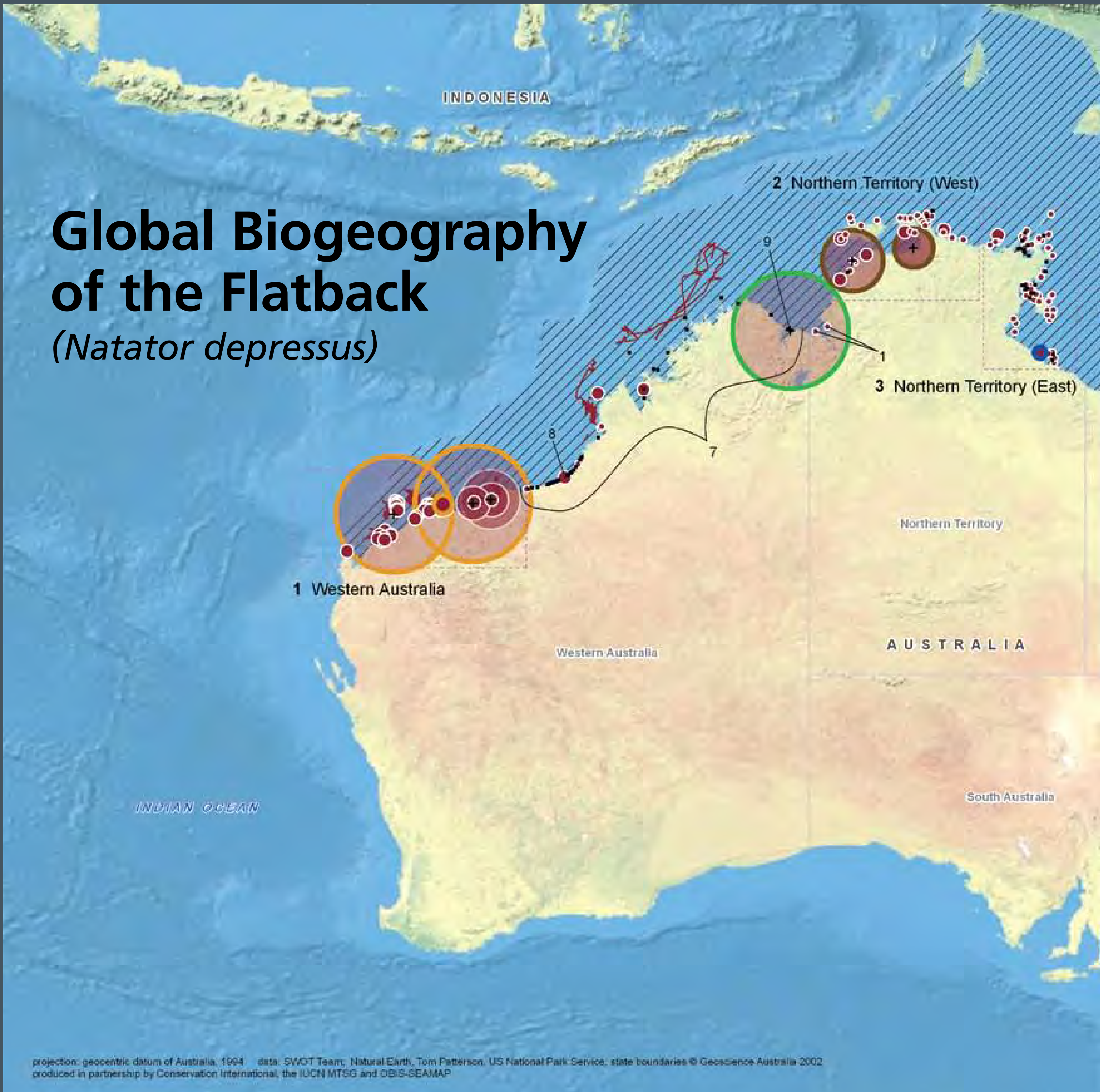
Flatbacks in Focus

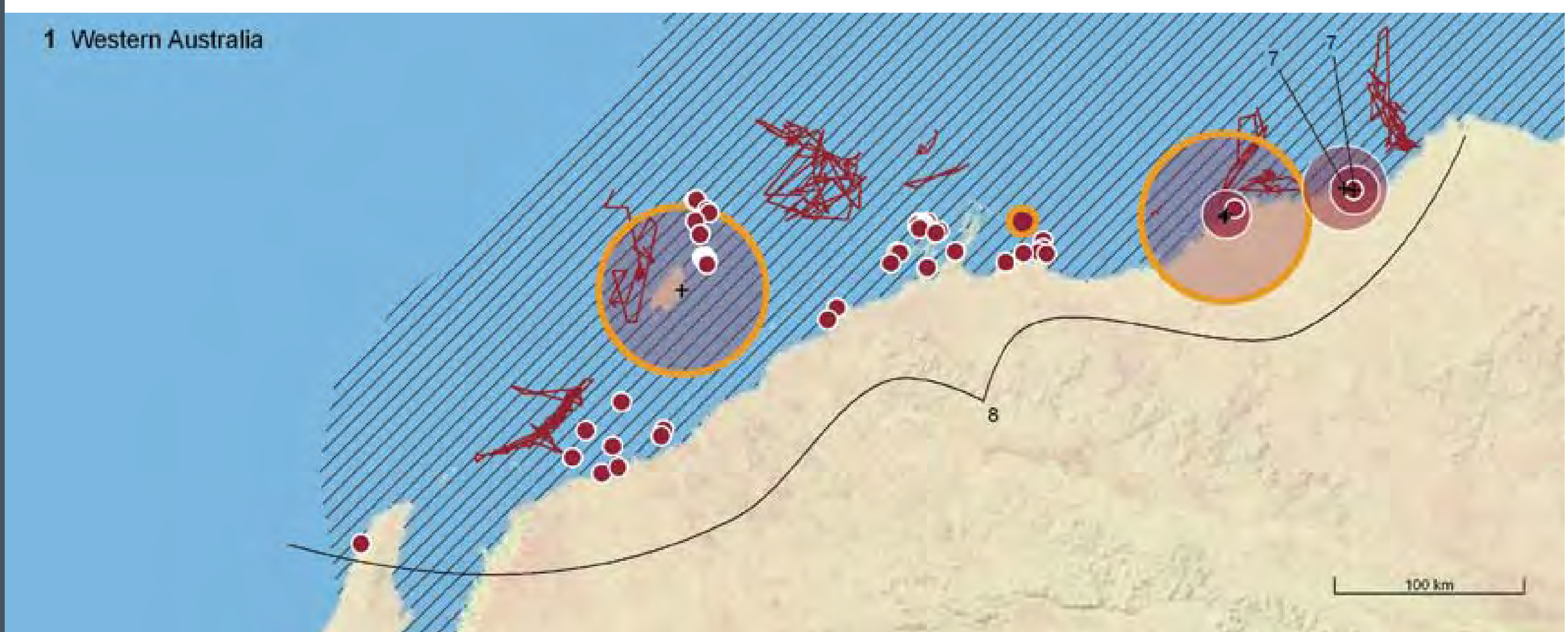
The year 2008 was a landmark for SWOT. For the first time, SWOT sent a photographer to the field for a special *SWOT Report* photo expedition. Nature photographer Calen Offield traveled to Western Australia for an up-close look at the unique flatback turtle. He worked side by side with flatback scientists and enthusiasts, and he spent hours on remote beaches capturing many of the images used in this year's Special Feature.

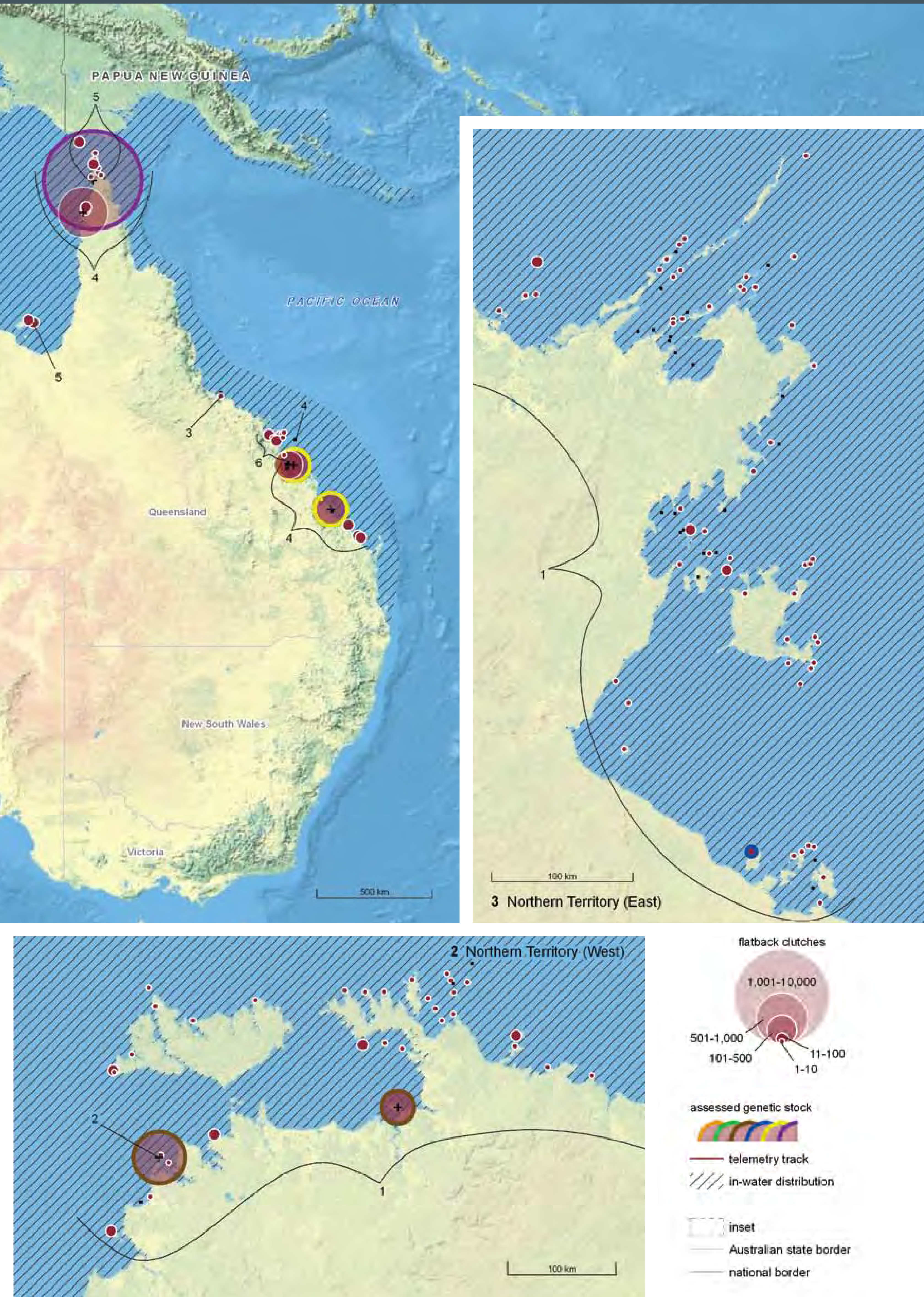
Visit **www.SeaTurtleStatus.org** to view a digital slideshow with additional images from Calen's expedition!

Global Biogeography of the Flatback

(Natator depressus)







PAPUA NEW GUINEA
PACIFIC OCEAN
Queensland
New South Wales
Victoria
500 km
3 Northern Territory (East)
100 km
2 Northern Territory (West)
100 km
flatback clutches
1,001-10,000
501-1,000
101-500
11-100
1-10
assessed genetic stock
telemetry track
in-water distribution
inset
Australian state border
national border

outreach & action

From Corail to KELONIA

l'observatoire des tortues marines

A New Chapter for Indian Ocean Sea Turtles

For thousands of years, sea turtles have been hunted for their meat and used to produce various consumer items such as jewelry, leather, and medicine. This consumption has ranged from subsistence to large-scale commercial practices. To meet those consumer demands, some people and groups have attempted to breed and raise sea turtles in captivity. Although nearly all of those facilities have since closed because of sea turtles' endangered status, trade restrictions, and dwindling demand, some have been redefined to live on in a new light. *Ferme Corail* (Corail Farm), on the French Indian Ocean island of Réunion, is one such facility, and to follow its story is to follow the changing landscape of human interest and intervention in the lives of sea turtles.

Ferme Corail sea turtle ranch was established in 1977. Constructed with local and national financial backing and the support of local communities and the French government, the primary goals of this facility were to create jobs and earn foreign revenue through the export of turtle meat and products.

The supporters of the ranch believed that marketing and selling "ranched" sea turtle products would lower the human pressure on wild turtle populations, yet still meet the demand for the products. Additionally, *Ferme Corail* would rely on the collection of hatchling turtles from the wild on nearby Europa and Tromelin islands. Because of this association, those islands were declared to be protected nature reserves.

Despite the fact that this endeavor was based on the premise of sustainable use of a natural resource and that it sought to balance conservation and consumption, the ranching project attracted serious criticism from environmental organizations at the time. In addition to this opposition, the listing of sea turtles on Appendix 1 of the Convention on International Trade in Endangered Species (CITES) in 1981 severely complicated basic operations by prohibiting the international export of sea turtles or their products and thereby limiting the market to Réunion itself.

However, by the 1980s, *Ferme Corail* had become the most visited tourist site on Réunion Island. So, in 1989, the Réunion Regional Council lent its support to sea turtle research, conservation, and tourism by buying the *Corail* complex and by petitioning the appropriate ministry to establish a legal framework under which a new institution could operate.

The subsequent "Rehabilitation of the *Ferme Corail"* was financed by the Réunion Regional Council and the European Union. Built directly on the site of the former turtle ranch, the new facility—Kélonia, the Observatory of Marine Turtles—was born in 2006 with a double mission: to educate the public about the importance of conserving the area's natural and cultural heritage regarding sea turtles, and to participate in and develop research and conservation programs for sea turtles and their habitats.

This innovative center of excellence for research and public education is a testament to the vision of the people of Réunion Island. Kélonia's exhibitions have been designed to illustrate the role of sustainable consumption, particularly of marine resources. The purpose is to encourage visitors to reflect on the necessity and the difficulty of reconciling economic factors, society, environment, and culture, with great emphasis placed on both social and natural sciences.

Today, more than 100,000 people visit Kélonia each year, making it a highly successful tourist attraction and positioning Réunion Island as a major player in the research and conservation of sea turtles and their habitats in the Indian Ocean.

***Stéphane Ciccione** is a marine biologist; manager of Kélonia, the Observatory of Marine Turtles of St. Leu, Réunion Island, France; and vice-chair of the West Indian Ocean Marine Turtle Task Force of the Indian Ocean-South East Asian Marine Turtle Memorandum of Understanding and Nairobi Convention.*

THIS PAGE: Built on the site of a former sea turtle farm, Kélonia's observation tanks give visitors a glimpse of sea turtles in their underwater world. © FRANÇOIS-LOUIS ATHENAS
AT LEFT: A tourist prepares green turtle hatchlings for release in Hawaii. Firsthand experiences with sea turtles spark wonder and appreciation, helping to foster long-term support for marine conservation. © DAVID DOUBILET

The vast majority of sea turtle studies happen on beaches when females emerge to nest, yet sea turtles spend virtually all of their lives at sea. Aside from the logistical challenge of studying the turtles down deep where they live, there are also potentially prohibitive economic components including skilled professionals, boats, and scuba (self-contained underwater breathing apparatus) gear. In spite of those challenges, since 1998 the Barbados Sea Turtle Project (BSTP) of the University of the West Indies, Barbados, has been monitoring hawksbill turtles on foraging sites at depths of up to 40 meters (131 feet).

Most foraging ground studies are conducted in shallow waters where sighting and capturing the animals are easier. Given sufficient turtle numbers in a shallow-water study site, researchers can achieve fairly high capture rates with minimal gear using common techniques such as netting, turtle rodeo-ing (jumping off a boat), and snorkeling or free-diving.

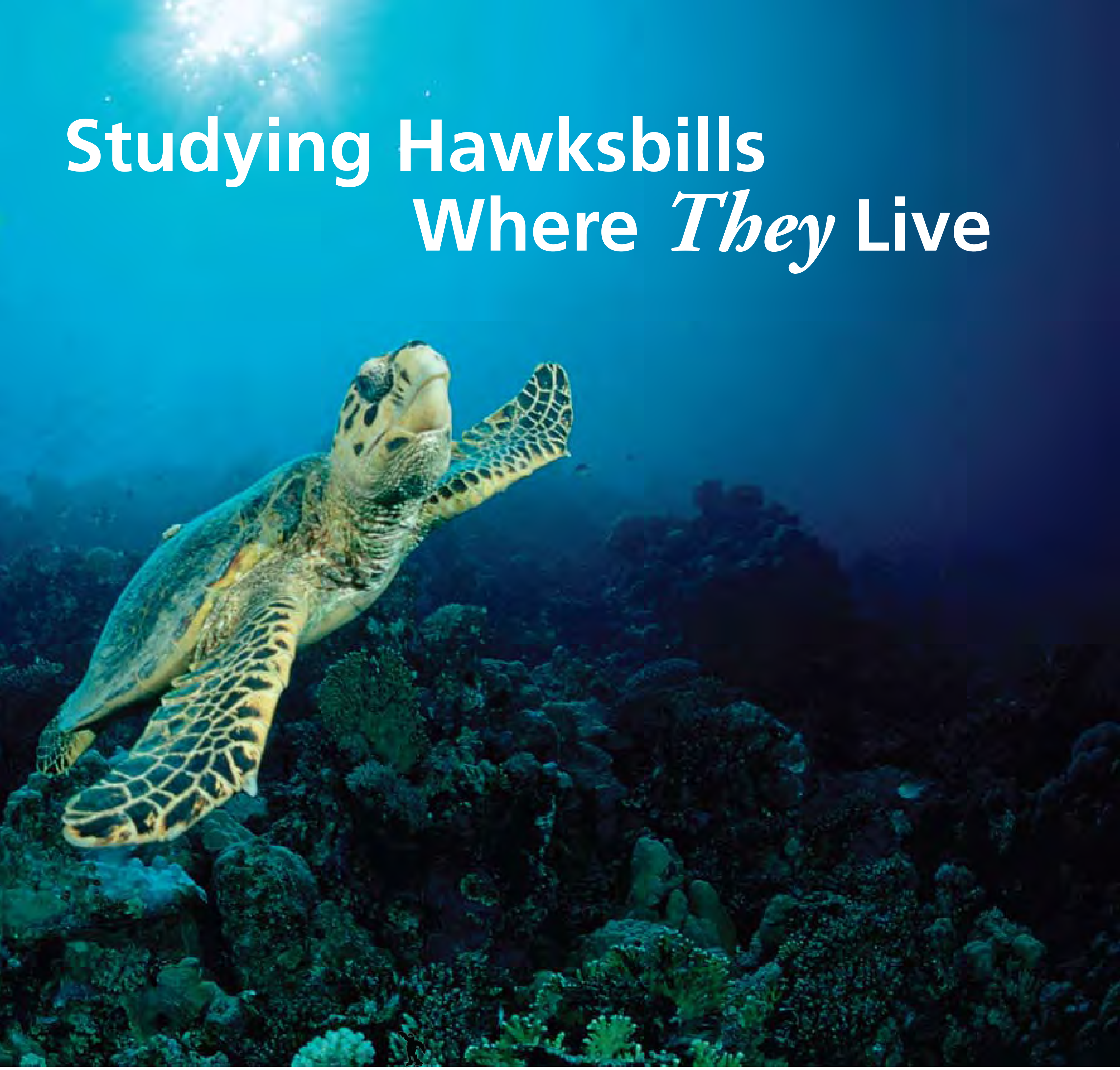
The study of turtles in deeper water habitats, however, requires a boat, a crew, and usually scuba diving. Although scuba diving allows people to enter underwater worlds that are otherwise inaccessible, it requires safety precautions that set certain limitations, such as the number of safe ascents and descents that can be made in a given time period. As such, the catch-per-unit effort is generally lower than with surface capture methods, and many hours of diving are required to catch a sufficient sample of turtles for research purposes. Surface capture studies generally have a high intensity of effort over a shorter period of time, whereas scuba diving requires a significant investment in time spread over a longer period.

In Barbados, BSTP has overcome the costs and logistical issues involved in operating a scuba diving–based turtle monitoring program by partnering with a recreational dive company, Hightide Watersports. The company generously allows the BSTP staff to conduct underwater research without paying for boat time, tank fills, or dive equipment. As a result, BSTP has conducted more than 2,500 hours of survey on 1,700 dives over the past decade. The project has captured approximately 1,000 turtles, mostly juvenile hawksbills, with many caught more than once and some up to 15 times over a 10-year period.

During the study, turtles are brought aboard the dive boat where researchers can collect standard morphometric data, apply tags, and collect samples. This program has provided important new information on growth and survival of juvenile and sub-adult size hawksbill turtles and has allowed BSTP to develop a tissue database representing many individuals, sampled over a long time span.

In return for supporting BSTP, Hightide Watersports is able to provide a unique experience for its customers. With sea turtle biologists conducting research on board, patrons are able to see turtles up close in a controlled environment in which they can watch the data collection process, ask questions, and take photographs. Non-divers can also go out on the dive boat to observe the monitoring, thereby providing the dive operator with an additional source of income. BSTP biologists use the opportunity to provide a thorough, educational experience for Hightide Watersports' customers, who often declare it to be "the highlight of their entire holiday." This experience often results in repeat visits by customers within the same holiday period, and it is also a driving force for repeated vacations to Barbados. The turtle experience can be so profound that many participants stay engaged with BSTP for years after their trip, writing to find out about the turtle(s) they saw captured during their dives.

Studying Hawksbills Where *They* Live



Deep-water research is providing life-history information about sea turtles that is of great importance in helping to conserve those animals and their habitats. In Barbados, it is also providing added business for a tourist-centered dive operation. Although the value of nesting sea turtles to tourism is well recognized, the value of foraging animals is seldom seen. The partnership between BSTP and Hightide Watersports serves as a model for how the challenges of conducting at-sea turtle research can be met through creative and mutually beneficial ties with the tourism industry.

A scuba diver trails after a hawksbill. © REINHARD DIRSCHERL / OCEAN-PHOTO.DE INSET: Barry Krueger prepares to release a hawksbill turtle after conducting research aboard a dive boat in Barbados. © BRIAN J. HUTCHINSON

Barry Krueger *is a Ph.D. student at the University of the West Indies (UWI), Barbados, currently conducting research in Western Australia with Pendoley Environmental Pty Ltd.* ***Julia Horrocks*** *is a professor in the Department of Biological and Chemical Sciences at UWI, Barbados, and director of the Barbados Sea Turtle Project.*

Visit **www.SeaTurtleStatus.org** to watch footage of Barry Krueger in the field!

Gone Turtling

Today is a rare day off the rugged Atlantic coast of northern Cape Breton Island in Nova Scotia, one of Canada's eastern provinces. Instead of blowing a gale as it usually does, the wind is quiet and the water is flat calm, reflecting the sky above it like a sheet of glass.

Bert Fricker, a commercial fisher from the tiny village of Neil's Harbour, looks over the water and announces, in a hopeful tone, that it is a perfect day for swordfishing. He leaps aboard the *Ben and Em,* his brother Blair's red-and-white Cape Island fishing boat.

Although the Frickers expertly set up a swordfish harpoon pole, it isn't that elusive animal—not seen for years in this area's waters where it was once abundant—for which they're going to sea today.

Today, as they have done for the past 10 years, the Frickers are off "turtling" with biologist Dr. Mike James of the Canadian Sea Turtle Network (CSTN). When James first arrived in Neil's Harbour a decade ago in search of the endangered leatherback turtle at sea, he met the Frickers at their homes with a giant hoop net for catching turtles strapped to a makeshift roof rack on his car. The comic scene brings laughter even now—the fishermen ribbing James for the heavy equipment that they immediately began helping adapt for the realities of working on the ocean.

The team has worked together since, chatting, even at this early hour, as they pile onto the *Ben and Em* for what looks to be a good day.

… the greatest threat to leatherback turtles in Canadian waters is entanglement in fishing gear.

This scene is remarkable not only for the long list of scientific information important to the conservation of leatherbacks that this teamwork has contributed, but also for the fact that the greatest threat to leatherback turtles in Canadian waters is entanglement in fishing gear. Yet, in Canada, the people who are working to save this species are commercial fishermen. In addition to the Frickers, CSTN works with more than 500 volunteer fishermen to conserve leatherbacks at sea.

Bert, Blair, and their nephew Josh are the core field team in Neil's Harbour, and they are involved in everything from designing equipment to capturing turtles. They record and help to analyze data. And they watch carefully, as the turtles that the team has satellite tagged make incredible journeys of thousands of kilometers from chilly Canadian waters down to nesting beaches throughout the Caribbean.

Other fishermen in CSTN disentangle turtles they find accidentally caught in their gear and call in sightings of the turtles they find at sea. Together, they have helped identify Canadian waters as critical habitat for this endangered species.

James and his colleagues at CSTN are adamant about the importance of working with fishermen to conserve marine species. Fishermen have proved to be willing and committed partners, when approached with respect and as the intelligent and knowledgeable mariners they are.

Today is also special in another way. As Blair navigates the *Ben and Em* in a wide arc around the breakwater and out to sea, his son, Ben, hops up next to him, hoping to be the first to spot a turtle. Ben is as eager to learn about the ocean and the animals in it as is his father—and many fishermen like him—to protect them for his future.

Kathleen Martin *is the Executive Director of the Canadian Sea Turtle Network, based in Halifax and Neil's Harbour, Nova Scotia.*

Father and son team, Blair and Ben Fricker, assist in the handling of an adult leatherback turtle near Neil's Harbour, Nova Scotia. © CANADIAN SEA TURTLE NETWORK

ghostnets

Most people have heard about the huge island of plastic rubbish in the north Pacific. Most have seen the photos of the seals and dolphins strangled by plastic bags. Most, too, know that the vast majority of this rubbish comes from urban centers—where people like you and me discard single-use plastic bags, bottles, and packing materials—and that many people are working to change this throw-away paradigm. There is, however, another lesser acknowledged form of rubbish that plagues our seas today: ghost nets.

Ghost nets are lost or discarded fishing nets that travel the world's oceans on the currents, indiscriminately trapping sea turtles and other marine life in their wake. Reaching up to 15 meters (49 feet) in depth and 90 kilometers (56 miles) in length, those nets may continue to "ghost fish" for up to 600 years, according to some estimates, before disintegrating. Huge, heavy, and dangerous, ghost nets are difficult to contend with anywhere. Nonetheless, two groups from very different parts of the world are confronting the ghost net problem head-on, thereby demonstrating promising ways of accomplishing the job.

"We believe our well-being and the turtles' well-being are inseparable. To put it another way, we belong to turtles and turtles to us—we sustain them and they us. As custodians and managers of sea country, we have the responsibility to work with others to manage turtles."

—Kennett, Mununggiritj, and Yunupingu

Partnering to Rescue Turtles from Ghost Nets on Shore

Sea turtles are culturally, economically, and ecologically important to the indigenous peoples of northern Australia, an area where six sea turtle species come to forage and breed. When indigenous sea rangers noted how many of those cherished animals were being trapped and killed by the ghost nets washing up on their remote shores, they decided to take action. In 2004, rangers from 18 different communities in the Torres Straits, Arnhem Land, and the Gulf of Carpentaria put aside local differences and came together to form the Carpentaria Ghost Nets Programme.

The Carpentaria Ghost Nets Programme takes a comprehensive, on-the-ground approach to solving the ghost net issue, following a methodology defined by "6Rs": Remove, Record, Rescue, Report, Reduce, and Research. Over the past three years, the group has walked and driven 1,500 kilometers (903 miles) of coastline while excavating, untangling, hauling, and cataloguing more than 4,700 ghost nets that originated from various places around the world. Apart from small crabs, sea turtles have accounted for 95 percent of marine life found in the nets, and more than half of the turtles encountered have been successfully rescued and returned to the wild.

In February and March 2008, monsoons brought a particularly high number of turtle strandings to Pennefather Beach—a 42-kilometer (26-mile) stretch of beach on Cape York. Amid extremely challenging weather conditions, Napranum Shire Council Rangers Peter Harper and Angela Christie organized volunteers to help patrol the beach for entangled marine life. A total of 62 turtles, mostly olive ridleys, were found over the course of a three-week period. Of those, 15 animals were found dead, 21 were released on site, and 26 were taken to a makeshift rehabilitation center where all but three were nursed back to health.

Three months later, the Sea Rangers were joined by a team from Conservation Volunteers Australia to begin the process of removing nets. During a period of nine days, the expanded group not only removed and processed 470 ghost nets and 40 bags of other marine debris, but also released the last remaining turtle from rehabilitation equipped with a satellite tag generously donated by Dhimurru Rangers from Nhulunbuy.

The success of the Carpentaria Ghost Net Programme is an example of what can happen when communities come together to find solutions.

Tackling Ghost Nets on the High Seas

Headquartered in Wasilla, Alaska, the High Seas GhostNet Project has taken a different approach to solving the problems posed by ghost nets. Rather than collecting nets that have already drifted ashore, this group of scientists, academics, and businesspeople aim to remove the nets from the open seas.

The project was born in May 2001 at an Alaska Regional Workshop in which U.S. Senator Ted Stevens, the keynote speaker, challenged workshop participants to find ways of using technology in ghost net mitigation. The team that responded proposed using ocean modeling, together with satellite and airborne remote sensing, to identify convergence zones in the north Pacific where lost or abandoned

fishing nets would be expected to accumulate. Initially funded by a grant from the National Aeronautics and Space Administration, the project is now supported by the National Oceanic and Atmospheric Administration (NOAA), and it currently consists of team members from Airborne Technologies, Inc. (ATI), NOAA's NESDIS/STAR (National Environmental Satellite, Data, and Information Service/ Center for Satellite Applications and Research), and the Joint Institute for Marine and Atmospheric Research.

The team's first field program was conducted during summer 2003 in the Gulf of Alaska, where, using satellite imagery, the High Seas GhostNet team identified and tracked four long-term eddies likely to draw debris. With near-real-time tracking capabilities provided by satellite, an aircraft with remote sensing equipment was directed to fly over the eddies. The aircraft confirmed the satellite data, identifying concentrations of debris retained within the eddies.

A drifter buoy program has also been initiated to help track ghost nets until their safe removal from the water is possible. Small drifter buoys developed and built by ATI are distributed to select ships travelling in these general areas of convergence. When ships come across debris, they tag it with a buoy that communicates its position by satellite, not only revealing the position of the nets, but also confirming the movement of debris in ocean circulation patterns.

Building toward more focused ghost-net removal efforts, ATI is currently developing a small Unmanned Aircraft System (UAS). The UAS will be capable of being deployed from ships directed into areas of convergence by satellite data and will help those ships to locate individual nets for immediate retrieval. Successful test flights were performed aboard a NOAA ship this past spring.

Our oceans are highly complex and are deeply affected by what we put in and take out of them. Cleanup programs aimed at removing ghost nets, such as those just described, are vital to overall ocean health and to the prevention of the loss of sea turtles and other marine life caught in their grips. Moreover, programs such as these provide a wonderful opportunity to create awareness about ocean conservation and to involve local people and scientists alike in hands-on problem solving. Long-term solutions for reducing this dangerous form of manmade waste will require an integrated program of action locally, nationally, and internationally and a concerted effort to broaden our understanding of marine pollution.

Riki Gunn *is the project coordinator of the Carpentaria Ghost Nets Programme in Karumba, Queensland, Australia.* ***Tim Veenstra*** *is the principal investigator of the High Seas GhostNet Project and the president of Airborne Technologies, Inc.*

THIS PAGE: A prototype for an Unmanned Aircraft System, meant to aid in the detection of marine debris in the open ocean, is tested aboard a National Oceanic and Atmospheric Administration vessel. © NOAA AT LEFT: Of the nearly 5,000 nets identified by sea rangers in the Gulf of Carpentaria, less than 10 percent are of Australian origin. © ALISTAIR DERMER / CARPENTARIA GHOST NETS PROGRAMME PREVIOUS PAGE: A green turtle is found entangled in a ghost fishing net in the Cayman Islands. © DOUG PERRINE / SEAPICS.COM

policy & economics

THIS PAGE: Revenues from TAMAR products support sea turtle research, conservation, education, and outreach in Brazil. © PROJETO TAMAR AT LEFT: Various bycatch mitigation measures are used in fisheries around the world to reduce incidental capture of seabirds, marine mammals, and sea turtles. Bycatch is a major hazard for those marine animal populations and can also be detrimental to the livelihoods of fishermen. © DAVID DOUBILET

Retail Sales Help Communities and Sea Turtles in Brazil

Founded in 1980, Projeto TAMAR is a strategic alliance of Brazilian government, nonprofit, and private-sector partners, as well as numerous local communities—all committed to the common purpose of promoting the wise use and protection of sea turtles in Brazil and internationally.

When their first research and conservation field stations were established nearly three decades ago, TAMAR's founders were faced with the challenges of finding viable economic alternatives for low-income coastal residents who, for decades, had survived by collecting turtle eggs and consuming nesting turtles. TAMAR researchers and volunteers worked directly with local citizens to accumulate detailed knowledge of community economics and to identify specific market opportunities that use turtles non-consumptively.

At first, TAMAR hired turtle poachers, paying them wages to protect rather than exploit the turtle population. Later, the poachers' wives, children, and other families became involved as well. The TAMAR effort now serves dozens of coastal communities in northeastern Brazil by providing employment and other public benefits to local residents.

TAMAR's visitor centers provide a variety of attractions for tourists such as museums, tanks and aquaria, educational exhibitions, video and multimedia auditoriums, cafeterias, and bars. A network of 13 TAMAR shops located at visitor centers and in airports and shopping malls throughout eastern Brazil are another fundamental part of TAMAR's self-sustainability and community interaction programs.

TAMAR shops are the exclusive sales points for a line of products including T-shirts, caps, local handicrafts, and other souvenirs. Revenue from retail sales pays for approximately one-third of TAMAR's annual budget. The souvenirs are inspired by TAMAR's principal objectives of sea turtle protection and research; thus, in addition to generating fiscal profits, the shops fill education and outreach roles.

The manufacturing of TAMAR souvenirs generates employment for hundreds of people and is a considerable stimulus to the local economy. The first cottage industry producing T-shirts was created in 1990 in Regência, Espírito Santo. Since then, both product quality and commercial sales have improved, thus inspiring the creation of a similar operation in Pirambu, Sergipe. TAMAR's social production chain provides local jobs from the acquisition of raw materials through to the production and delivery of goods and services, and it ensures a regular flow of supplies and products among TAMAR's several field stations, shops, and visitor centers. Communities close to the field stations and those in areas with limited potential for tourism are all involved. Presently, more than 1,200 jobs are maintained through TAMAR's social production chain.

Ecotourism and the retail sale of locally produced souvenirs help not only to fund research and conservation of sea turtles in Brazil, but also to fulfill critical environmental education and outreach objectives and to boost local economies that once depended on the nonsustainable use of sea turtles. Moreover, TAMAR's social production chain has helped to create a heightened sense of social inclusion and pride among involved community members. This reconciliation of conservation and turtle-friendly economic activities for community members is one of TAMAR's most notable achievements.

Guy Marcovaldi *is an oceanographer, Director of Projeto TAMAR-ICMBio, the federal government agency responsible for the Brazilian Sea Turtle Conservation Program, and member of the board of Fundação Pró TAMAR.* ***Neca Marcovaldi*** *is an oceanographer, President of Fundação Pró TAMAR, the nongovernment organization that co-manages the Brazilian Sea Turtle Conservation Program, and Vice Chair of the IUCN Marine Turtle Specialist Group for the Western South Atlantic region.* ***Joca Thomé*** *is an oceanographer, Regional Coordinator of Projeto TAMAR-ICMBio, Vice Chair of the Marine Turtle Specialist Group for the Western South Atlantic region, and member of the board of Fundação Pró TAMAR.*

Juvenile loggerheads spend decades traversing the north Pacific Ocean. © GARY BELL / OCEANWIDEIMAGES.COM

TurtleWatch

Turtle Watch Minimizes Clashes between Loggerheads and Longliners

Juvenile loggerheads leave their natal beaches in Japan and spend a large portion of their early life in the open ocean traveling and foraging along a trans-Pacific "highway," with some turtles reaching foraging grounds in Baja California. On journeys lasting many years, turtles migrate and forage along convergent fronts of temperature and productivity that span the entire north Pacific. This loggerhead highway crosses, at times, into the fishing grounds of the Hawaii-based pelagic longline fleet that targets swordfish and tuna, and head-on collisions between loggerheads and longline fishing gear can result from this overlap. The Hawaiian longline fishery has been closed in the past because of high sea turtle bycatch, and it currently operates under strict limits on the number of allowable interactions with sea turtles. For several years, scientists from the National Marine Fisheries Service of the National Oceanic and Atmospheric Administration (NOAA) and the fishing industry have been working together to determine how to avoid such accidents. They have recently developed a dynamic tool that helps fishers avoid loggerhead bycatch while continuing their normal operations.

Combining information from two decades of satellite tracking of turtle movements with data on fishing effort, researchers have devised a means to predict where turtles and the longline fishery are most likely to overlap. This predictive capability was the basis for the development of the *TurtleWatch* initiative by the NOAA Pacific Islands Fisheries Science Center (PIFSC). *TurtleWatch* generates a daily map posted on the PIFSC website that provides up-to-date information to the longline fleet and fishery managers about the thermal habitat of loggerhead sea turtles, highlighting areas of potential overlap between turtles and fishing gear so that fishers can avoid the area north of the Hawaiian Islands. In essence, *TurtleWatch* is playing the role of traffic light in the north Pacific, trying to keep collisions between loggerheads and longline gear to a minimum. Through *TurtleWatch,* NOAA National Marine Fisheries Service hopes to provide benefits not only to the turtles, but also to the fishers.

TurtleWatch uses the best available data on sea-surface temperature and ocean-current conditions to provide the predicted location of waters preferred by turtles. Because loggerheads tend to associate with the frontal system demarcated by a consistent 18°C (65°F) band of water north of Hawaii, *TurtleWatch* displays the predicted location of this temperature front and recommends that fishers avoid setting gear in that area (see figure at right).

When *TurtleWatch* was first released on December 26, 2006, its initial recommendation was that fishers avoid setting shallow longline gear targeting swordfish in areas of the north Pacific colder than 18.5ºC (65.5ºF). Automated updates were provided daily throughout the 2007 fishing season. In keeping with predictions, 65 percent of the loggerhead interactions with fishing gear occurred in the areas identified by *TurtleWatch.*

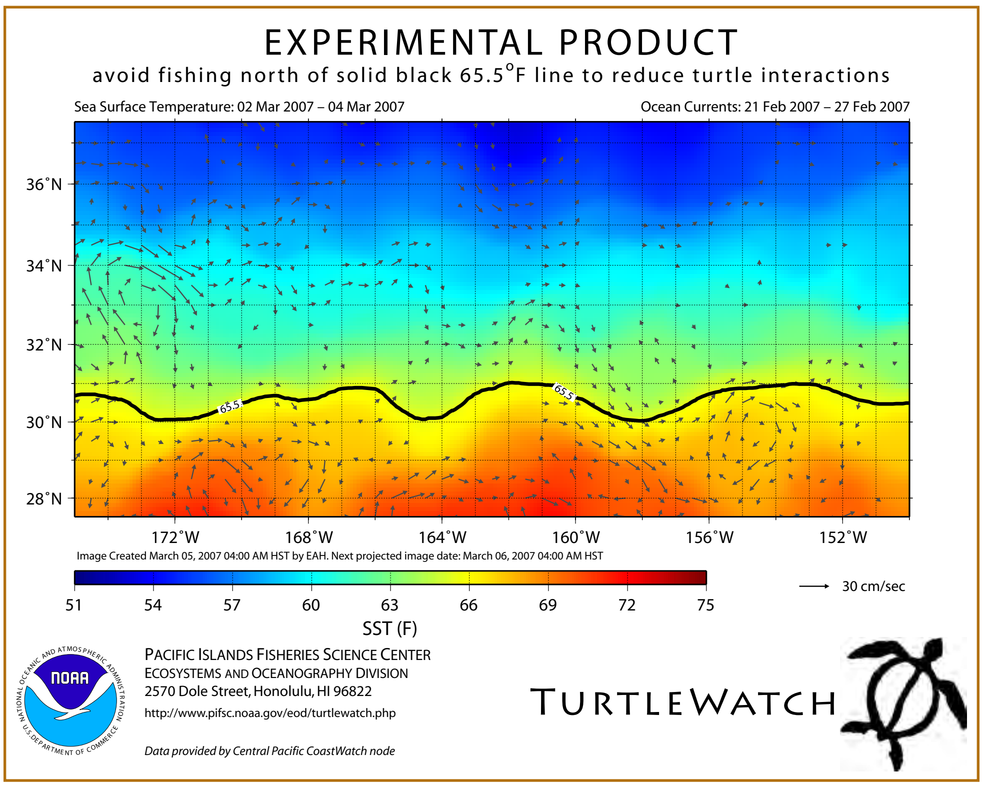
Building on information gathered during 2007, PIFSC made improvements to the *TurtleWatch* product for the 2008 fishing season, with a new recommendation that fishers avoid setting shallow gear where ocean temperatures were between 17.5ºC (~63.5ºF) and 18.5ºC (~65.5ºF) (see figure below). Additionally, in early 2008, GeoEye—a company providing oceanographic data services to the longline industry—began to distribute the *TurtleWatch* product to fishers, thereby increasing its use in the fishing community. Preliminary results indicate that *TurtleWatch,* in conjunction with other conservation steps taken by the longline industry, has been helpful: zero loggerhead turtle interactions have been reported in 2008 by the Hawaii-based longline fishery.

The final verdict on whether *TurtleWatch* is truly effective in reducing loggerhead bycatch will require further observation. Nonetheless, *TurtleWatch* achieved one of its primary objectives: an increased understanding and awareness of the critical overlap between the oceanic habitats of turtles and fishing activities. In this regard, *TurtleWatch* is already a success and serves as a novel model for future ecologically based conservation efforts designed to minimize undesirable interactions between fishing activities and protected species.

For more information about *TurtleWatch,* visit www.pifsc.noaa.gov/eod/turtlewatch.php.

Evan Howell *is a research oceanographer at the National Marine Fisheries Service, Pacific Islands Fisheries Science Center.* ***Dr. Donald Kobayashi*** *is a fisheries biologist at the National Marine Fisheries Service, Pacific Islands Fisheries Science Center.* ***Denise Parker*** *is a marine turtle research associate at the National Marine Fisheries Service, Pacific Islands Fisheries Science Center.* ***George Balazs*** *leads the Marine Turtle Research Program within the Protected Species Division at the National Marine Fisheries Service, Pacific Islands Fisheries Science Center.* ***Dr. Jeffrey Polovina*** *leads the Ecosystems and Oceanography Division at the National Marine Fisheries Service, Pacific Islands Fisheries Science Center.*

TurtleWatch uses up-to-date oceanographic information to give recommendations to longline fishers about which areas to fish if they are to avoid accidentally catching loggerheads (see the highlighted area on graph). © NOAA PACIFIC ISLANDS FISHERIES SCIENCE CENTER



ancient mariners, ancient fuels

how sea turtles cope with our modern fossil fuel dependency

We crave oil and gas, and we are running out of those fuels. To meet the challenge brought about by increasing demand and dwindling supply, our current effort to extract such energy sources has resulted in some of the boldest technological feats ever undertaken, including hydrocarbon exploration, development, and production in locations as inconvenient as the open sea. This offshore production of oil and gas uses intense industrial activity including shipping, port terminals, pipelines, and offshore platforms. Some of the platforms are among the largest structures ever built, each housing a small city of workers. Many thousands of platforms are now clustered on offshore oil and gas fields around the world.

In a way, sea turtles perform a similar extraction of resources, but without all the high technology: they search for food in the same shelf waters dotted with offshore platforms, and they nest on adjacent beaches. This juxtaposition of sea turtles and industry poses many challenges to conserving these endangered creatures.

The potential risks for turtles living amid offshore platforms are varied. Artificial lighting on platforms and from coastal terminals can disrupt the orientation of hatchlings making their way from nests to the sea. Explosions from rig-removal operations can kill turtles living near decommissioned platforms. Channel dredging can destroy foraging habitat, erode nesting beaches, and kill turtles that come in contact with suction dredge heads. Increased vessel traffic can result in turtle deaths from boat strikes. Discharge of heavy metals and organochlorines can negatively affect sea turtle health. Oil can leak, spill, and gush with adverse effects on sea turtles that include ingestion of tar, as well as both chemical and physical effects from contact.

Major oil spills can also affect sea turtles at all life stages; indeed, it is likely that nearly all turtles coming in contact with an errant oil slick will die or become severely debilitated. Major spills are grim events, but, thankfully, they are uncommon. What was probably the largest oil-spill threat to sea turtles occurred over a period of months beginning in June 1979 in the Gulf of Mexico, just a few hundred miles southeast of Rancho Nuevo, Tamaulipas, Mexico. It is difficult to imagine a more "perfect storm" of bad location and timing for sea turtles. The location was offshore from the only nesting beaches for the Kemp's ridley, the world's most endangered sea turtle. The timing coincided with the peak of the Kemp's ridley nesting season. The spill itself was big, occurring when an exploratory oil well on the Ixtoc platform suffered a "blowout"—an event now recognized as the largest unintentional oil spill in history. Throughout the months of hatchling production at the Rancho Nuevo nesting beach and into the spring of the following year, between 10,000 and 30,000 barrels per day flowed into the Gulf. In total, an estimated 500,000 tons of oil distributed itself along Gulf currents.

Although several dead, oil-covered green turtles and Kemp's ridleys reached land, where their appearance was recorded, most of the evidence of sea turtle mortality probably remained far out to sea. Most of the turtles affected were likely the young pelagic or oceanic "lost-year" turtles that are seldom seen either live or dead. But with our current knowledge about their habitat, it seems clear that the same oceanographic forces transporting and collecting young turtles along with their drift community would also concentrate spilled oil and tar. So, it seems reasonable that mortality in this open-ocean life stage is probably high for large spills.

Including mortality of vulnerable but difficult-to-count oceanic-stage turtles, individual oil spills are probably worse for sea turtles than we can measure. But are spills in general an important worldwide threat? The *Oil Spill Intelligence Report* lists about 4,100 major spills (greater than 34 tons) that occurred in more than 100 countries between 1978 and 1995. Is this number a lot? It is to the unlucky life forms in the path of a spill, but in terms of total oil entering the sea, perhaps not. According to the 1995 National Academy of Sciences report *Oil in the Sea,* about 62 percent of the oil in our oceans comes

AT LEFT: Oil rigs operate 24 hours a day and need a brightly illuminated drilling floor and deck. This artificial lighting can disorient sea turtles. © REBECCA McLEAN

A juvenile green turtle drifts within pelagic *Sargassum* in the open waters of the Gulf of Mexico off the coast of Florida, U.S.A. Green turtles, loggerheads, hawksbills, and Kemp's ridleys all associate with open-ocean *Sargassum* during their early life stages. © BLAIR WITHERINGTON

from natural undersea seeps. And of the remaining oil spilled by us, most leakage comes from everyday use of oil rather than from major spills.

Today, there is a strong case to be made that oil-spill risk has greatly declined. Modern oil companies are now intensely concerned about spill events and have numerous safeguards in place to make such acute hazards rare. Still, chronic effects from oil can be important. In a study of post-hatchling loggerheads in the Atlantic Ocean off Florida, U.S.A., about 40 percent of the young turtles had ingested tar. Of the ingested tar that was analyzed to determine its origin, most came from shipping fuel oil. This threat underscores deficiencies in the practices of oil users rather than producers.

> … it is likely that each new development of offshore platforms … has some associated environmental perturbation and loss of sea turtle habitat.

In Western Australia, one of the most significant threats to sea turtles posed by offshore oil and gas extraction has come from the artificial lighting of platforms and terminals. This lighting has included flares (flames of vented gas) and the glaring high-intensity lighting typical of any 24-hour industrial operation. Where those lights have been visible from green turtle, flatback, and hawksbill nesting beaches, hatchlings emerging from nests are misdirected away from the sea. Some of those hatchlings that are able to reach the surf may eventually become disoriented by additional offshore light sources. Thanks to increased attention to this problem, oil and gas industry operations in northwestern Australia now have light-management plans that include guidelines meant to reduce light usage, to minimize wattage, to direct light away from beaches, and to replace lighting with long-wavelength sources that have reduced effects on sea turtles.

Other effects from oil and gas operations are even more difficult to measure than are those from spills and lighting. Habitat loss is one of the more difficult effects to understand. However, it is likely that each new development of offshore platforms, undersea pipelines, shipping channels, and port terminals has some associated environmental perturbation and loss of sea turtle habitat. Similar to managing artificial lighting, reducing effects on sea turtle habitat has also become a goal that influences hydrocarbon development.

Even direct effects can be difficult to measure. Dredges are well known to kill turtles, and in some areas with hard sea bottom, explosives are used to facilitate dredging and pipeline installation. However, the actual number of sea turtle deaths is unclear in all but the most intensely scrutinized of those activities. Explosives are also used to remove offshore platforms that have been decommissioned. In the Gulf of Mexico, the United States has closely examined the threats to sea turtles caused by explosive rig removal. During almost two decades of observing rig explosions, the National Marine Fisheries Service reports that four loggerheads were injured and only one was killed. Of course, the eventual removal of each of the 7,000 or so offshore platforms worldwide will have a substantially larger effect. But a greater effect could result from allowing the platforms to collapse on their own.

Additional uncertainty concerns threats from vessel strikes. Like other perturbations arriving with oil and gas operations, additional boat traffic is certain to have some effect. However, aside from the understanding that vessels do strike and kill sea turtles in high numbers where traffic is frequent, there is currently no way to estimate risk brought about by additional traffic. Nor is it clear what types of vessels pose the greatest risk to sea turtles. Nonetheless, minimizing intersections between boats and turtles makes sense. Thus, researchers are using satellite-tracking data to identify home ranges and pathways for the industry to steer around.

In addition to uncertainty about individual threats, however, threats posed by oil and gas operations remain unclear for entire regions. In western Africa's hydrocarbon-rich Gulf of Guinea, three developing countries (Angola, Equatorial Guinea, and Nigeria) have seen economic explosions from the proceeds of recent offshore petroleum activity. The result has been an unprecedented expansion of exploration and development in what is likely one of the most important nesting and foraging areas for sea turtles in the world. The island of Bioko, deep within the Gulf of Guinea, provides nesting beaches for large numbers of leatherbacks and green turtles, in addition to scattered hawksbills and olive ridleys. The island also happens to be at the center of Equatorial Guinea's offshore oil industry, which has recently propelled this small country into the world's fastest-growing economy.

The nesting beaches on Bioko Island have been largely protected from human activity by steep mountains immediately to the north. Further, because few people live near the nesting beaches, there is little artificial lighting that would threaten nesting turtles and hatchlings. Presently, most oil industry activities take place beyond the north end of the island, in the waters between Bioko Island and mainland Africa. As a result, offshore oil and gas extraction, a coastal petroleum refinery, and a large methanol plant remain opposite the principal nesting beaches on the island. In the past decade of oil and gas operations near Bioko Island, there have been no major oil spills, and regional oil companies have taken an active role in the area's sea turtle conservation programs. Keeping this apparent harmony between industry and sea turtles will be a challenge and, with continued diligence, a developing success story.

Although it seems as if the age of fossil fuels has been tough on sea turtles, one could argue that they have survived more tumultuous times. This view might be difficult to fathom for modern observers of sea turtles and the seaborne hydrocarbon industry in a place such as the Gulf of Mexico. Today, in addition to being habitat for five species of sea turtles, the Gulf of Mexico happens to have more than half of the world's offshore platforms, together with tens of thousands of miles of pipeline and an intense level of shipping—all commensurate with the oil hunger of the United States, Earth's largest consumer of petroleum.

Mexico's Cantarell oil field is the second-largest oil-producing complex in the world. The field was formed roughly 65 million years ago when the monstrous Chicxulub asteroid struck Earth. In addition to making an enormous basin of petroleum deposits, the asteroid's impact also shocked the planet to the point that all the dinosaurs died. Yet, somehow the Cretaceous ancestors of our modern sea turtles survived. Today, the oil from Cantarell contributes little by little to the recent, chronic, planetary change with which we—and sea turtles—will struggle to cope. By comparison, managing a softer offshore energy industry would seem simple.

Threats to sea turtles are not likely to halt multi-billion-dollar operations. Nor will sea turtles play any more than a minor role in our weaning from fossil fuels. Although we have set upon the path of realization that burning carbon results in a hot planet with rising seas, fully realizing those consequences apparently requires a soaking-in period (unlike the consequences themselves, which are, literally, soaking in as we ponder them). Yet, in the short term, sea turtles are playing—and will continue to play—a role in shaping how we extract and use hydrocarbons.

… effects on sea turtles from offshore industry can be vastly reduced with some research-guided planning and small operational changes.

For a massive oil tanker that is difficult to stop, minor steering adjustment can avoid catastrophic collisions. Similarly, effects on sea turtles from offshore industry can be vastly reduced with some research-guided planning and small operational changes. With adequate information on site-specific sea turtle life history, some effective spill contingency plans could guide sea turtle protection following accidents; light-management plans could guide protection of nearby nesting beaches; and a host of other *best practices* could be made into industry standards to reduce effects from vessel traffic, dredging, and other activities.

Blair Witherington *is a Research Scientist with the Florida Fish and Wildlife Research Institute in Melbourne Beach, Florida, U.S.A.* ***Kellie Pendoley*** *is a Marine Conservation Biology Consultant who has worked with sea turtles in northwestern Australia for 25 years.* ***Gail Hearn (Ph.D.),*** *Professor of Biology at Drexel University, is also the Executive Director of the Bioko Biodiversity Protection Program, part of the academic partnership between Drexel University and the National University of Equatorial Guinea.* ***Shaya Honarvar (Ph.D.)*** *is a Post-Doctoral scientist in Drexel University's Department of Biology and serves as the Research Coordinator for the Bioko Biodiversity Protection Program*

Female green turtles rest in the intertidal zone around Barrow Island in western Australia during mating season. Barrow Island is home to a major oil and gas development. © KELLIE PENDOLEY

the SWOT team

SWOT Develops Minimum Standards for Monitoring Effort and Census Data

For the past four years, SWOT has received sea turtle nesting data from SWOT Team members around the world and has displayed those data in maps that provide snapshot status assessments of nesting distribution and abundance. Because of the vast diversity of ways in which data are collected and reported on different beaches around the world, quantitative comparative analyses of nesting data have been next to impossible.

Until now.

During the past year, SWOT has developed a strategy to achieve the long-term goal of making SWOT a global monitoring system for sea turtle populations and species. To do this, we are developing minimum standards for SWOT data that enable comparisons across sites with different levels of monitoring effort, and allow for the estimation of population abundances and long-term population trends. We convened two technical meetings (Loreto, Mexico, in January; and West Virginia, U.S.A., in June) that brought together some of the sea turtle community's leaders in data collection and statistical techniques.

The main outcome of these meetings is a one-of-a-kind statistical modeling program that will be a tool for researchers and data providers to analyze their data and to estimate actual nesting numbers in the absence of complete monitoring coverage. Eventually, this model will be freely available (online) as a software program, and SWOT Team members will be able to run their data sets through the model to estimate nesting numbers for situations in which beach monitoring is incomplete. This capability will allow us to compare nesting sites with different levels of monitoring effort and, eventually, to detect nesting population trends within a reasonable time frame.

In addition, we are developing a *SWOT* minimum data standards manual that will outline recommendations for minimum monitoring guidelines and will include all possible monitoring schemes used by nesting beach programs around the world. This manual will allow different researchers to select the monitoring scenario that best fits the logistics of their study site, and it will ensure that resulting data meet minimum standards and can be included in future abundance and trend analyses.

In the future, we plan to build a Web-based interface that will facilitate easy data entry and will automatically generate nesting abundance estimates for the SWOT database, as well as a practical report for SWOT Team members to use for their projects. Those processes are ongoing, but we expect to launch and implement the minimum data standards early in 2009, and we look forward to the input of the SWOT Team as products are tested and put to use.

Finally, we have also revamped how SWOT collects, compiles, and displays data contributed by SWOT Team members. We have restructured the SWOT database and have improved the data request form to include greater detail to ensure that we are collecting the appropriate information from respective nesting beaches. We initiated the most recent round of data requests in October 2008, and we welcome continued contributions from the SWOT Team and new data providers.

To enhance our display and outreach abilities, SWOT is teaming up with the Duke Marine Geospatial Laboratory's OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations) project (http://seamap.env.duke.edu/) to put SWOT sea turtle nesting data in the geospatial context of other marine species (e.g., seabirds and marine mammals) and oceanography. The SEAMAP application will allow users—including SWOT Team members—to interact with SWOT data in an up-to-date, global-scale, biogeographical context.

SWOT has made its name by showing a wide audience information about sea turtle status in a common, global context. With the recent improvements to how we collect, analyze, and display data contributed by SWOT Team members, SWOT can more effectively assess the status of sea turtle species and communicate it with the world. As SWOT makes strides toward becoming the premiere global monitoring initiative for sea turtles, it is heartening to remember that SWOT derives its strength from the growing network of SWOT Team researchers, field workers, conservationists, and enthusiasts around the world.

THIS PAGE: Researchers excavate a leatherback nest on Bioko Island in Equatorial Guinea. © JOEL SARTORE / JOELSARTORE.COM AT LEFT: Researchers and volunteers from the Karen Beasley Rehabilitation Center in North Carolina, U.S.A., smooth the carapace of a loggerhead turtle. This preparation extends the time an attached transmitter might stay on. © NEIL EVER OSBORNE / WWW.NEILEVEROSBORNE.COM

Acting Globally

2008 SWOT Outreach Grants

SWOT Report is a tool that is meant to be used and used plenty! In 2008, for the third consecutive year, SWOT has distributed small grants to organizations wishing to put *SWOT Report* to work in local outreach efforts. This year's five grant recipients have, once again, fused vision with determination to engage communities around the world in sea turtle conservation in new and exciting ways.

A young man reads *SWOT Report* after participating in a C3 workshop. © COMMUNITY CENTRED CONSERVATION / C3

Community Centred Conservation—Union of the Comoros

The Union of the Comoros in the Indian Ocean has some of the most important green turtle nesting beaches in the world. A 2007 study evaluating the effects of bycatch on sea turtles and marine mammals in the Comoros revealed that these exceptional green turtle populations were under serious threat from accidental and intentional capture by artisanal fishermen. On the basis of those findings, Community Centered Conservation (C3) used its 2008 SWOT Outreach Grant to organize educational workshops in five of the villages found to have the highest capture rates on the island of Grande Comore.

Fishermen attending the workshops received copies of *SWOT Report* and waterproof stickers for their boats with the affirmation: "I don't eat turtles; they are an endangered species!" Additional *SWOT Reports* were distributed in village libraries, community centers, and fishing syndicate offices, thereby providing further opportunities for community members to learn about the importance of their local sea turtle populations.

The Alliance for Tompotika Conservation—Indonesia

In Central Sulawesi, Indonesia, the Alliance for Tompotika Conservation/Aliansi Konservasi Tompotika (AlTo) has taken a comprehensive approach toward protecting sea turtles along the Tompotika peninsula, while simultaneously confronting immediate and long-term challenges. In its campaign to stop poaching—the most urgent threat to local sea turtle populations—AlTo hires former turtle poachers to patrol beaches, and works with village leaders to enforce turtle protection laws. At the same time, AlTo seeks to foster long-lasting support for conservation efforts within the community through its Sea Turtle Conservation Awareness Campaign, which, to date, has reached more than 2,000 people.

In 2008, a SWOT Outreach Grant helped AlTo hold educational meetings in schools and villages where it distributed information and worksheets to predominantly young audiences. As one former turtle poacher said: "We now understand about the turtles and how we have to protect them. The children really loved the awareness meeting, and they are now all talking about sea turtles. Your conservation message has been received."

Children from Tompotika proudly show off their sea turtle coloring sheets after an AlTo Awareness Campaign meeting. © AlTo

Visit **www.SeaTurtleStatus.org** to apply for a 2009 SWOT Outreach Grant!

ProTECTOR president, Stephen Dunbar, discusses sea turtles with schoolchildren on Roatan Island. Visit www.SeaTurtleStatus.org to watch a video about Stephen's work! © ProTECTOR

ProTECTOR—Honduras

Helped by a SWOT Outreach Grant, the Protective Turtle Ecology Center for Training, Outreach, and Research (ProTECTOR) launched an island-wide educational outreach initiative involving school children ages 6–15, on Roatan Island, Honduras, with the goal of promoting a Turtle Nesting Hotline.

Together with presentations on sea turtles, *SWOT Reports* were provided to schools as library references, and students were invited to assist in launching the Turtle Nesting Hotline by producing artwork and jingles to publicize the Hotline numbers throughout Roatan Island and the Bay Islands. From the materials submitted by the children, four art designs and one jingle were chosen. When fully operational, the Hotline will provide vital information about where turtles are nesting at any given time, thus helping to focus monitoring efforts on high priority beaches and establishing conservation measures for reducing human impacts at those sites.

Sea Turtle Conservation Project—China

China's Hainan Province comprises some 200 islands strewn along the country's southern coast. The area boasts a successful fishing industry and beautiful, pristine beaches that attract tourists and sea turtles alike. Unfortunately, although business in Hainan has grown, sea turtle populations have declined. With the support of a SWOT Outreach Grant, Dr. Yamin Wang of Shandong University set out to educate visitors and residents about the importance of protecting the region's sea turtles.

During the three-month-long campaign, Dr. Wang and his colleagues distributed more than 150 copies of *SWOT Report* and 1,000 copies of related pamphlets, focusing, in particular, on speaking with fishermen. In addition, the team circulated a petition in Hainan's capital city of Haikou to draw greater support for conservation activities. The success of the initiative has brought a new level of attention to important local and global issues such as bycatch, poaching, and illegal trade.

Fishermen study educational pamphlets about sea turtles in Hainan Province. © WANG YAMIN

Community members peruse the University of Algarve's poster exhibition on Boavista Island, Cape Verde. © CHRISTIAN RODER

The University of Algarve—Cape Verde

Just off the western coast of Africa, the Cape Verde archipelago provides significant nesting and foraging habitat for three species of sea turtle. In May 2007, the University of Algarve in Portugal, with the support of the Sisbon Oceanarium, began an ambitious sea turtle conservation initiative in Cape Verde that established the Sea Turtle House environmental education center; launched the Live Labs beach patrol and experiential education program; and produced an Environmental Education Package of lesson plans, activities, and posters for elementary and secondary school teachers.

In 2008, a SWOT Outreach Grant helped to strengthen the programs with additional educational materials and to create posters for a traveling exhibit aimed at influencing national authorities. The exhibit was displayed at the first Praia Environmental Fair and was visited by the Cape Verdean president; prime minister; and minister of the Environment, Rural Development, and Marine Resources.

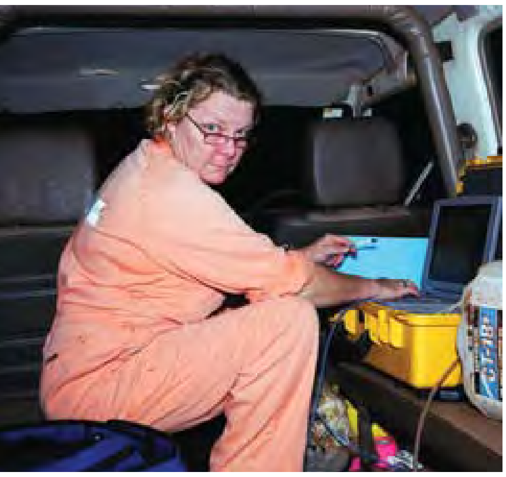
SWOT Team Profiles

Visit **www.SeaTurtleStatus.org** to watch video interviews with SWOT Team members!

Colin Limpus (Australia)

Queensland Parks and Wildlife Service, SWOT Team Member since 2005

My interest in sea turtles began as a child on the beaches around Bundaberg, Australia. In 1968, I commenced the first field studies of flatback turtles to solve local problems. This soon expanded to other species and expanded to northern Australia and internationally. The project depends on a large volunteer network. Our persistence through the years has led to the compilation of one of the world's largest, longest, and most comprehensive collections of sea turtle data. I've worn many hats in international sea turtle conservation and management, including my work for the Queensland Parks and Wildlife Service since 1974, my membership in the IUCN Marine Turtle Specialist Group since 1976, my appointment as Scientific Councillor on turtles to the Convention on Migratory Species since 1995, and my current presidency of the International Sea Turtle Society (2008–2009). Interesting Fact. Col was the lead author on the publication that re-described the flatback sea turtle as *Natator depressus* in 1988.



Kellie Pendoley (Australia)

Pendoley Environmental Pty Ltd., SWOT Team Member since 2007

I have been working in Western Australia for 25 years, principally in the Pilbara Region. I work with industry on environmental hazard and impact assessments. My research helps to mitigate the impacts to sea turtles caused by activities such as dredging, construction, petroleum operations, and port facilities. Much of the sea turtle work done in Western Australia is still unpublished, and SWOT provides a way to get the basic information out in a format that is easily accessible. Interesting Fact. Kellie holds the first—and only—Ph.D. on sea turtles awarded by a Western Australian university.

Neil Ever Osborne (Canada)

Freelance Photographer, SWOT Team Member since 2007

I blend my backgrounds in the biological sciences and photojournalism with the intent to share images and stories that advocate the preservation of biodiversity and threatened habitats. Because sea turtles swim all of Earth's ocean basins and migrate across political and geographical barriers, telling their story is a way of communicating the overarching necessity of international cooperation in conservation initiatives. In 2007, I began a photographic project called "Faces of Chelonia," which attempts to strengthen the international sea turtle community through the creation of a global, visual perspective of sea turtle conservation. I am pleased to contribute my photographic work to SWOT in the hopes of inspiring greater conservation action. Interesting Fact. Neil launched his career in photography while mentoring under world-renowned photographer, Frans Lanting.

Calen Baker Offield (U.S.A.)

Freelance Photographer, SWOT Team Member since 2008

As a nature photographer, I try to create unique and inspiring photographs of animals in their natural habitats as a means of contributing to conservation. I also have a strong interest in science, and most of my photographs are taken while working as part of a scientific study or expedition. My journey to Western Australia to photograph flatback turtles for this year's *SWOT Report* (vol. 4) was my first professional experience with sea turtles. I feel very lucky to have been able to help highlight these incredible animals and some of the special people working to protect them. Interesting Fact. Calen is the first photographer to be sent on assignment by SWOT.

SWOT Data Contributors

Definitions of Terms

Clutches: A count of the number of egg clutches laid by flatback females during the monitoring period.

Nesting females: A count of observed individual nesting female flatbacks during the monitoring period.

Crawls: A count of observed number of emergences of female flatbacks from the ocean onto the beach during the monitoring period. These counts include successful oviposition events (egg clutches), failed nest attempts, or false crawls.

Failed nest attempt: An emergence onto the beach by a female flatback that includes attempted nest construction, but does not result in oviposition.

False crawl: An emergence onto the beach by a female flatback that does not result in any attempt to nest, but is a track only.

Nest: The physical structure created by a female flatback into which she deposits her eggs.

Estimated number of clutches/nesting females: An estimate of the number of flatback clutches laid/nesting females in a season. Methods of estimation vary.

Monitoring effort: The level of effort used to monitor nesting activity on a given beach.

Year: The year in which a given nesting season begins (e.g., data collected between late 2005 and early 2006 are listed as year 2005).

Genetic stock: Group of nesting female flatbacks that share haplotype frequency of the mitochondrial control region DNA. Different nesting rookeries are assigned to distinct genetic stocks on the basis of sufficient differences in their haplotype frequencies.

In-water distribution: Spatial extent of flatback marine habitat across life stages, on the basis of tag returns, satellite telemetry, description of habitat use, and other observations

Flatback Data Citations

Guidelines of Data Use and Citation

The flatback nesting data below correspond directly to this report's feature map (pp. 24–25), organized alphabetically by state and beach name. Every data record with a point on the map is numbered to correspond with that point. These data have come from a wide variety of sources and in many cases have not been previously published. To use data for research or publication, you must obtain permission from the data provider and must cite the original source as indicated in the "Data Source" field of each record. See SWOT's Data Sharing Protocol online (www.SeaTurtleStatus.org). Only original data are reported here—not the converted values that were sometimes used in the feature map. For more information on data conversions, see the introductory text to the map on page 23.

In the records below, nesting data are reported from the last complete nesting season (2007 or 2008) or are reported as an annual average during the monitoring period from all available beaches. For those beaches from which recent data were not available, the most recent available data are reported.

Important Notes about Flatback Data

Great effort has gone into providing sufficient information with each data record to allow the quality and source of the record to be fairly evaluated. Although every attempt has been made to ensure the accuracy of these data, absolute accuracy cannot be guaranteed. Information on monitoring effort and its relativity to the nesting season are reported where available in order to allow for a more complete evaluation of the data.

NORTHERN TERRITORY

DATA RECORD 1

Data Source: Chatto, R., and B. Baker. 2007. The distribution and status of marine turtle nesting in the Northern Territory. Parks and Wildlife Service of the Northern Territory, Australia.
Comments: These abundance estimates were extracted directly from the above report, which describes all records of marine turtle nesting during aerial and ground surveys from 1990 to 2004. Values for most sites are annual averages across several years of monitoring within the time period covered in the report. Below, we have grouped all nesting sites with annual nesting abundance estimates of ≤ 10 clutches within regions and have listed separately all other nesting sites. See report for site-specific details of monitoring efforts and abundance estimates. Counts listed here are likely to be underestimates.

Nesting Beaches: 4 sites in Anson-Beagle, Northern Territory
Count: ≤ 6 clutches

Nesting Beach: Casuarina Beach, Anson-Beagle, Northern Territory
Count: 15 clutches

Nesting Beach: North Peron Island, Anson-Beagle, Northern Territory
Count: 17 clutches

Nesting Beaches: 31 sites in Arnhem-Wessel, Northern Territory
Count: ≤ 8 clutches

Nesting Beach: NW Crocodile Islands, Arnhem-Wessel, Northern Territory
Count: 23 clutches

Nesting Beaches: 2 sites in Cambridge-Bonaparte, Northern Territory
Count: ≤ 4 clutches

Nesting Beaches: 15 sites in Coburg, Northern Territory
Count: ≤ 4 clutches

Nesting Beach: North Goulburn Island, Coburg, Northern Territory
Count: 24 clutches

Nesting Beaches: 30 sites in Groote, Northern Territory
Count: ≤ 9 clutches

Nesting Beach: Isle Woodah, Groote, Northern Territory
Count: 14 clutches

Nesting Beach: Bustard Island, Groote, Northern Territory
Count: 21 clutches

Nesting Beaches: 13 sites in Pellew, Northern Territory
Count: ≤ 6 clutches

Nesting Beaches: 7 sites in Tiwi, Northern Territory
Count: ≤ 9 clutches

Nesting Beach: SW Bathhurst Island, Tiwi, Northern Territory
Count: 17 clutches

Nesting Beaches: 3 sites in Van Diems Gulf, Northern Territory
Count: ≤ 5 clutches

Nesting Beach: Greenhill Island, Van Diems Gulf, Northern Territory
Count: 11 clutches

DATA RECORD 2

Data Source: Guinea, M. 2009. Flatback nesting at Bare Sand Island, Northern Territory: Personal communication. In *SWOT Report—The State of the World's Sea Turtles,* vol. 4 (2009).
Nesting Beach: Bare Sand Island
Year: 2008 **Count:** 289 clutches
Comments: From June 16 to July 14, 2008, 189 nesting adult female flatbacks and 341 crawls were recorded. Annual estimate of adult females across several years is *ca.* 300.
SWOT Contact: Mick Guinea

QUEENSLAND

DATA RECORD 3

Data Source: Sea Turtle Foundation. 2009. Flatback nesting on Aims Beach, Queensland. In *SWOT Report—The State of the World's Sea Turtles,* vol. 4 (2009).
Nesting Beach: Aims Beach
Comments: Between 1 and 10 flatback clutches per year are recorded at this site.

DATA RECORD 4

Data Source: Limpus, C. J., and Environmental Protection Agency, State of Queensland. 2009. Flatback nesting in Queensland: Personal communication. In *SWOT Report—The State of the World's Sea Turtles,* vol. 4 (2009).

Nesting Beach: Avoid Island, Broad Sound, Queensland
Count: 50–150 females per year
Monitoring Effort: Mid-season 2-week tagging period during the peak of nesting activities.

Nesting Beach: Curtis Island, Queensland
Count: 50–150 females per year
Monitoring Effort: Mid-season 2-week tagging period during the peak of nesting activities.

Nesting Beach: Moore Park Beach, Queensland
Count: 1–10 females per year
Monitoring Effort: Tagging and crawl counts during an 8-week period.

Nesting Beach: Woongarra coast (including Mon Repos), Queensland
Count: 1–10 females per year
Monitoring Effort: Complete tagging census.

Nesting Beaches: Wreck Rock beaches, Queensland
Count: 1–10 females per year
Monitoring Effort: Mid-season 6-week tagging period during the peak of nesting activities.

Nesting Beach: Crab Island, Gulf of Carpentaria, Queensland
Count: 1,000–5,000 females per year
Monitoring Effort: Intermittent crawl counts.

Nesting Beach: Flinders Beach, Gulf of Carpentaria, Queensland
Count: 100–500 females per year
Monitoring Effort: Tagging and crawl counts during an 8-week period.

Nesting Beach: Janie Beach, Gulf of Carpentaria, Queensland
Count: 10–50 females per year
Monitoring Effort: Tagging and crawl counts during an 8-week period.
Comments: Count data provided earlier are annual averages derived from several years (even decades) of monitoring at each site. Monitoring is ongoing at these sites.

Data Source: Limpus, C. J. 2007. *A Biological Review of Australian Marine Turtles. 5. Flatback Turtle Natator depressus (Garman).* The State of Queensland. Environmental Protection Agency, 2007.

Nesting Beaches: 1 site in eastern Gulf of Carpentaria
Count: Confirmed but unquantified nesting

Nesting Beaches: 9 sites in Northern Queensland
Count: Confirmed but unquantified nesting

Nesting Beach: Wild Duck Island, Queensland
Count: > 100 nesting females per year
Comments: Information for the above sites was extracted directly from the report cited earlier, which is a synopsis of biological information on the flatback turtle since the 1980s. Values for most sites are annual averages across several years of monitoring within the time period covered in the report. Several sites have confirmed but unquantified nesting. See report for site-specific details of monitoring efforts and abundance estimates.
SWOT Contact: Col Limpus

DATA RECORD 5

Data Source: Hamann, M. 2009. Flatback nesting in the Gulf of Carpentaria and Torres Strait: Personal communication. In *SWOT Report—The State of the World's Sea Turtles,* vol. 4 (2009).
Nesting Beaches: Badu Island area, Dagadan Beach (Mornington Island), Hawkesbury Island, Mabuiag Island, Pisonia Island, Prince of Wales Island, Red and Woody Wallis Islands, Seisa, and Wednesday Island
Comments: Between 1 and 10 flatback clutches per year are recorded at each of these sites.
Nesting Beaches: Dagadan Beach (Mornington Island), Deliverance Island, Hawkesbury Island, and Pisonia Island
Comments: Between 11 and 100 flatback clutches per year are recorded at each of these sites.
SWOT Contact: Mark Hamann

DATA RECORD 6

Data Source: Mackay Turtle Watch. 2009. Flatback nesting in northern Queensland. In *SWOT Report—The State of the World's Sea Turtles,* vol. 4 (2009).
Nesting Beaches: Blacks Beach and Rabbit Island
Comments: Between 11 and 100 flatback clutches per year are recorded at each of these sites.
Nesting Beaches: Cape Hillsborough, Carlisle Island, Cockermouth, St. Bees Island, Temple Island, and Wigton Island
Comments: Between 1 and 10 flatback clutches per year are recorded at each of these sites.
SWOT Contact: Mark Hamann

WESTERN AUSTRALIA

DATA RECORD 7

Data Source: Prince, R. I. T., and Western Australia Marine Turtle Program. 2009. Flatback nesting in Western Australia: Personal communication. In *SWOT Report—The State of the World's Sea Turtles,* vol. 4 (2009).
Nesting Beaches: Abutilon Island; Adele Island; East Lighthouse Beach, Airlie Island; Caesar Island; Cape Domett (2 sites); Cape Lambert (2 sites); Dampier Archipelago (8 sites); Eighty Mile Beach (approx. 20 sites); Geoffrey Bay, Governor Islands; Janawan (North Help Island), King Sound; Kingfisher Island; Lacrosse Island; Lowendal Islands (10 sites); Monte Bello Islands (2 sites); Muiron Islands (2 sites); Mundabullangana coast (2 sites); North Kimberley coast (2 sites); Point Torment; Slate Islands (1 site); East End Beach, Thevenard Island; Troughton Island; Yardoogarra.
Comments: Flatback nesting has been confirmed at these sites in the past, since 1980, but most sites are not currently monitored and nesting is unquantified. Also, although some of these sites are being monitored at present, abundance estimates are not yet available.

Nesting Beaches: Cape Keraudren, Cable Beach, Riddle Beach
Count: 8 clutches

Nesting Beaches: 2 sites in Cape Missieissy
Count: 13 clutches

Nesting Beach: Cemetery Beach
Year: 2004–2007 **Count:** 750 clutches per year

Nesting Beach: Helpman Islands
Count: 50 clutches per year

Nesting Beach: Pretty Pool
Year: 2005–2007 **Count:** 125 clutches per year

Nesting Beach: West Island, Lacepede Islands
Count: 50 clutches
Comments: Some of the earlier counts are annual averages representing varying monitoring periods since the 1980s, and thus do not have specific years associated with the values. The counts for Cemetery Beach and Pretty Pool were provided to R.I.T. Prince by Kellie Howlett, Western Australia Marine Turtle Project.
SWOT Contact: Bob Prince

DATA RECORD 8

Data Source: Pendoley, K. 2009. Flatback nesting in the Pilbara Region of Western Australia: Personal communication. In *SWOT Report—The State of the World's Sea Turtles,* vol. 4 (2009).
Nesting Beach: Barrow Island
Years: 2005–2007 **Count:** *ca.* 1600 adult females per year

Nesting Beach: 1 site in Pilbara Region
Years: 1985–2008 **Count:** < 315 crawls per year

Nesting Beaches: 2 sites in Pilbara Region
Years: 1985–2008 **Count:** < 50 crawls per year at each site

Nesting Beaches: > 50 sites in Pilbara Region and adjacent islands (including Delambre Island, Dampier Archipelago)
Years: 1985–2008 **Count:** < 50 crawls per year at each site

Data Source: Pendoley, K., Chaloupka, M., and R. I. T. Prince. Forthcoming. An encouraging conservation outlook for the most atypical marine turtle species in the world: the endemic flatback. *Endangered Species Research.*
Nesting Beach: Mundabullangana
Years: 1998–2007 **Count:** *ca.* 1700 (±1200–2200) nesting females per year
Monitoring Effort: Long-term monitoring program; flipper tagging each year for 14-day period during December 5–22 (during peak of austral summer nesting season). Nesting abundance estimates were derived from Horwitz-Thompson type estimates using recapture probabilities from best-fit capture-mark-recapture models.
SWOT Contact: Kellie Pendoley

DATA RECORD 9

Data Source: Whiting, A. U., Thomson, A., Chaloupka, M. Y., and C. J. Limpus. Forthcoming. Seasonality, abundance, and breeding biology of one of the largest populations of nesting flatback turtles, *Natator depressus:* Cape Domett, Western Australia. *Australian Journal of Zoology.*
Nesting Beach: Cape Domett
Year: 2006 **Count:** estimated 3,250 clutches per year
Monitoring Effort: The population estimate was calculated from counts throughout the year for 5 to 15 nights every 7 weeks
Comments: The 95 percent confidence interval of the population estimate is 1,431–7,757 clutches per year.
SWOT Contact: Andrea Whiting

GENETIC STOCK INFORMATION

Data Source: FitzSimmons, N. 2009. Known genetic stocks of the flatback turtle: Personal communication. In *SWOT Report—The State of the World's Sea Turtles,* vol. 4 (2009).
Comments: The following list presents the six known genetic stocks (at the time of printing) for flatbacks, including all flatback nesting sites that have been sampled for genetic stock determination. These sampled sites are displayed on the centerpiece map with colored rings around the corresponding nesting abundance points.

1. **Northwest Shelf, Western Australia** (Mundabullangana, Barrow Island, Delambre Island)
2. **Cape Domett, Western Australia**
3. **Bare Sand Island and Field Island, Northern Territory**
4. **West Island. Northern Territory**
5. **Crab Island, Queensland**
6. **Eastern Australia, Queensland** (Wild Duck Island, Peak Island, Curtis Island)

SWOT Contact: Nancy FitzSimmons

SWOT Online

The Internet is a powerful tool that offers near endless opportunities for exchanging information and for building communities. Until now, SWOT has only skimmed the surface of this vast potential. This year, we are diving in and doing our part to put the Internet to work for sea turtle conservation.

SeaTurtleStatus.org is being overhauled! At the heart of this undertaking is the creation of a more dynamic online presence for the *SWOT Report.* The new site will capitalize on the Internet's boundless space and will provide additional content that includes extended stories, video highlights, and photo slideshows.

TurtleVision is a channel on YouTube.com that brings the world of sea turtle conservation to new audiences through video shorts that were shot in the field by SWOT Team members around the globe. This visual storytelling initiative highlights the human side of sea turtle work, thereby showcasing the countless unique voices from within this extraordinary community. With a generous grant from Pure Digital Technologies, the makers of Flip Video, SWOT will be awarding 30 Flip Video camcorders to SWOT Team members interested in putting their video stories online. See www.youtube.com/turtlevision.

Oceaneers.org is an online meeting place where volunteer-dependent field projects and adventurous marine enthusiasts can find one another. Set to launch in March 2009, the site's social networking platform will enable project leaders and past volunteers to share their experiences and to recruit new volunteers, thus fostering a mobilized community of people inspiring and encouraging each other to take further action on behalf of marine conservation.

Visit **www.SeaTurtleStatus.org** to apply for a TurtleVision Flip Video Grant!

PHOTO: © DAVID LIITTSCHWAGER

Acknowledgments

SWOT has been built from the ground up by a dedicated and generous group of supporters over the past five years. This network—the SWOT Team—has made unprecedented progress in marine biology and conservation. These accomplishments would not be possible without the individual contribution of each SWOT Team member, whether submitting hard-earned research data, writing an article, contributing a photograph, or giving time and money. We are deeply grateful to all of you who have been a part of this shared success. In particular, we would like to acknowledge the contributors to this issue and to our ongoing data collection (below), as well as our key financial supporters in 2008, including the Anderson-Rogers Foundation, the Comer Foundation, Classic Party Rentals, Dan Cohen and family, the Gale family, the Goldring Family Foundation, the Hufschmid family, IUCN—International Union for the Conservation of Nature, Karen Jones and Mildred Schou, George Meyer and Maria Semple, the Moore Family Foundation, National Fish and Wildlife Foundation, the Offield Family Foundation, the Panaphil Foundation, and Nancy Ritter.

Sincerely,
Rod, Brian, Patricia, Bryan, and Lucy—*SWOT Report* Editors

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Bringing Conservation into Focus

The International League of Conservation Photographers (ILCP), a consortium of professional photographers working to raise conservation awareness through photography, has provided several photos to this issue of *SWOT Report*. The SWOT Team thanks ILCP for those important contributions, which are indicated throughout the magazine with the ILCP logo.

Sea Turtles in the News, 2008

Threatened Atlantic Leatherback Turtles Split into Two Groups to Forage, Isotope Analysis Suggests
Source: *ScienceDaily* (March 26, 2008)

Turtle Tagged in 1977 Still Providing Feedback
Source: ABC Wide Bay Qld (November 21, 2008)

New Theory for How Salmon, Sea Turtles Find Their Birthplace
Source: The News & Observer (December 1, 2008)

First Known Turtle Swam on the Half Shell
Source: MSNBC—Live Science (November 26, 2008)

Hundreds of Sea Turtles Die Along Odisha Coast
Source: *Kalinga Times* (December 10, 2008)

PFC Pollutant Harming Loggerhead Turtles, Could Also Signal Danger for Humans
Source: *ScienceDaily* (February 22, 2008)

Turtle Nesting Threatened by Logging Practices in Gabon, Smithsonian Warns
Source: *ScienceDaily* (May 19, 2008)

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Bangladeshi Turtle Conservationist Receives Prestigious Whitley Award
Source: Whitley Fund for Nature (May 21, 2008)

Malaysia Seizes Thousands of Endangered Turtle Eggs
Source: BBC (November 4, 2008)

Philippines Seizes Vietnamese Boat Near Malampaya
Source: Reuters (September 1, 2008)

To read these stories, visit the SWOT website at www.SeaTurtleStatus.org.

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