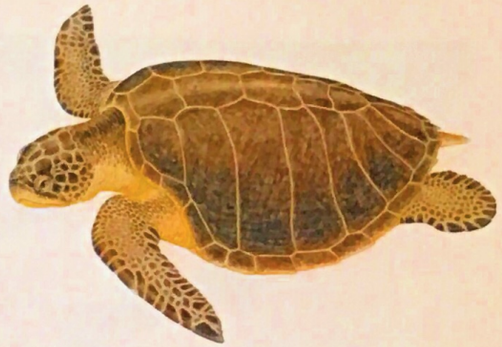


THE OLIVE RIDLEY TURTLE IS A BEAUTIFUL DANCER. ON CERTAIN CLOUDY, moonless nights you can hear the female's dance as she covers her nest of eggs. Long before you see her a series of thumping sounds can be heard in the night air. Then you spot a little (by leatherback standards) turtle bouncing on the sand, pounding it flat and hard with her plastron. Propped up on her front flippers and hind legs, she alternately bounces her plastron side to side in a little dance that seals the site where she has just deposited her offspring. It strikes one as unusual and unexpected: Look at the silly turtle dancing on the sand.

Most sea turtles cover their nests with their hind flippers and throw sand with their front flippers. These species have enough mass and strength to compact the sand with their rear flippers and tail. The relatively light olive ridley, however, must pound the sand down like the head of a hammer, dancing her way around the place where she has just put the next generation.

Olive ridleys do something else that is phenomenal. When it is time to nest, most olive ridleys come ashore in groups of many thousands. The Spanish call these arrivals *arribadas* and they are arguably the greatest display of animal reproduction in the world. Imagine 50,000 olive ridleys laying 110 eggs each on 1 mile (1.6 km) of beach, coming ashore in wave after wave over a 3-day span. That's a total of 5.5 million eggs weighing 1.4 ounces (40 g) each or 485,000 pounds (220,000 kg) of eggs.

Another striking thing about olive ridleys is that they nest in the daytime as well as at night. Some years ago my colleague Ed Standora and I demonstrated that large sea turtles could not nest during the heat of the day because they became overheated. Like Kemp's ridleys, which nest mainly in the daytime, and flatbacks, which often nest during the day, olive ridleys are able to accomplish this feat because of several adaptations. First, they avoid nesting during the hottest part of the year and during the hottest part of the day. Occasionally, you can find turtles of many species, even leatherbacks, nesting during the morning. Presumably they came out late at night on a morning high tide and were greeted by the sun. Ridleys, however, purposefully nest during the morning and late afternoon.

Intuitively we might think that a small sea turtle would heat up faster than a large one, just as a small block of ice melts faster than a large one. However, olive ridleys are

Previous pages: A small olive ridley *arribada*, or mass nesting, at Ostional on the Pacific coast of Costa Rica. At the height of an *arribada* the beach is literally a blanket of turtles, digging nests, covering them up, and walking to and from the ocean. Turtles come and go for two or three days at a time, resulting in thousands—or perhaps millions—of eggs in the sand.

Opposite: Olive ridleys clambering up the beach to dig nests and lay eggs at Ostional, Costa Rica. Ridleys plod along with an alternating gait that leaves a characteristic track. During an *arribada* they seem unconcerned by the presence of humans.

lighter in color than the larger green, loggerhead, and leatherback turtles, so they absorb less solar radiation. Their smaller size also allows them to cool more effectively from the convective action of wind. *Arribadas* are often associated with windy and cloudy days, so for added protection they apparently select advantageous weather conditions, thus reducing the heat load on the turtles and increasing heat loss by convection. In addition, they are fast nesters. Although most sea turtles take 60-90 minutes to nest (green turtles can take 2-3 hours), ridleys complete the entire nesting process in less than an hour.

Distribution

Olive ridleys thrive in the tropical to warm-temperate Pacific and Indian Oceans, but are uncommon in the western Pacific and eastern Indian Ocean. They also inhabit the Atlantic Ocean along the west coast of Africa and northeastern coast of South America. Although olive ridleys are seen as far north as Alaska and as far south as New Zealand and Chile, their infrequent visits occur only during unusually warm periods. While a few olive ridleys are present in the West Indies, they do not occur in the Gulf of Mexico or in most of the North Atlantic Ocean.

About 3-5 million years ago, when the Isthmus of Panama formed and closed off the Atlantic from the Pacific, olive ridleys and Kemp's ridleys began traveling down different evolutionary paths. We believe that at the time only the ancestors of the Kemp's ridley sea turtle lived in the western Atlantic. In the 1990s, geneticist Brian Bowen conducted studies that suggested olive ridleys spread from the eastern Pacific to the western Pacific and Indian Oceans. Olive ridleys in the eastern Pacific then died out apparently, perhaps owing to climate change or loss of nesting beaches. When climatic

Countries with Populations of Solitary Nesting Olive Ridley Turtles Producing 100 to 2,000 Nests a Year

Region	Nation	Beaches
Western Atlantic	French Guiana	Malmonoury Beach
	Brazil	Sergipe
West Africa	Ghana	
	Gabon	
	Angola	
	Guinea Bissau	Bijagos Archipelago
	São Tomé	
	Equatorial Guinea	Bioko Island
	Togo	
	Benin	
	Cameroon	
East Pacific	Guatemala	Hawaii
	Honduras	Punta Ratón
	Costa Rica	Guanacaste, Playa Hermosa and Osa Peninsula
	El Salvador	Toluca and San Diego
	Mexico	El Quelite, Sinoloa; Chacala, Nayarit; Maruata, Colima; Mexiquillo, Michoacan, Cuajinicuilapa, Guerrero; and 42 more
Western Indian Ocean	South Africa	
	Mozambique	
	Kenya	
	Tanzania	
	Oman	
Central Indian Ocean	Pakistan	
	India	Saurashtra Peninsula and Bhaidar Island; In Gujarat; Tamil Nadu; Andhra Pradesh; South Andaman Island; Great Nicobar Island
	Sri Lanka	
	Bangladesh	
Eastern Indian Ocean	Burma	
	Thailand	
Western Pacific Ocean	Australia	Crab Island
	Brunei	
	Malaysia	
	Indonesia	
	Vietnam	

Major and Minor Olive Ridley *Arribada* Beaches

Beach	Nation	Number of Turtles
Major		
Ostional	Costa Rica	500,000
Nancite	Costa Rica	100,000
La Escobilla	Mexico	450,000
Gahirmatha	India	135,000
Eilanti	Suriname	Disappeared
Mismaloya	Mexico	Disappeared
Piedra de Tlacoyunque	Mexico	Disappeared
Chacahua	Mexico	Disappeared
Minor		
La Flor	Nicaragua	10,000-20,000
Chacocente	Nicaragua	2,000-5,000
Isla Cañas	Panama	2,000
Ixtapilla	Mexico	2,000
Barunei River	India	2,000-10,000
Masachapa	Nicaragua	Disappeared
Pochomil	Nicaragua	Disappeared
South Andaman Island	India	Disappeared

conditions improved about 200,000 years ago, olive ridleys expanded out of the Indian and western Pacific Oceans and recolonized the eastern Pacific. At that time, the genetic lineages suggest, they also moved into the southern Atlantic Ocean.

Olive ridleys can be seen in coastal waters, but scientists have reported observing them far out to sea in drift lines of seaweed (*Sargassum* algae) and floating debris along convergence zones between warm and cold water regions.

While solitary nesting occurs on the beaches of 32 countries, *arribadas* are found in only a handful. One of the *arribada* beaches, Playa Nancite in Costa Rica, is protected as part of Santa Rosa National Park. Another Costa Rican beach, Playa Ostional, is a national wildlife refuge, but it is also the site of a village of 90 houses. Ostional's people collect olive ridley eggs in a legal harvest. Little information is available about the effect of this harvest on the turtle population.

In Mexico, olive ridleys nest in *arribadas* at Playa La Escobilla in the state of Oaxaca. The beach is protected and studies suggest the ridley population is actually increasing. Another large *arribada* beach, Gahirmatha, is in Orissa, India. The beach is protected by the government but increased fishing activity in the region has drowned many adult turtles. Smaller *arribadas* of 2,000-20,000 turtles occur in other parts of Mexico and India as well as in Nicaragua and Panama.

Because of olive ridleys' nesting behavior it is difficult to accurately count them. They come and go constantly, literally piling up on top of one another. Some fail to complete a nest because there is just no room on the beach. Repeated attempts mean that they can be counted twice or three times. It is also difficult to count solitary nesters because they visit so many different beaches and in such small numbers. There are simply not enough biologists to count them all (or perhaps not enough money to hire enough biologists to count them all).

The most reliable estimates that I have seen suggest that annually there are about 500,000-600,000 olive ridleys nesting in Costa Rican *arribadas*, 450,000 in Mexico, and 135,000 in India. There may be another 40,000-60,000 nesting at the smaller *arribada* beaches and as solitary nesters. Since olive ridleys reproduce once every 1.7 years, on average, the total world population of nesting females is probably about 2 million. If adult males occur in similar numbers, there are about 4 million adults and anybody's guess as to the number of juveniles. Thus olive ridleys are undoubtedly the most abundant sea turtle in the world.

Unfortunately, this large number hides the fact that olive ridleys are in serious decline. Consider that Mexico had more than 10 million olive ridleys around 1950 and India supported about 600,000 olive ridleys as recently as 1994. Indeed, past *arribadas* of several hundred to tens of thousands of individuals have completely disappeared in Suriname and on South Andaman Island off the coast of Thailand. Ridley populations have declined precipitously in Bangladesh, Burma (Myanmar), Malaysia, Pakistan, and Sri Lanka. The number that at first sounds so safe soon resembles a line on an extinction chart.

Life History

Most olive ridleys lay 2 or 3 clutches of eggs each year they nest (2.2 on average), numbering about 110 eggs weighing 1.4 oz (40 g) each. The clutches are laid at intervals of 17-45 days during the nesting season. They usually nest in the open sand but at Playa Nancite, Costa Rica, some turtles nest under trees, a practice that tends to produce male hatchlings. Olive ridleys appear to waddle along as they use alternate flippers to quickly ascend the beach and leave a distinctive track about 30 inches wide. The female ridleys return to nest every year or two.

Hatchlings weigh 0.6 oz (17 g) and generally emerge from the sand at night. The pivotal temperatures for sex determination are 86-88°F (30-31°C) at Playa Nancite and about 84°F (29°C) at Gahirmatha, India. In Costa Rica, temperatures of 90°F (32°C) and higher will produce hatchlings that are 100 percent female. In India, temperatures of 86°F (30°C) and higher produce 100 percent females. It takes 50-65 days for an egg to hatch depending upon nest temperature.

On *arribada* beaches thousands of hatchlings swarm to the sea at once, usually emerging at night. The beach literally splits open and erupts with tiny turtles that quickly fill the ocean. Most biologists think that this behavior has the effect of "swamping" predators, ensuring that many hatchlings survive the gauntlet from nest to the open ocean miles offshore.

That gauntlet begins while the eggs are still developing in the nests, which are so shallow that it is easy for animals to dig them up. Only by overwhelming predators, placing thousands of nests on a beach or by hiding nests one at a time on widely scattered beaches, can olive ridleys hope to avoid their many predators.

At sea they face hungry fish. Here too, perhaps, the swarm of hatchlings provides safety in numbers, as a fish can take only one turtle at a time.

Even crocodiles get into the act. When I first went to Playa Nancite in 1980, biologists Georgita Ruiz and Merri Camhi had seen a three-foot-long (91 cm) female American crocodile leave the estuary at night and eat hatchlings as they emerged and ran to the sea. In the early 1990s, Pam Plotkin (then a graduate student) watched the same crocodile, then eight feet (2.4 m) long, swim in the ocean to catch hatchlings and chase adults. By the late 1990s, Dr. Heather Kalb saw the same crocodile—12 feet (3.7 m) long by then—cruise the shoreline eating adult female ridleys as they swam to and from the beach during the *arribada*. Today that crocodile's offspring continue the hunting tradition.

Little is known about the early life of olive ridleys. We don't know how fast these young turtles grow, but we believe Kemp's ridleys mature in 11-16 years. So that's our best estimate for olive ridleys, as well.

Adult olive ridleys are omnivorous. They eat crabs, snails, clams, barnacles that encrust floating objects, salps and sea squirts (soft-bodied relatives of the vertebrates that float free or attach to objects), bryozoans (hard-bodied or soft, often jelly-like colonial animals that attach to *Sargassum* and other firm objects), algae, fish, fish eggs, and jellyfish. They dive deep into cooler water that lies under the warm tropical sea and have been captured in nets as deep as 350 feet (107 m). They spend considerable time at the surface basking, presumably in an effort to speed their metabolism and digestion after a deep dive.

Olive ridleys dig quickly and work strenuously when preparing their nest. After laying their eggs they throw sand with their foreflippers and pound the nest down with their whole plastron.

About two months after an *arribada* the sand releases thousands of hatchling olive ridleys. They race to the sea past egg shells and dead eggs that were thrown out of nests by turtles nesting in the last part of the previous *arribada*.

Nomads of the Ocean

Olive ridleys embark upon unique and complex migrations after the reproductive season. They are true oceanic nomads and swim hundreds or thousands of miles over vast reaches of the ocean to their oceanic feeding grounds. They move away from the beach as individuals take varied paths. For example, some Nancite turtles move along the coast from Costa Rica to Ecuador while others move out from shore to the north, west, and south. They do not move in direct migratory corridors but rather seem to wander over vast stretches of the ocean, possibly using water temperature more than any other environmental cue.

It appears that the olive ridleys are seeking oceanic features that move, such as thermal fronts and the edges of cool water masses. The location of these features may not be predictable to the turtles, so they have to wander and search vast areas of the ocean for appropriate places to feed.

Like other sea turtles, olive ridleys probably use the position of the sun as well as magnetic signals to locate general areas in the ocean. The large amount of magnetite in their brains may help them detect the earth's magnetic field. Some years ago the presence of an internal compass became clear to me in a strange way. Jack Rudloe, an expert on loggerheads, was visiting us at Playa Langosta on the Pacific coast of Costa Rica. One of our students found a dead olive ridley hatchling on the beach in the morning and brought it back to the lab to show us. Jack took the opportunity to demonstrate the magnetic properties of the ridley brain in a very convincing fashion. He placed the ridley hatchling on a small sponge in a large pan of water and was able to pull it and spin it around by placing an ordinary magnet near its head. If he placed the magnet near the tail, the turtle slowly spun around and moved toward the magnet headfirst.

Olive ridleys probably remember good feeding grounds from the past and move in that general direction. They also wander and move with the shifting water masses as the ocean changes over the course of the year. In El Niño years there is little mixing of cold and warm water in the tropical Pacific and thus the ocean is not very productive. Olive ridleys have a hard time finding food and do not return to nest for two or more years. However, in La Niña years, when cool water upwellings and cold-water masses are more common, the ocean is very productive and food is plentiful. As a result the turtles may nest in consecutive years.

Breeding Behavior

Most adult males and females migrate toward the coast and assemble at breeding grounds off the *arribada* beaches. Some males, however, choose not to migrate and stake their claim on the oceanic feeding grounds. There they intercept females en route to the breeding grounds and nesting beaches. After mating, *arribada* females remain close to shore for several weeks or even a few months and periodically join *arribadas* to lay their eggs. As a result there are vast aggregations of ridleys in the ocean near nesting beaches for several months during the main nesting season.

Solitary nesting females go ashore alone throughout most of the species' range and lay two clutches a season at 14-day intervals. They may use geographically distant beaches within the same season. *Arribada* nesting females have strong nest site fidelity within and between seasons.

Dr. Pam Plotkin tracked the migrations of olive ridleys during *arribadas* by attaching satellite radio transmitters to their carapaces while they were on the nesting beach at Nancite, Costa Rica. She found that females laid two clutches at approximately 28-day intervals, sometimes delaying nesting for 6-8 weeks when environmental conditions were unfavorable.

In Costa Rica, olive ridleys nest in every month of the year but peak nesting occurs in the latter half of the rainy season from August to December. *Arribadas* in the dry season, from January to April, and in the beginning of the rainy season tend to be smaller and last one or two nights. Most *arribadas* start on a windy night within a few days of the first or last quarter moon. Once mating and nesting is completed olive ridleys quickly migrate to their oceanic feeding grounds.

Above: Dogs and pigs from the village freely dig up nests on Playa Ostional, Costa Rica. Nests are shallow, and broken eggs from an *arribada* often lead animals directly to the feast. On natural beaches eggs are an important resource for coatis, raccoons and other wildlife.

Opposite: Vultures readily eat single hatchlings on Playa Nancite. When thousands of hatchlings come out of the sand at once they can swamp the predators.

A Bountiful Feast

Predators swarm *arribada* beaches during the nesting season. It is a feast that may provide sustenance for animals from miles around. The beach is literally bursting with millions of eggs. Even before the *arribada* starts, animals begin to assemble at the beach. Vultures sit on tree branches and coatis line the edge of the forest. When we were at Playa Nancite studying the conditions on the beach, coyotes wandered through our campsite at night, as did raccoons and other animals. They seemed to know that the turtles were coming.

Once the turtles start to come ashore the feast begins. Coyotes kill and eat adult females on Playa Naranjo, Costa Rica. Jaguars did the same until they too were reduced to a fraction of what they once were. At Playa Nancite vultures and coatis seem to have worked out a cooperative system for digging up nests. Coatis are good diggers but do not see very well. Vultures have excellent eyesight but cannot dig up a nest. So the coatis dig up the nests and as eggs are flung out the vultures grab some. If a large predator like a coyote, jaguar, or human gets close, the vultures squawk and fly off. That alerts the coati, which then runs away. A bonus for the vulture is that when the coati returns it may dig up a different nest and leave the open one for the vulture to pick over.

As the *arribada* progresses and turtles try to dig their nests they inadvertently destroy many of the nests from previous days. While all this is going on raccoons, coyotes, and other predators join the coatis and vultures in feasting upon the eggs

that are inevitably strewn about the beach. By the time the *arribada* is finished, the beach from a distance looks like it is covered with giant scattered snowflakes, but up close it smells like a garbage pile because of all the rotting eggs. Predators continue to feast on eggs for the entire incubation period, and then when the hatchlings emerge the animals gorge themselves on the little turtles.

This is one of nature's great examples of the movement of nutrients. The ridleys bring literally tons of nutrients to the beach, where most are redistributed to the animals of the nearby forest. Moving resources from the ocean to the land keeps the dry forest ecosystem alive and healthy.

The Hand of Man

Nowhere in the sea turtle world has the effect of humans been as obvious as on the *arribada* nesting beaches of olive ridley turtles. Nowhere has the slaughter at sea been as great as in the flotillas of olive ridleys that congregate offshore waiting for a chance to mate or lay their eggs. Industrial turtle harvesting began in Mexico in the 1960s, and the death toll was horrendous. Between 1965 and 1970, 2 million olive ridleys were taken from the waters off of Mexican beaches or slaughtered when they came ashore to nest. During the late 1970s in Ecuador as many as 148,000 olive ridleys were killed each year.

Harvesting of adults at sea and on the beaches continued in Mexico, and people took almost all of the eggs laid on *arribada* and solitary nesting beaches. By the time this over-collection was banned by the Mexican government in 1990, turtles had disappeared from 3 of the 4 major *arribada* beaches. In addition, at least 15 other important solitary and small *arribada* beaches lost their turtles.

Only the *arribada* at La Escobilla survived. While the fishing at sea was taking a tremendous toll on the number of females, research camps and hatcheries established in 1968 directly produced hatchlings and increased protection on the rest of the beach. This rear guard action helped to hold off the collapse of the turtle population. La Escobilla is a rare bright spot. The number of nesting females had dipped to 23,000 in 1988 but with protections it increased to some 450,000 a year. The new turtles must have come from hatchlings produced by the conservationists at the La Escobilla turtle camps during the 1980s. Their efforts, it seems, have paid off. It was a major victory for the species, one that could not have been achieved without the combination of a tireless effort by conservationists and legal provisions enacted by the Mexican government.

By the 1990s, direct killing of adults and taking nearly 100 percent of the eggs destroyed the *arribada* nesting beach of Eilanti, Suriname. The story is the same for olive ridleys in Guyana. The greatly reduced population in Sergipe, Brazil, is finally beginning to recover after 20 years of protection.

The story in West Africa is, in a word, grim. Nesting olive ridleys are systematically harvested along most of the West African coast both on the beaches and at sea. Turtles are used for meat, medicines, and in the tourist shell trade. Carapaces are turned into large masks and decorated with bronze. People also systematically take eggs from most beaches, including those in national parks where turtles are more abundant. Because we lack systematic monitoring we do not know the full extent of the decline, but it is very grave indeed.

Along the shore of the Indian Ocean people kill olive ridleys for their supposed aphrodisiac properties, for livestock feed, to make leather from their skins, for calipee, to make potions from their blood, and to use as fishing bait. The harvest of adults and eggs depleted the populations in Pakistan, Bangladesh, Burma (Myanmar), Malaysia, Thailand, and Sri Lanka.

At the major *arribada* beach of Gahirmatha in Orissa, India, humans have collected eggs since colonial days. Some 1.5 million eggs were taken in the 1973-74 season alone. Egg harvesting was prohibited in 1975 but we know that about 800 ridleys entered the commercial trade in nearby Andrah Pradesh in 1988, suggesting that illegal collecting continued. Before 1981 more than 80,000 adult ridleys were killed every year in Orissa, then about 50,000 a year until the mid-1980s. In the 1990s more than 90,000 adult ridleys washed up dead along the Orissa coast having drowned in shrimp trawls. Orissa's great *arribada* failed to appear in three of the five years between 1996 and 2001. In addition, the turtles that do arrive are smaller than those

Randall Arauz: Turtles and Sharks

Randall Arauz was born in Los Angeles, California, in 1961 of Costa Rican immigrants. He lived there until the age of nine when his family returned to Costa Rica. As a boy Randall watched *Jacques Cousteau's Undersea World* on television and was inspired by the inventor, biologist, and filmmaker. Randall went on to study biology at University of Costa Rica where he saw a posted flier advertising for students to study sea turtles. He responded to the flier and soon went with Dr. Douglas Robinson to Ostional Wildlife Refuge in 1982 during an olive ridley *arribada*. Randall couldn't believe his eyes. He was so impressed with the mass nesting of turtles that he decided to dedicate his life to sea turtles.

After graduating and establishing a family, Randall made his living as an ecological tour guide. However, the "call" to save turtles drew him back. In 1991 he became administrator of the Green Turtle Research Station in Tortuguero. In 1993 he became Director of Las Baulas de Guanacaste Marine National Park. There he and his wife Isabel worked wonders in developing positive relationships with local residents. But all was not Eden. Randall survived many verbal attacks and threats and was almost run over by an angry visitor.

In 1994 Todd Steiner of the Sea Turtle Restoration Project hired Randall to direct a program in Central America. Randall supervised a community-based conservation project in Playa La Flor Wildlife Refuge in Nicaragua and monitored the use of Turtle Excluder Devices

(TEDs) throughout Central America. Randall's down-to-earth approach helped him to establish an open collaboration with fishermen. As a result of Randall's tireless efforts, Costa Rica is the only country in the world certified by the U.S. to use its own "Tico" TED.

Randall now directs PRETOMA, a grass roots organization that operates four community-based conservation projects (San Miguel and Caletas in Guanacaste, and Punta Banco and Caña Blance in the South Pacific). Collectively, they have saved over 150,000 eggs and released over 100,000 hatchlings safely into the sea.

In 1997 Roberto Vargas filmed a juvenile leatherback turtle hooked by a Costa Rican longliner off the Galápagos Islands. Seeing the film, Randall immediately knew what he had to do. Leatherback populations in the Eastern Pacific had declined dramatically to a fraction of their original size and it was apparent that the decline coincided with a boom in longline fishing. Longlining was destroying the sea creatures that Jacques Cousteau had shown to Randall so many years before!

Randall set into motion an observer program aboard longline vessels from Costa Rica. He demonstrated the impact of uncontrolled fisheries on both sharks and sea turtles. However, the market force for longline fishing is strong because of the demand for shark fins in Asian countries. "Shark finning" is a barbaric form of hunting in which the shark's fins are hacked off and the shark's body, sometimes alive, is thrown back into the ocean. Randall is currently directing a campaign to stop shark finning in Costa Rica and the world. His vision is that Costa Rica will become the leading example of marine conservation in the world. Hopefully Costa Rica and the world will follow the example of leadership that Randall provides.

that nested in the past, indicating that they are younger. The fate of Gahirmatha as an *arribada* beach hangs in the balance.

Despite the fact that olive ridleys seem to be in a precipitous decline, adults and eggs continue to be taken in the Central American nations of Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, and Panama. While some collections are legal, many are not and result from an unwillingness to protect and prosecute, and from the lack of a conservation ethic among the poachers. By the 1970s two *arribada* beaches were lost in Nicaragua. At various beaches in Guatemala local people were allowed to take 90 percent of the eggs and 10 percent were protected. Nevertheless, the decline in those populations has continued. In Honduras people take 88 percent of the eggs at Punta Ratón and protect the rest in a hatchery. The jury is still out on this program's effectiveness but the population seems to be stable. In El Salvador 100 percent of the eggs are taken and people have remarked that the number of turtles is decreasing. Various attempts to control the egg harvest at Playas Chacocente and La Flor in Nicaragua have failed to sustain either the local families' incomes or the ridley populations.

Given the heavy exploitation of olive ridley eggs in Central America, I am amazed that any nesting females remain. Certainly the hatcheries in El Salvador, Guatemala, and Honduras have helped compensate for the almost total destruction of nests in those countries. Efforts in Nicaragua must also be of some importance. It may also be that hatchlings from the *arribada* beaches of Costa Rica have supplied adults (after a decade or two) to beaches in the rest of Central America.

The Ostional Experiment

An industrial-scale, legal harvest of eggs at Ostional, Costa Rica, has been taking place since 1988. Costa Rican law outlawed the taking of turtle eggs in 1966 but enforcement was lax and egg poaching rampant. In 1987 the Costa Rican Congress approved a new law to legalize the taking of eggs at Ostional to provide both economic development for the local village and a legal source of cheap eggs to swamp the demand for eggs around the country. The idea was to provide a market-based solution to egg poaching in Costa Rica. The local community maintains a legally sanctioned cooperative that takes eggs laid during the first 36 hours of an *arribada*. They then guard the eggs laid during the next two or three days, a period of time that represents the height of the *arribada*.

Some biologists have claimed that the result has been a stable population of turtles at this beach. Yet, at the same time, the population at nearby Nancite beach supposedly has declined. This loss is attributed to the low hatching success at that beach (about 2 percent) owing to the destruction of 20-50 percent of nests by nesting turtles, bacteria and fungi growth in the sand due to all of the broken eggs, and reduced oxygen levels in the sand because of all the eggs' metabolism and the rotting

that is taking place. In contrast, and in theory, the taking of the early eggs should reduce this problem.

It's a great story: Taking eggs can actually help turtles. But is it true? The problem with this story is that there are no reliable data to support it. Turtle counts on these beaches are not done in a scientific manner, so the estimates are suspect. At Ostional it is not possible to tell if the numbers of turtles are actually increasing or if new counting techniques introduced in 1999 have changed the estimates. In addition, Ostional ridleys nest along four miles of beach but the main *arribada* concentration usually occupies only 700 yards (640 m). Although the location of the *arribada* shifts from one *arribada* to the next, the location for counting turtles does not. So estimates are "eyeballed." At Nancite the sampling is not systematic, with some *arribadas* going completely uncounted. Even when they are counted the counting seems partial and insufficient. We simply do not have an accurate idea of what has been happening to these two populations. Also, there is no estimate of the numbers of hatchlings produced on either Ostional or Nancite. We must establish an accurate way of counting nesting olive ridley turtles and determining just how many hatchlings are being produced from these beaches. Only then will we know if Ostional is a success or whether it requires changes in management.

There are also practical problems, including the lack of any real control on the beach at Ostional. Dogs and pigs are allowed to roam the beach and dig up nests at will. Worse, despite the claims of local enforcement, people do take eggs when it is not allowed. Indeed, instead of swamping the demand for eggs with cheap olive ridley eggs as hoped, the legal harvest at Ostional serves as a cover for illegal egg taking elsewhere in Costa Rica.

Even leatherback turtle eggs are sold in markets and bars in the capital San Jose under the olive ridley cover. If you ask the vendor "Where did those eggs come from?" he answers "Ostional, Ostional!" Ostional is a bleeding sore for sea turtle conservation in Costa Rica. The legal egg trade makes it nearly impossible to control poaching elsewhere. Well-intentioned people buy eggs in the belief that they are supporting a worthy goal, when in truth the eggs were taken illegally.

These issues are problems for the human population, as well. People who are always looking down, digging in the sand, do not look up to improve their education and employment skills. They are stuck in an old system that will ensure that they will never have the opportunity to join Costa Rica's new economy. In a country that is becoming prosperous through ecotourism and light manufacturing there must be a better way to provide for citizens than to keep them busy digging up sea turtle eggs for a trade that should not exist.

To add to the situation, the killing of olive ridleys at sea continues to this day. South American shrimp boat captains rarely use turtle excluder devices and have been killing hundreds, probably thousands of ridleys each year. If the Nancite population is declining, perhaps shrimping, and not nesting success, is the reason. It is

encouraging that these *arribadas* still exist but it is unwise to assume that they will do so forever without study and honest, effective, and wise management.

The Future

There are several obvious lessons that we can learn from what we have discovered about the olive ridley turtle. First, although it is a very abundant turtle it is not invulnerable to human pressures. If we take all of the eggs from a nesting beach, the population will obviously disappear. If we take most of the eggs, we may be postponing the demise of the *arribada* for a while but there is no doubt about its inevitable doom. If we kill too many adults at sea, the same thing will happen. If we do both, the end will be quick.

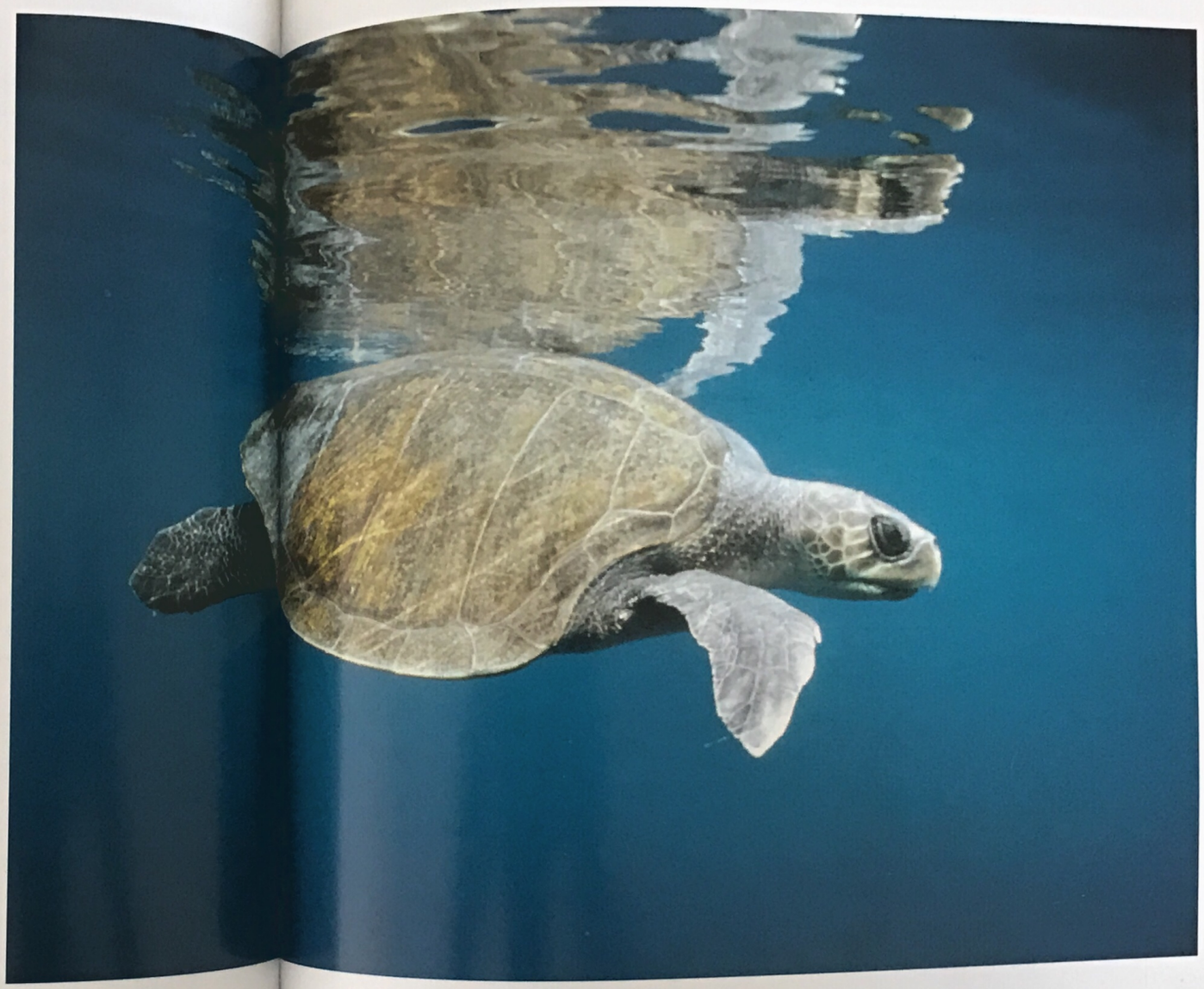
Second, the olive ridley turtle is very resilient. In Mexico one *arribada* beach recovered its population when strong protection was established at sea and on land. There is reason to hope that we can restore populations in other areas, as well. The keys to this restoration are improved laws, improved law enforcement, economic development for local communities, and local communities' involvement in conservation.

Third, there are still four important *arribada* beaches in the world. These form the nucleus for rebuilding ridley populations elsewhere. They need to be protected and the *arribada* phenomenon needs to be better understood. Some biologists and conservationists have assumed that the olive ridley is invulnerable because there are two million of them. This has led to reluctance on the part of agencies and organizations to commit resources to the study of this species. However, we can no longer assume that because there are a lot of turtles nesting on a beach that the population will continue forever. We need to do the science needed to understand the biology of the olive ridley before it is too late to ensure its continued survival.

People once thought that the passenger pigeon was invulnerable to hunting. They were surprised when flocks that once darkened the skies over the midwestern United States disappeared. Let's not repeat that mistake.

Now that we know that olive ridleys, like green turtles and hawksbills, are threatened, it is the challenge of every caring person to help see that these creatures are still swimming and dancing for many years to come. Governments can be remarkably responsive, but only when the problem is a priority will something be done to fix it. I did not begin studying sea turtles in 1978 because I wanted to save them. But the more I learned the more I came to see that saving them was the main point.

Several organizations are working to protect the olive ridley around the world. Join them. Those people on the beach at Escobilla in the 1980s felt that their backs were against the wall. Their valiant effort, as well as political support for improved laws and protection for turtles on the beach and at sea, was successful in saving that population. The *arribadas* are still strong at Nancite and Ostional. We can build on those strengths and take back the beaches one by one.



Olive ridley swimming in the open ocean off the Galápagos Islands. Olive ridleys wander the oceans looking for food along thermal fronts, drift lines, and convergence zones. They are often found alongside drifting logs and other debris.