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'MARINE TURTLES SPLIT FROM
THEIR TERRESTRIAL RELATIVES
MORE THAN 100 MILLION
YEARS AGO. THEY SURVIVED
THE ASTEROID THAT KILLED
THE DINOSAURS.'

PHOTO: THOMAS P. PESCHAK

SURVIVING, DESPITE



Green sea turtles congregate near a dock in the Bahamas. They were so numerous during Columbus's day that "it seemed the ships would run aground on them."

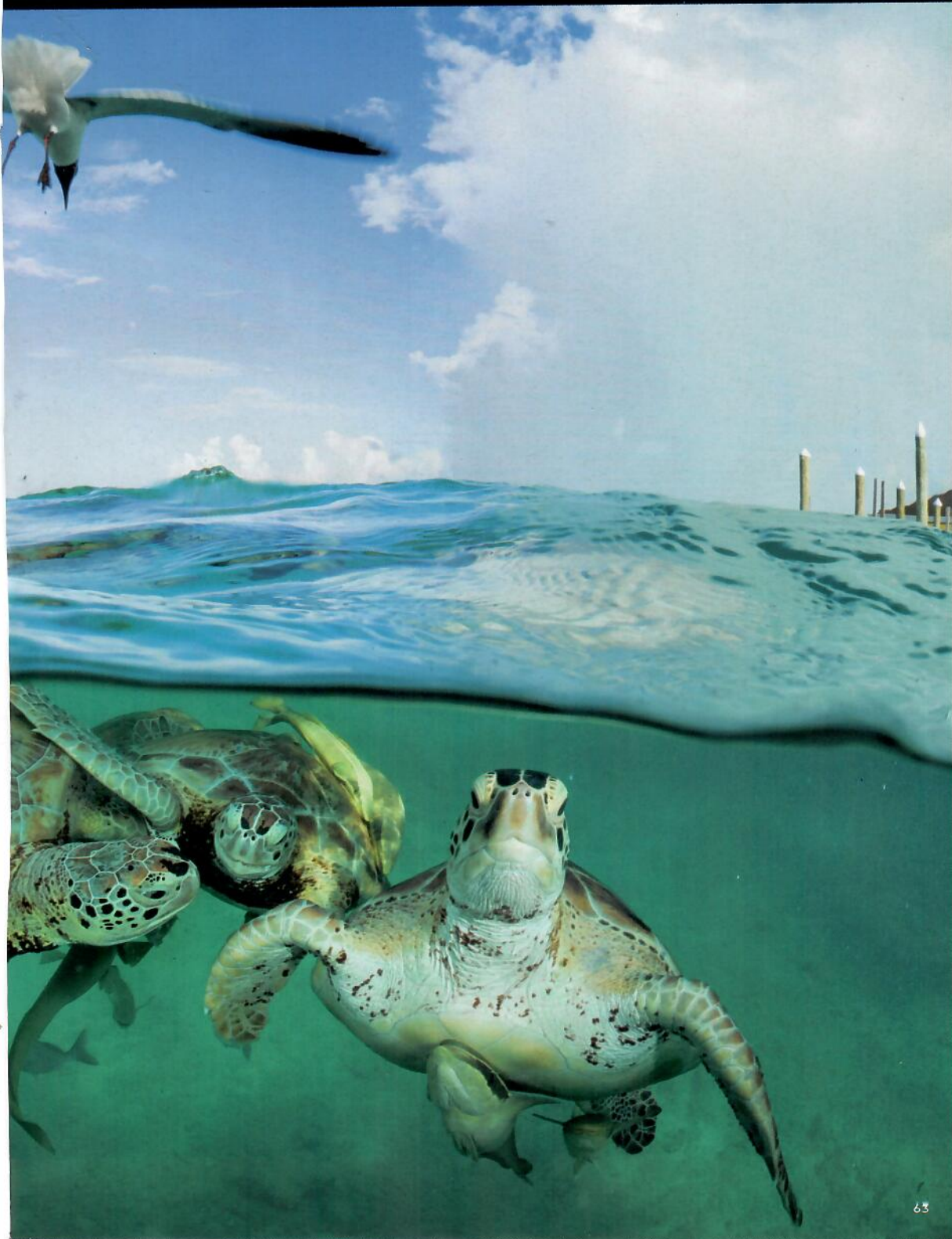
US

SEA TURTLES HAVE ROAMED THE OCEANS FOR 100 MILLION YEARS,
BUT WE ARE PUTTING THESE RESILIENT REPTILES AT RISK.

BY CRAIG WELCH

PHOTOGRAPHS BY THOMAS P. PESCHAK

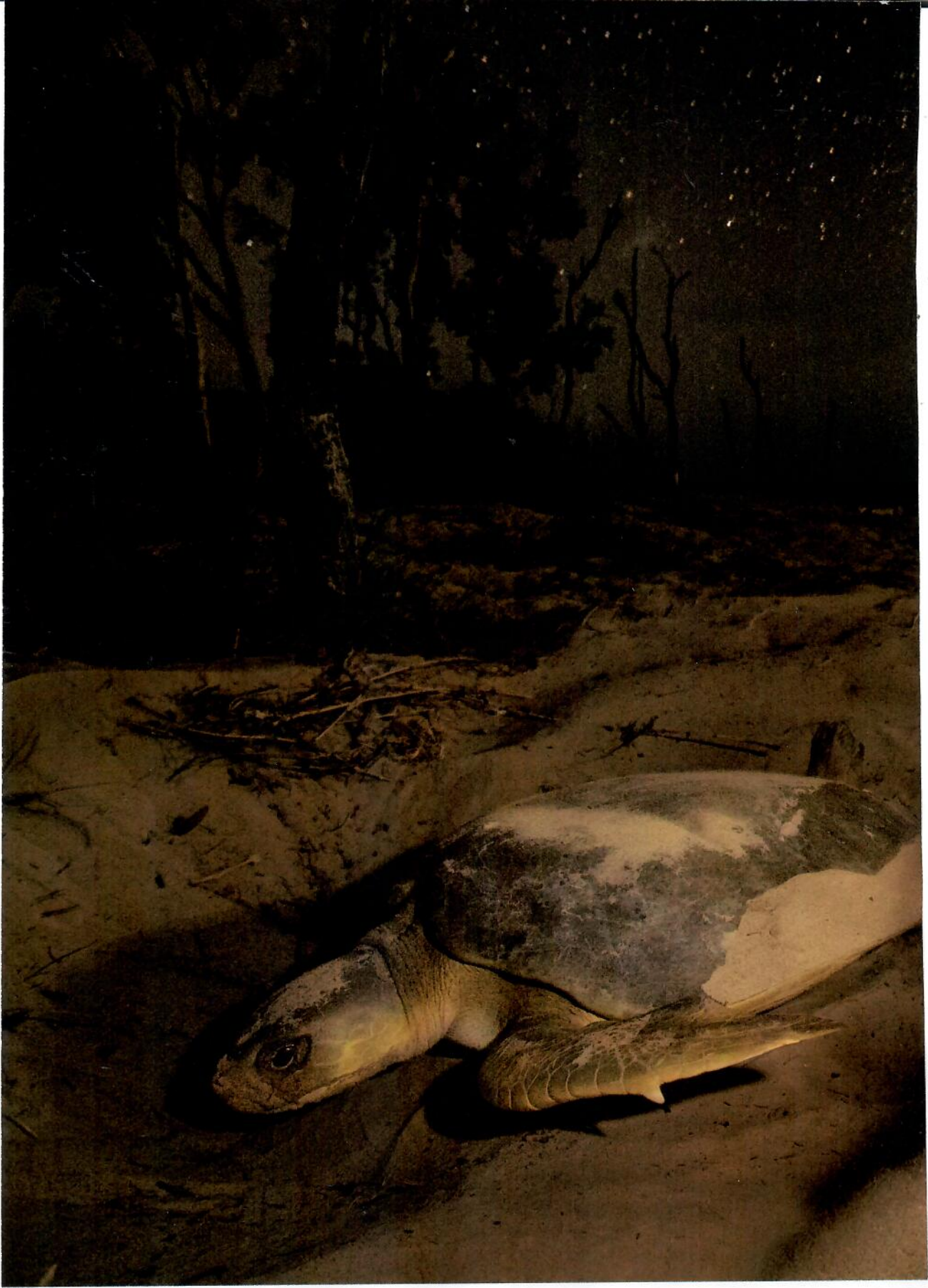
VANISHING: A SPECIAL ISSUE

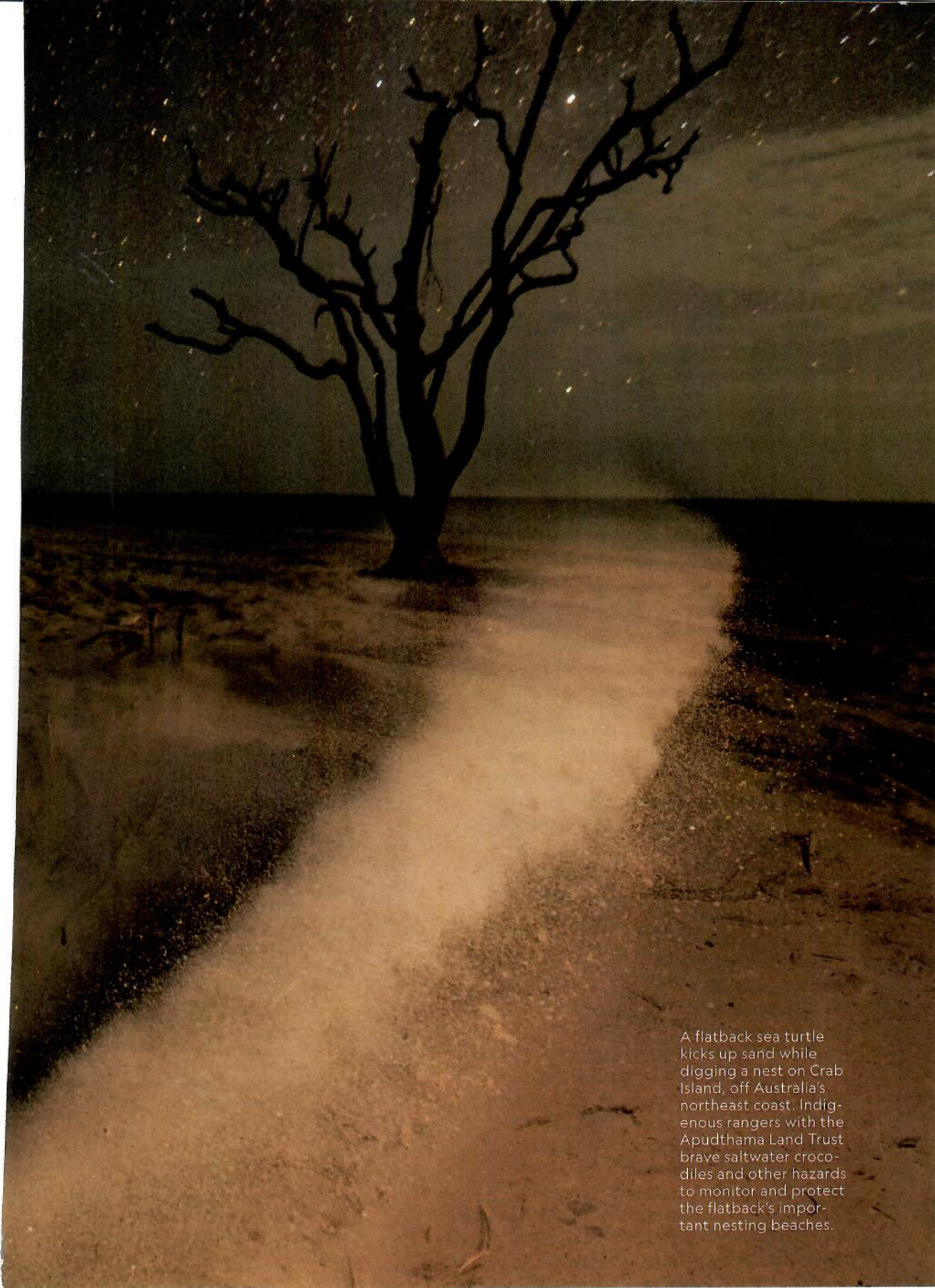




Blood seeps from a dying leatherback harpooned by an indigenous hunter near Indonesia's Kei Islands. Leatherbacks are the largest of the seven sea turtle species and one of the most imperiled. The West Pacific population has fewer than a thousand females.







A flatback sea turtle kicks up sand while digging a nest on Crab Island, off Australia's northeast coast. Indigenous rangers with the Apudthama Land Trust brave saltwater crocodiles and other hazards to monitor and protect the flatback's important nesting beaches.

TO

SEE ALL THAT'S HOPEFUL and appalling about the way we treat sea turtles, there's no better place to start than the Burj Al Arab Jumeirah hotel. This shimmering tower of blue and white glass is shaped like the jib of a sailboat bound for shore. It rose two decades ago on an artificial island amid the steel forest of construction cranes that is Dubai, part of the United Arab Emirates. A royal suite, at 8,396 square feet, comes with a private cinema and 17 pillow options. A weekend stay can top \$50,000. I have come here, though, to see its nonpaying guests.

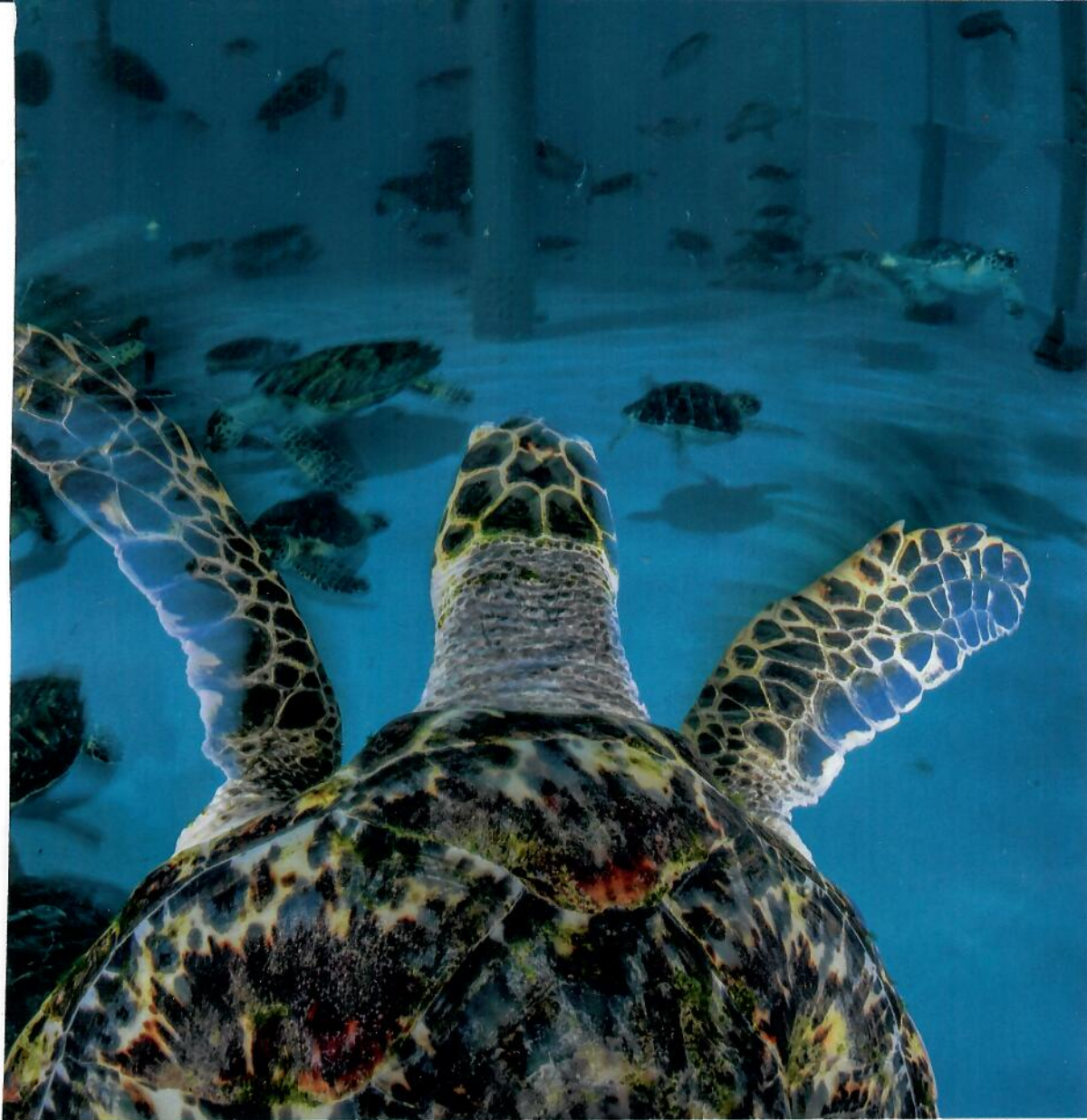
Passing a fleet of white Rolls-Royces, I meet British expat marine biologist David Robinson. We take an elevator down to a parking garage and walk by Lamborghinis to our destination: a labyrinth of pipes and plastic pools, the intensive care unit of an elaborate marine turtle hospital. In one tub a green sea turtle struggles with internal organ damage. One floor up, sick, critically endangered hawksbills fill aquariums.

The hotel housing this rehab center is owned by a holding group whose driving force is Dubai's emir. His Highness Sheikh Mohammed bin Rashid al Maktoum, the architect of the region's lightning growth, wants his city to become a model of environmental stewardship.



At a sea turtle rehabilitation center in Dubai, hawksbills and green turtles circle a tank before being set free. The rescue center has treated and released more than 1,600 sick and injured turtles in the past 15 years.

Photographic coverage for this story was supported by Hussain Aga Khan, the Paul M. Angell Family Foundation, and the Save Our Seas Foundation.



But the reptilian miseries unspooling in this epicenter of consumption reveal much about the ills we humans heap on these creatures. Workers here have seen turtles with balloons lodged in their intestines, turtles with flippers broken after getting caught in fishing nets, a turtle bashed in the head and tossed off a boat. One female green turtle was struck by a ship just down the road, near the world's ninth busiest seaport. The impact crushed her shell, carving out a jagged three-pound wedge as big as an iron.

"People are doing this," says Robinson, a former operations manager for this facility. "Everything—every aspect, every single

species of turtle, every threat that they face—is anthropogenic."

He certainly doesn't mean just here. From Kemp's ridleys no bigger than car tires to leatherbacks that can outweigh polar bears, six of the world's seven sea turtle species are considered vulnerable, endangered, or critically endangered. The status of the seventh, the flatback of Australia, is unknown.

And yet these beasts soldier on, despite the obstacles we place before them. Of the sea turtle nesting colonies that were reviewed in a recent analysis, more than twice as many were increasing as were trending downward. Scientists this

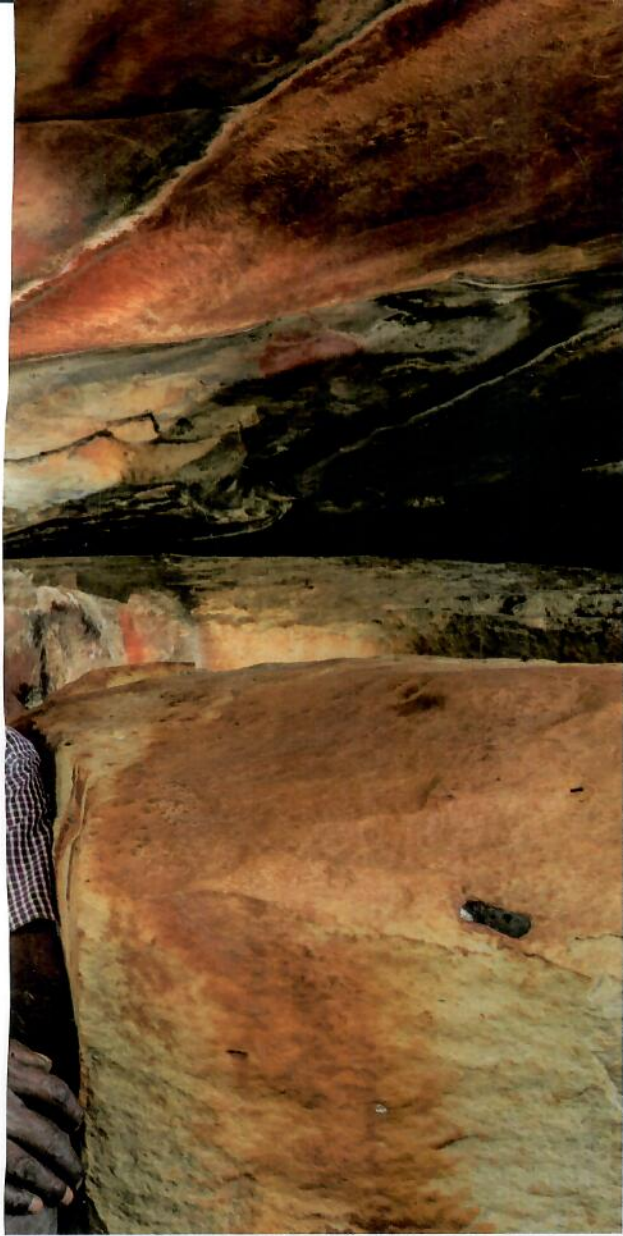


year found that turtle populations protected by the U.S. Endangered Species Act were on the upswing. Hawaii's green turtles, long in trouble, are rebounding far faster than anyone expected. One turtle released from Robinson's care after 546 days of treatment for a head injury made the longest documented journey by a green sea turtle. She traveled 5,146 miles, from the Middle East nearly to Thailand, before her tracking device finally gave out.

Sea turtles, it appears, may be more resilient than once thought. "I've seen all sorts of crazy injuries, deformities, illnesses, and they just keep going," says Bryan Wallace, who oversees

sea turtle assessments for the International Union for Conservation of Nature, or IUCN. "Where's the dodo or the passenger pigeon of the sea turtle world?" While a few local stocks are in real danger of blinking out—Malaysian leatherbacks, for example—all seven species are hanging on regionally and globally.

As we've plundered the seas, built up coastlines, and set about heating the planet, it's reasonable to wonder whether we're dooming these animals. But after months of reporting on sea turtles in several countries, I think we should consider another query instead: How might these reptiles fare with a bit more help?



Ida Mamarika and her husband, Christopher Maminyamanja, visit a cave on an island off northern Australia where a gallery of Aboriginal rock art believed to be at least 5,500 years old includes an image of a green sea turtle. Mamarika's clan reveres the green turtle as a totem, or spirit animal.

SPEND ENOUGH TIME watching sea turtles and it's hard to escape how astonishing they are. They soar through oceans with winglike front flippers, dig nests using back appendages that scoop and toss sand almost like hands, and squeeze salt water, like tears, from glands near their eyes. Their mouths are similar to bird beaks, perhaps because turtles share a common ancestor with chickens. All but leatherbacks, with their layer of thick skin, have bony external skeletons covered in scutes of keratin, the material found in rhinoceros horns and our own fingernails. But each species is different. Hawksbills help reefs by eating sponges that can smother coral. Loggerheads use powerful jaws to crush horseshoe crabs. Leatherbacks feed on jellyfish and sea squirts and can easily migrate from Japan to California.

Marine turtles split from their terrestrial relatives more than 100 million years ago. They survived the asteroid that killed the dinosaurs and squeaked past a marine extinction two million years ago that cut their numbers almost in half. Today sea turtles are found on the beaches of every continent except Antarctica, and they swim in all tropical and temperate waters.

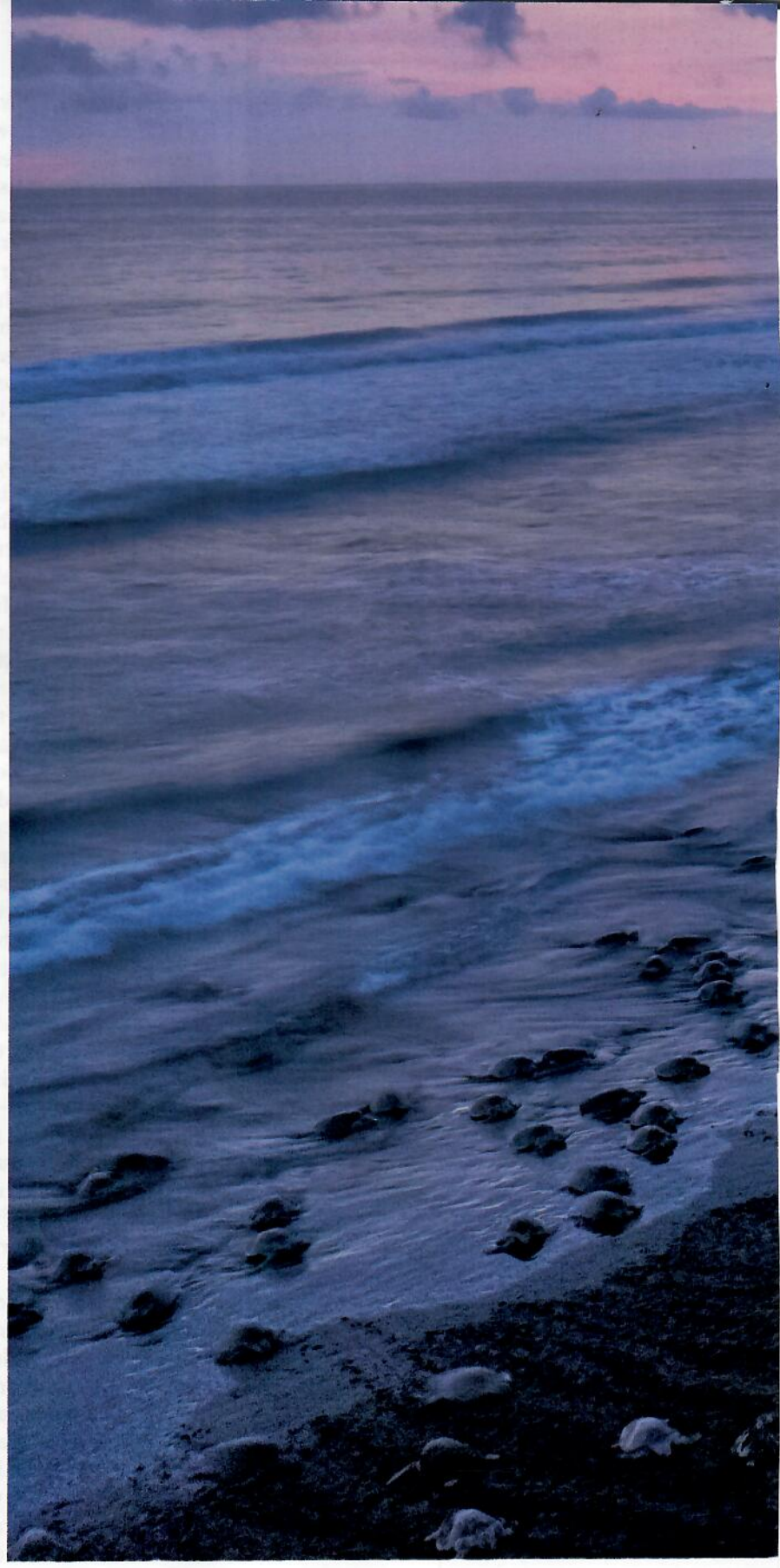
Perhaps their ubiquity explains the many roles they've played for people. They tell our stories: In Chinese mythology, sea turtle legs hold up the sky. We turn to them for healing: Turtle meat in West Africa was once believed to fight leprosy, and bathing in a broth of loggerhead plastron, the bony undershell, was considered a tonic for lung ailments. Even today, bones and scutes are sold as medicine from China to Mexico.

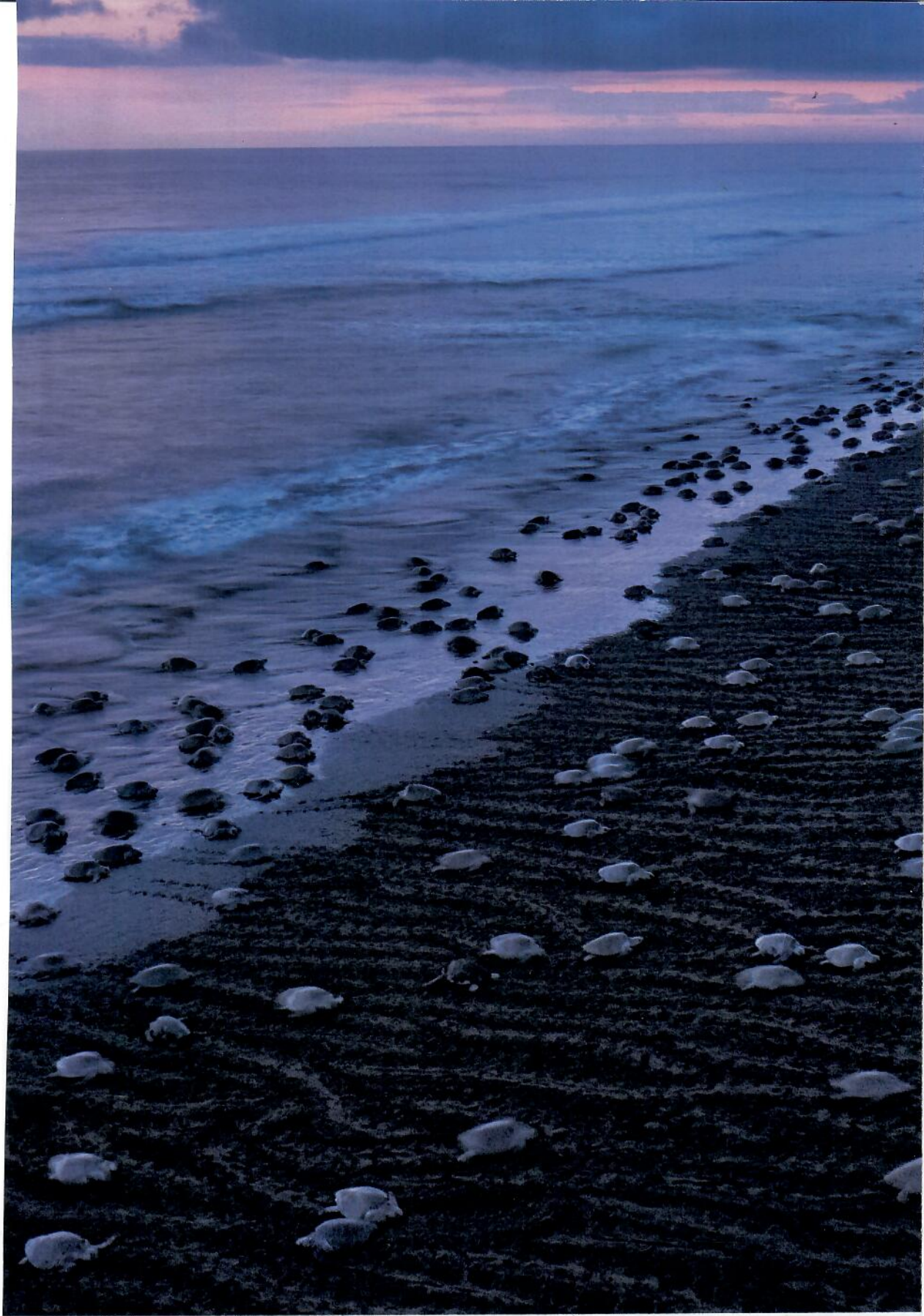
Through most of this shared history, turtles haven't just survived—they've thrived. "The sea was all thick with them, and they were of the very largest, so numerous that it seemed that the ships would run aground on them," a Spanish priest wrote of Christopher Columbus's view of Cuba's sea turtles in 1494, during his second voyage.

Some scientists today believe the pre-Columbian Caribbean alone may have been home to 91 million adult green turtles. That's roughly 10 times as many as all the adult sea turtles of every species believed to be alive today. So many occupied the Cayman Islands in the 1700s that English settlers used them to supply Jamaica with meat. It wasn't long before West Indies turtles were being served in London pubs and John Adams was slurping sea turtle soup

Faint, illegible text from the reverse side of the page, appearing as bleed-through.

Once or twice a month during Costa Rica's rainy season, female olive ridley sea turtles come ashore by the tens of thousands and lay eggs in a mass nesting event known as an *arribada*. Hatchlings begin emerging about 45 days later.







SEA SURVIVORS

HARD SHELL

Six of the seven species have hard shells fused to their ribs and overlaid with keratin scutes. They also have claws on their flippers.

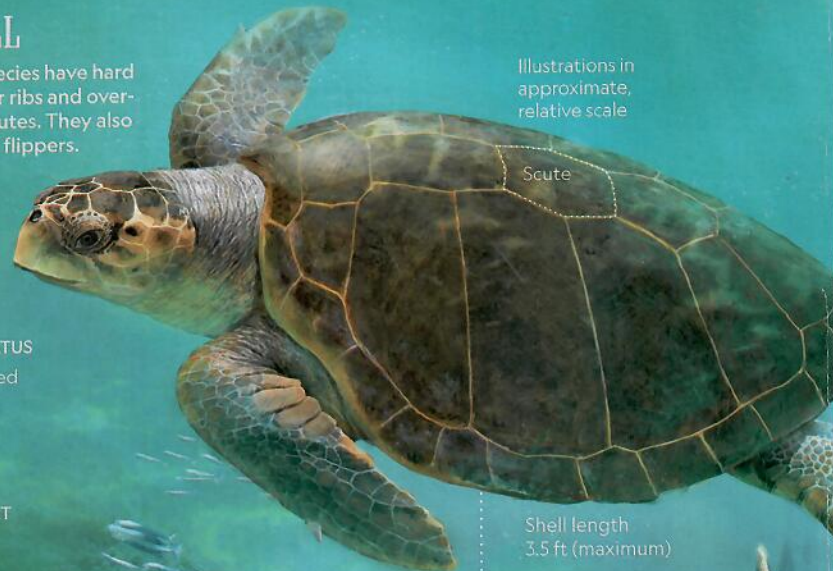
Illustrations in approximate, relative scale

CONSERVATION STATUS

- ◆ Critically endangered
- ◆ Endangered
- ◆ Vulnerable
- ◇ Insufficient data

PRIMARY ADULT DIET

-  Invertebrate
-  Marine plant
-  Horseshoe crab
-  Sponge
-  Crustacean
-  Mollusk
-  Fish



Scute

Shell length
3.5 ft (maximum)



2.1 ft



◆ KEMP'S RIDLEY

Lepidochelys kempii

Accidental capture and egg overharvesting have made the smallest sea turtle the world's most threatened.



◆ LOGGERHEAD

Caretta caretta

The most abundant sea turtle in the U.S. is named for its giant head. Its strong jaws can crack conch shells.



Nesting area
Range
Population at highest risk

Sea turtles have navigated the oceans since the time of the dinosaurs more than 100 million years ago. Today all seven species are under threat at every life stage because of human activities, from accidental capture in fishing nets to overharvesting of eggs and widespread plastic pollution.



All sea turtles have glands around the eyes to remove excess salt from their bodies.

Brain



The green turtle's serrated beak helps tear marine plants.

Esophagus

Claw



Interlocking scutes prevent water loss and cover flattened, fused ribs that separate at the tips.

Ribs

Lungs

Stomach

Liver

Fat

4 ft

Adult males can be identified by their long tails, which hold sex organs.

Front flippers act as wings for propulsion. Rudder-like hind feet stabilize and steer.



3.1 ft

Female

◇ FLATBACK

Natator depressus



The flatback makes the shortest migration: around Australian waters. It has a nearly flat body with flared edges.



200 ft

◆ GREEN

Chelonia mydas



Named for a layer of green fat under their shell, green turtles start as omnivores before turning into herbivores.



500 ft

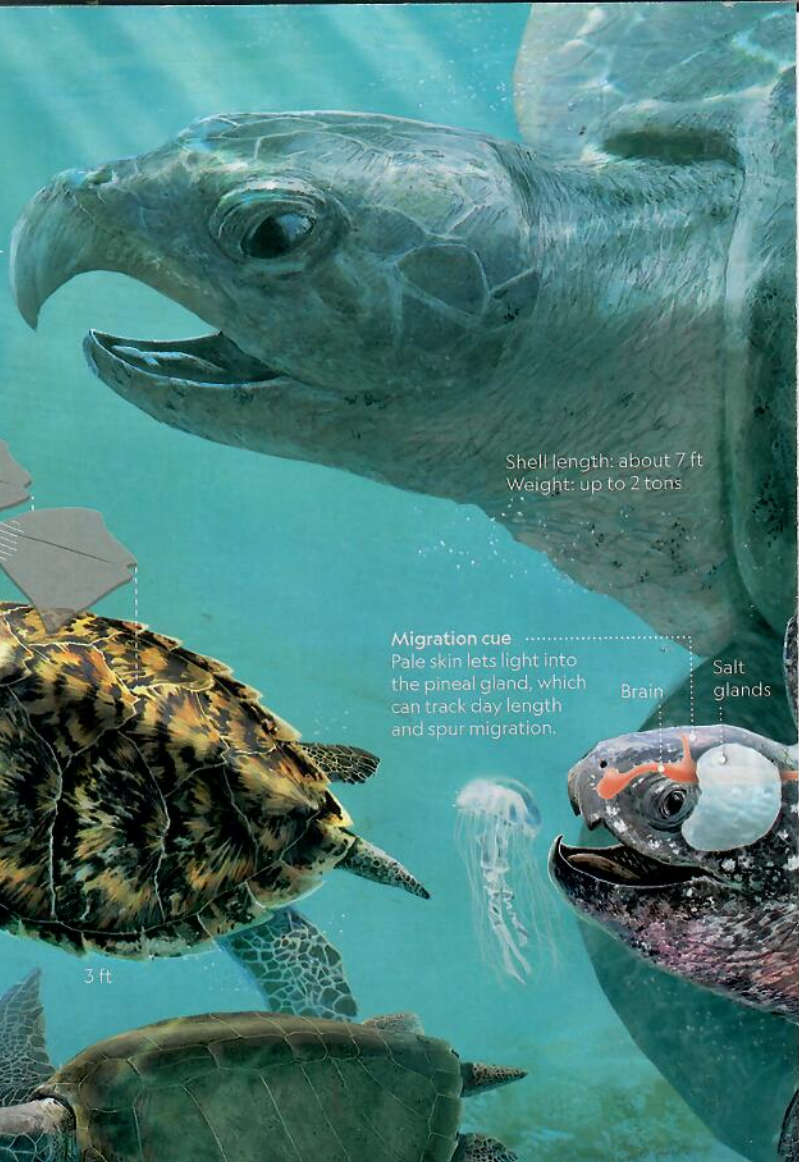




To fight poachers in Costa Rica, researcher Helen Pheasey fits decoy eggs with GPS transmitters, then slips them into sea turtle nests. Pheasey has tracked stolen eggs to commercial outlets many miles inland from nesting sites.

Archelon (extinct)

This giant that roamed the seas 75 million years ago had unfused ribs, like its close relative, the modern leatherback.



Shell length: about 7 ft
Weight: up to 2 tons



Scute

The hawksbill is the only turtle with overlapping scutes and serrated edges on its shell.

3 ft

Migration cue
Pale skin lets light into the pineal gland, which can track day length and spur migration.

Brain

Salt glands



2.3 ft

◆ **HAWKSBILL**

Eretmochelys imbricata



Hawksbills' intricately patterned, translucent scutes have long been used to decorate jewelry and luxury items.



300 ft

◆ **OLIVE RIDLEY**

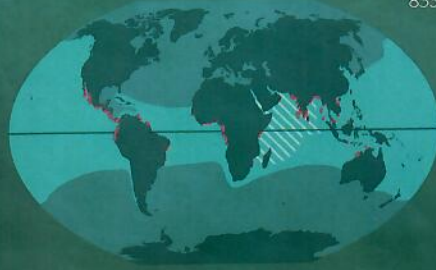
Lepidochelys olivacea



The most abundant species exits the sea en masse to nest, a safety-in-numbers strategy against predators.



835 ft

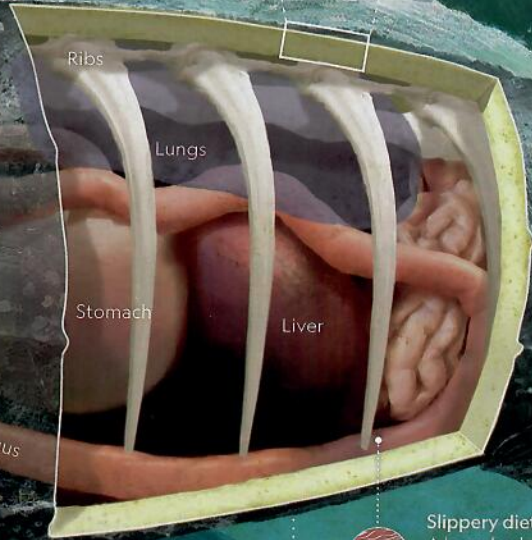


FLEXIBLE SHELL

Leatherbacks are the only living species with unfused ribs, rubbery skin over layers of connective tissue, and a flexible shell of bony plates.



Waxy skin covers a shell of coin-size bony plates that can withstand the pressure of deep dives.



Slippery diet
A long, barbed esophagus traps jellyfish and keeps them moving into the stomach.

Artery
warm
blood

Vein
cool
blood



Transferring heat
Blood flowing to flippers warms returning cold blood, maintaining a warmer core than hard-shell turtles have.

◆ LEATHERBACK

Dermochelys coriacea

The largest and deepest diving turtle makes the longest migrations and can weigh up to 2,000 pounds.



Longest documented sea turtle migration
12,174 mi







In Ostional, Costa Rica, olive ridleys nest so close together that they tend to crush and destroy one another's eggs, so authorities allow local residents to gather some turtle eggs for their own use and domestic sale. The harvest and sales are regulated.

during the First Continental Congress. Within a century, though, Caribbean turtle populations had crashed, sending turtle hunters to new coastlines, foreshadowing a great transition.

THE RAIN is just starting on a dark Costa Rican night when Helen Pheasey and I cut across a beach with a red flashlight. Pheasey, a Ph.D. candidate who studies the black market trade in reptiles, is working with a U.S.-based conservation outfit called Paso Pacifico. In her pocket she carries a fake turtle egg implanted with a GPS transmitter, and we're looking for its potential mom. She gestures toward an olive ridley, alone and kicking up sand in the dark. As the pregnant turtle drops her eggs, Pheasey crawls toward the turtle's tail, reaches into the mound of Ping-Pong ball-size eggs, and places the decoy in the middle of the pile. She's hoping hurried egg poachers will nab her fake along with their intended loot.

Turtle eggs are hot commodities in parts of Asia and Latin America. They may be boiled in soup, cooked into omelets, or dropped raw into a shot glass with lemon, tomato juice, and pepper. Eggs don't bring huge dollars, but because most turtles lay 50 to 100 or more at once and leave long sandy tracks from sea to nest, they're easy to find and steal in volume.

In most countries, selling turtle eggs has been illegal for years. Yet in 2018, police seized a pickup in Oaxaca, Mexico, loaded with garbage bags stuffed with 22,000 turtle eggs. Malaysian authorities two years earlier intercepted four Filipinos in wooden boats carrying 19,000 eggs. The \$7,400 those sailors stood to make was nearly three times the average yearly wage in their community. Egg theft is often linked with poverty or drug and alcohol abuse, Pheasey says. But the hope is that fake eggs could help stop organized traffickers.

On a recent Saturday near Guanacaste, Costa Rica, thieves raided 28 nests—a haul that included one of Pheasey's fake eggs.

At 7 a.m. Monday, Pheasey watched on smartphone apps as her egg traveled from the peninsula to the back of a building on the mainland. After a delay, the egg moved again, to a neighborhood in San Ramón, 85 miles from the beach. Pheasey traced the route in her car. The egg had stopped at a supermarket loading dock. There it probably changed hands before being ferried to someone's house.

Pheasey and Paso Pacifico are still working out kinks in their tactics, but even if the decoy eggs show promise in fighting smugglers, that's just one of the many problems turtles face. We're chewing up nesting beaches by erecting oceanfront skyscrapers, hotels, and subdivisions. We've illuminated coastlines with disorienting streetlights. When turtles manage to find sand in which to lay eggs, bright lights often send them wandering. Some get hit by cars. Pollution, from oily toxics to plastics, spills into coastal waters. Straws and plastic forks get sucked up turtles' noses. Hungry leatherbacks mistake plastic bags for jellyfish.

New research suggests that nine million hawksbills were slaughtered in the past 150 years, mostly for their fiery red and gold carapaces, which were fashioned into hair clips, eyeglasses, jewelry boxes, and furniture.

The Convention on International Trade in Endangered Species (CITES) began banning the sale of turtle goods in the 1970s, but that hasn't always worked. In 2012, researchers found thousands of hawkbill pieces for sale in Japan and China. Solid numbers are unavailable, but scientists estimate that only 60,000 to 80,000 nesting female hawksbills remain worldwide.

Meanwhile some countries still allow subsistence hunts for turtle meat. But even in countries where that practice has been outlawed, bans are meaningless without enforcement, buy-in from local residents, and alternatives for food or income. In Mozambique and Madagascar alone, for example, tens of thousands—perhaps hundreds of thousands—of both young and adult green turtles are illegally killed each year by hunters.

THERE HAS BEEN some promise in places where residents have bought in to the idea of turtle conservation. One morning in Costa Rica I sit in a delivery truck as the ocean flickers through the royal palms. Our payload: 80 large bags filled with 96,000 turtle eggs. A few miles down the road, we back up to an open shed. Men unload this delicate cargo onto a sorting table, where women begin placing the eggs in smaller bags. Soon they'll be repackaged and sold to restaurants and bars as far away as the capital, San José. Here it's all perfectly legal—and may even help turtles.

Every month this beach in Ostional, on Costa Rica's upper Pacific Coast peninsula, is the site of

one of the world's largest mass-nesting events. Known as an *arribada*, it typically begins in the dark, as it did this morning. Female olive ridleys by the thousands congregate offshore, their forms silhouetted by the starry sky. Then, following some mysterious cue, they start crashing ashore. They come in waves, bumping and pushing past one another, oblivious to the threats around them: egg-scavenging vultures, wild dogs, hungry raccoons. Then they start digging, uncovering and crushing each other's eggs, filling the new holes with future offspring before lumbering back to sea.

The humans arrive at dawn. Barefoot men perform an odd step dance, bouncing gingerly heel to toe, feeling for loose earth with their feet. Finding some, they squat and dig until they reach eggs. Then teenagers and women begin filling bags.

Ostional didn't really become much of a community until sometime after World War II. But by the 1970s, settlers had come to rely on turtles. Soil nearby wasn't great for farming, and there were few jobs, so residents plucked turtle eggs to feed their pigs. "Turtles were no more special to us than our chickens," Maria Ruiz Avilés says during a break from labeling egg bags.

**I'VE SEEN ALL SORTS
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WHERE'S THE DODO
OR THE PASSENGER
PIGEON OF THE
SEA TURTLE WORLD?**

—BRYAN WALLACE, IUCN

Costa Rica began trying to prohibit egg harvests in the 1970s, but enforcement was lax. Researchers eventually recommended an arrangement: a regulated, legal, domestic trade. So many turtles show up during an *arribada* that they dig far more nests than the beach can accommodate. Even without poaching, up to half of the eggs on the beach were being destroyed, mostly by other turtles. Costa Rica's national government allows the few hundred residents of Ostional to legally collect a portion of the eggs.

Today Ostional's egg harvest is viewed by many as a success. Residents take a small

number of eggs, and some biologists think riding the beach of the excess keeps microbes from killing more. Sales pay for beach patrols and enforcement to keep poachers out. Paperwork follows every sale, so buyers know the eggs are legal. Invested residents drive off predators to help remaining hatchlings get to the sea. "We do a good job," Ruiz Avilés says.

That doesn't mean this model should be exported. Demand for eggs here is a fraction of what it is in, say, Mexico. And *arribadas* here offer an embarrassment of riches, because culling eggs may help more baby turtles survive. "In my opinion, Ostional should never ever be taken as an example for conservation anywhere else—ever," says Costa Rican Roldán Valverde, a professor at Southeastern Louisiana University. While some experts suggest this legal harvest prevents far more eggs from being taken illegally, others fear that legitimizing any of this trade perpetuates the black market. Unfortunately, we're stuck making decisions with imperfect information.

IN FACT, IT'S OFTEN unclear how many sea turtles of each species remain—or how many is enough to ensure their survival. New research suggests that some population counts based on nesting beaches may be far too generous. But nest counts can also underestimate turtle numbers. "We need to understand a lot more about what's happening in the water, where sea turtles spend 99 percent of their lives," says Nicolas Pilcher, a sea turtle biologist who does fieldwork for governments and nonprofits.

Pilcher is piloting a boat across shallow seagrass beds about 50 miles west of Abu Dhabi. He's conducting a turtle rodeo, chasing a green turtle as it zigs and zags just below the water's surface. Near the bow Marina Antonopoulou, with Emirates Nature-World Wildlife Fund, perches on the gunwale. When Pilcher shouts the signal, she launches onto the carapace, trying to wrestle the turtle to the surface and into the boat. But it wriggles free. Antonopoulou stands in the water, frustrated but amused. Pilcher pushes on.

Antonopoulou and a team of scientists, including some from the Abu Dhabi government, are cruising the U.A.E.'s Marawah Marine Biosphere Reserve to gauge where these speedsters are headed. Near Pilcher's feet a half dozen green turtles lounge. A quick surgical procedure



Leatherback hatchlings encounter plastic bottles and other debris as they crawl across Trinidad's Matura Beach to reach the ocean. Nature Seekers, a local conservation group, organizes regular beach cleanups that have helped leatherbacks rebound there.





After harpooners land a leatherback in Indonesia's Kei Islands, villagers gather on the beach to watch the butchering process. Weighing up to 2,000 pounds, leatherbacks have long been a significant source of protein for the island communities.



will tell him whether these animals are male or female and ready to mate and nest. The team will attach tracking devices to some, then release them all. "We're trying to link where these turtles live, which is here, with where they lay their eggs," Pilcher says. That's key to saving turtles.

But turtles often feed in waters controlled by one government and nest on beaches controlled by another. This is especially true in the Middle East, where U.A.E. turtles may lay eggs in Oman, Saudi Arabia, Kuwait, Iran, or even Pakistan. Conservationists and the Abu Dhabi government can't negotiate with neighboring countries for more protection without knowing which turtles go where. That matters, of course, because development in the Middle East is booming, and "nesting habitat for turtles is continually shrinking," Pilcher says.

SEA TURTLE CONSERVATION has made great strides in recent decades in many places around the globe. In Florida and Hawaii, coastal resorts and hotels are reducing beachfront lighting. Use of devices that let unsuspecting turtles escape fishing nets helped save Kemp's ridleys in Mexico and loggerheads in the Atlantic and is being tried in other areas. We've closed fisheries and changed commercial fishing hooks to prevent accidental snagging. A few fishing fleets employ observers who document turtle interactions.

Still, even as we make progress, complex new challenges are emerging. The sex of turtles is determined by the temperature of the sand where eggs gestate. Warmer sands produce more females, so as climate change drives sand temperatures higher across the tropics, more turtles are being born female.

On a warm evening in a San Diego, California, bay, I watch a crew of scientists hold an adult green turtle while Camryn Allen quickly draws a vial of blood. For several years Allen, with the National Oceanic and Atmospheric Administration, has used hormones such as testosterone to track the sex of sea turtles. Here the ratio of females to males has increased slightly, but her recent work in Australia truly alarmed her.

Raine Island, a 52-acre half-moon of sand on the edge of the Great Barrier Reef, is the biggest nesting island on Earth for green sea turtles. More than 90 percent of the northern Great Barrier Reef's green turtles deposit eggs here and on nearby Moulter Cay. But Allen and her colleagues discovered that as temperatures have



A conch fisherman draws the attention of green sea turtles at Little Farmer's Cay in the Bahamas. Once prized for their meat, the island's green sea turtles are now valued more as tourist attractions.



risen, female green turtles born on Raine have come to outnumber males 116 to one.

"Seeing those results scared the crap out of me," Allen says.

It's not the only threat climate change poses. As hurricanes become more powerful, they're wiping out more turtle nests. Rising seas also are flooding nest sites and drowning eggs.

And yet for all that, there are hopeful signs. Turtles didn't survive 100 million years without developing strategies to weather hard times. They can slow their metabolism and go months without eating. Some females have skipped nesting seasons for years, only to show up again a

decade later. New research suggests males may mate with many females when populations are stretched thin. And sea turtles may switch nesting beaches in times of stress.

Allen's initial fear has tapered off as she's seen turtles' versatility. "We may lose some smaller populations, but sea turtles are never going to go away completely," she says. "I think turtles, out of all the other species, might actually have a pretty good shot." They just can't do it by themselves. □

Staff writer **Craig Welch** reported on thawing permafrost in the September issue. This is photographer **Thomas P. Peschak's** tenth assignment for *National Geographic*.