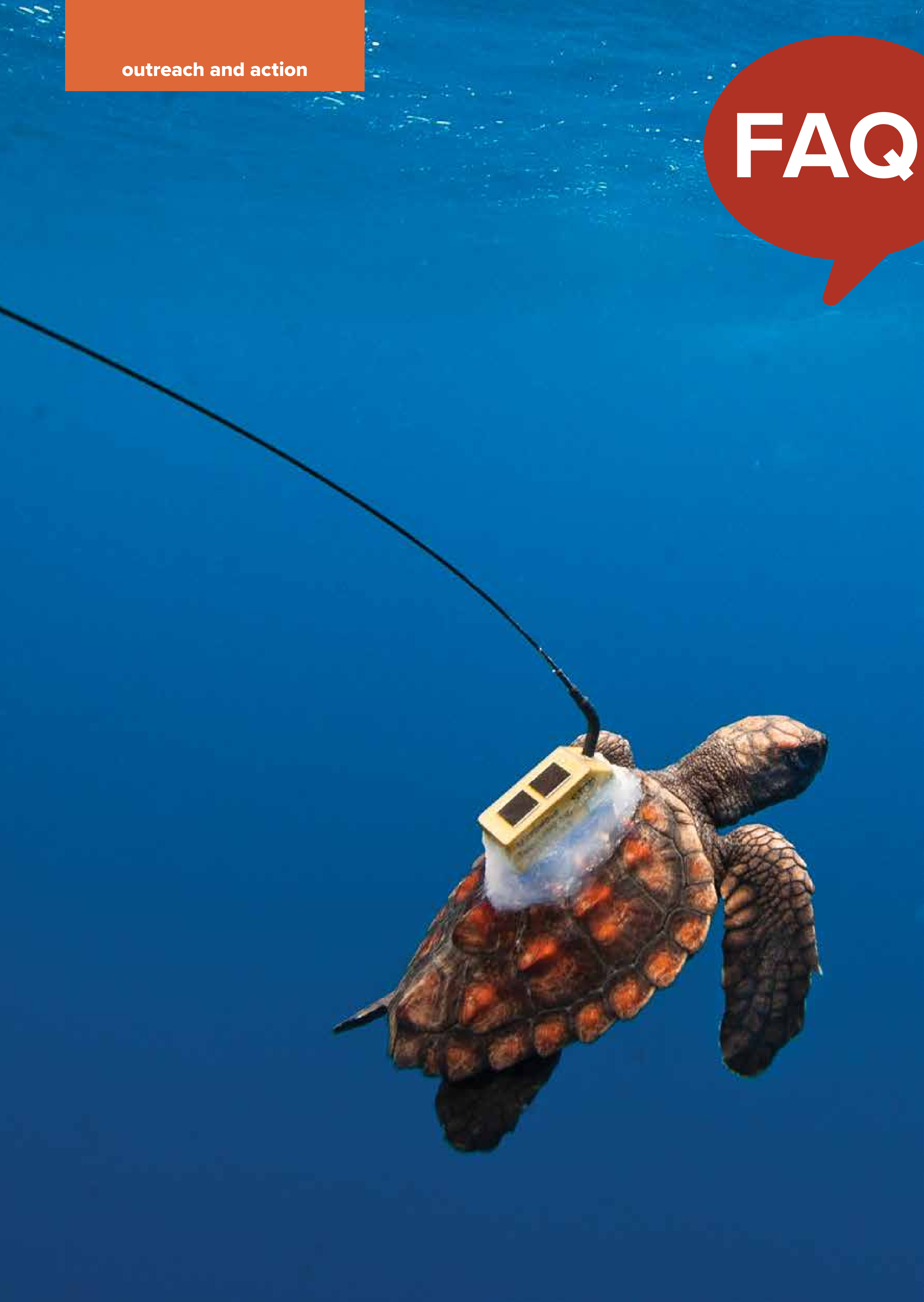

FAQs About Sea Turtles

With their specialized biology and their unique behaviors, sea turtles tend to provoke a lot of questions. Spend an hour with someone who is watching a turtle nest for the first time, and inevitably the questions will come: How old do they get? Where will she go after she leaves the beach? Where did she mate? When will she come back? How long until the babies become adults? And so on.

When it comes to turtles, however, the answers to such seemingly simple questions can be surprisingly elusive. Those of us who work with turtles have therefore grown accustomed to answering with phrases such as "We don't really know, but …" or "Our best guess is that …." Although the lack of concise answers to basic questions about sea turtle biology can be frustrating, that lack is precisely what makes sea turtles so interesting to study. After 60 years of science, sea turtles are still mysterious in many ways.

Increasingly, however, advancements in technology and the results of long-term studies are giving scientists the information they need to answer with increasing certainty some age-old questions about turtles. Some mysteries are being solved, and yet others are still answerable only with our best guess. With such continuing mysteries in mind, we thought it would be fun to invite three experts to weigh in with current perspectives about three of the most frequently asked questions concerning sea turtles, and here is what they had to say.

How Many Eggs Does It Take to Make an Adult Turtle?

By PILAR SANTIDRIÁN-TOMILLO

Shortly after arriving at our project in Pacific Costa Rica, volunteers go on beach patrol and excitedly anticipate their first encounter with a nesting leatherback turtle. Walking along the beach in the middle of the night or watching a turtle lay eggs in the beam of a red light will make anybody wonder about sea turtle biology. Not surprisingly, many excellent questions arise. A common one we hear is "How many eggs make an adult turtle?" The answer to this apparently simple question is actually very complex and requires many assumptions. In fact, there is not one magical number that serves as the correct answer.

A female of any species in a stable population (and this is the first assumption) produces enough offspring to replace herself and her male partner. Because we know very little about male turtles and because natural sex ratios are complex (they are normally female biased as hatchlings but are possibly more evenly balanced among reproductive animals), we make a second assumption that there are 1:1 sex ratios (i.e., a female needs to reproduce herself and one male in her lifetime). We could make the problem more complicated, because sea turtles exhibit both polyandry and polygyny, but to answer this question succinctly, we'll keep it simple.

Next, we also need to know how many eggs a female will lay, on average, during her lifetime to be able to replace herself and a male. This question implies knowing how many eggs she lays per clutch, how many clutches she has per season, how frequently she reproduces, and how long her reproductive lifespan lasts. The last piece is especially difficult, because most projects haven't been around for long enough to exceed the reproductive lifespan of a long-lived sea turtle, but some projects have observed that turtles can reproduce over a period of 20–30 years.

So, let's say that an average female leatherback in Pacific Costa Rica lays 66 eggs per clutch, lays 6 clutches per season, reproduces every 3.7 years, and has a reproductive life of 20 years. Such a female will lay 2,141 eggs in her lifetime to replace two adults (herself and her partner), which yields an estimate of about 1,000 eggs to make one adult turtle.

To arrive at our estimate, we have made a rough, but educated, guess. It is based on the best available information from a single population of a single species. Although it is by no means accurate, nevertheless, it gives us an idea of the effort that it takes to keep sea turtle populations stable. From this calculation, we can see that turtles must make a huge investment in reproduction because many eggs, hatchlings, and juveniles die before reaching maturity. The investment needed to keep the population stable varies among species, across populations, and with changes in survival of the different age classes within the same population. Moreover, populations are not stable; they are dynamic and change over time. The best way to approach this question, therefore, is to look at the unique characteristics of each nesting population and to make the calculations using population-specific numbers.

In the end, finding an exact number to this elusive question may be less valuable than the thinking that is stimulated by simply asking it.

AT LEFT: Researchers fitted juvenile loggerheads with small satellite tags in Brazil to study their movements. © PROJETO TAMAR

How Old Is That Sea Turtle?

By LARISA AVENS

Maybe folklore and popular culture have imbued turtles with the aspect of the eternal, or maybe sea turtles seem improbably and impossibly large (and presumably old) compared to most of their terrestrial and freshwater counterparts. Whatever the reason, one of the most common questions that sea turtle researchers and conservationists hear from the public is “How old is that turtle?”

From the moment they hatch and leave the beach to disperse in the marine environment, sea turtles make it very difficult for us to calculate how old they are. Their long migrations and their multiple habitat shifts often span entire ocean basins and thus impede our ability to follow wild individuals throughout their lives so we can directly monitor their age and growth.

Captive turtles have shown remarkable growth potential, but hard-won mark-recapture data for wild turtles have typically demonstrated slower overall growth rates. And because there is so much variability in growth rates across species, populations, and even individuals, it is impossible to accurately predict age on the basis of size alone. Moreover, unlike some turtle species, sea turtles do not retain lifelong records of annual growth increments in the scutes of the carapace or plastron.

In light of those challenges to directly quantify sea turtle age by size or appearance, researchers have explored a number of indirect approaches for studying growth and aging among live turtles. Unfortunately, attempts to relate rates of change in molecular or chemical “clocks” to age in wild sea turtles have been hampered by limited information about individual histories, such as influences of heredity, thermal environments, and stressors.

Another indirect approach to studying growth and aging is to examine growth increments in the bones of dead animals (similar to using tree rings to estimate a tree’s age), a practice known as *skeletochronology*. Given the large numbers of sea turtle strandings that occur worldwide, this method makes it possible to collect age and growth data relatively rapidly, as long as a number of considerations are recognized and addressed. These considerations include (a) finding the most optimal bone and processing method to measure skeletal growth marks, (b) verifying whether the marks are deposited annually to allow age estimation, and (c) defining the relationship between bone and body growth to permit somatic growth rate calculations from bone growth mark spacing.

Because early growth marks at the center of the bone are often absorbed in larger juvenile and adult sea turtles, it is also necessary to collect samples from all life stages so we can develop predictive models that account for any early marks that were lost. Finally, because this method is limited to studying stranded turtles whose cause of death is typically unknown, sample sizes must be large enough to ensure that the data are truly representative of the study population (i.e., finding the signal in the noise).

Over the past few decades, advances have been made in meeting such requirements, primarily for hard-shelled sea turtle species. Recent skeletochronological studies have generated size-at-age relationships and somatic growth rates for individuals and populations over periods spanning decades. Those studies provide valuable information regarding long-term, large-scale patterns in age and growth. One of the most important insights recently highlighted through correspondence among mark-recapture, captive-rearing, and skeletochronology data is that a spectrum of sizes at any given age is possible, depending on interactions among a suite of individual-specific influences and experiences. As a result, the ages and sizes at which wild sea turtles transition between life stages and mature will vary extensively.

Admittedly, this approach is not very helpful for answering the question of how old any particular live turtle might be. That being said, using the same standardized skeletochronological approach for wild loggerheads and Kemp’s ridleys in the western North Atlantic has provided a valuable opportunity for comparison between species. The time to maturation for loggerheads—as well as their reproductive longevity—appears to be two to three times longer than that for Kemp’s ridleys, thereby highlighting species-specific life history strategies and potentially providing a framework for evaluating relative influences of anthropogenic threats and management approaches.

Characterization of sea turtle age and growth using diverse approaches is ongoing, and additional comparisons among populations and species will be forthcoming. In addition, by our combining skeletochronology with recent advancements in stable isotope and trace element analyses, we can now integrate age, growth, foraging ecology, and habitat use data, which further increases our understanding. As new technologies are developed, refined, and applied, we will continue to make progress on solving the mystery of how old that turtle really is.

Where Do the Baby Turtles Go?

By KATE L. MANSFIELD

Given the terrestrial nature of humans, coastal beaches are where we are most likely to encounter sea turtles, their tracks in the sand, or nests they leave behind. It is incredibly labor-intensive, logistically difficult, and expensive to follow or survey turtles, especially little ones, in the middle of the open ocean. As a result, most of what we know about sea turtle biology derives from work conducted on beaches. Very little is known about sea turtles from the time little hatchlings depart their nesting beaches and enter offshore, oceanic waters, until they return to shallower coastal waters years later as larger “teenage” turtles.

In fact, so little was historically known about this period in sea turtles’ lives that it has been dubbed the “lost years.” Nonetheless, the time that sea turtles spend on land equates to but a blink of an eye when compared to their long lives spent at sea. Understanding sea turtle behavior at all their life stages is critical for ensuring the conservation and survival of those threatened and endangered species.

So, where do the baby turtles go after they leave the beach? How do they get there? How do they interact with their environment? Are they passively drifting with ocean currents or actively orienting and swimming to developmental habitats? Where and when are human activities more likely to affect their survival and their health? How long do they spend in oceanic waters before returning to coastal habitats as larger juveniles?

Historically, much of what we once knew about the sea turtle lost years was based on opportunistic sightings offshore or within boating distance of islands or the coast, or knowledge was derived (a) from lab-based studies of young turtles’ sensory capabilities, behavior, and orientation or (b) from short-term tracking studies (spanning a period of hours) of baby turtles from their nesting habitats. But little by little, technology is enabling us to answer some of the great questions about sea turtle biology.

Beginning in the late 2000s, satellite tags became small enough to enable researchers to track little three- to nine-month-old loggerheads in the western North Atlantic. Small, 9-gram, solar-powered bird tags (modified for a marine environment) were attached to the young turtles’ shells with a combination of manicure acrylic, neoprene from old wetsuits, toupee glue, and aquarium silicone. The turtles were then released off their natal beaches in southeast Florida, providing the first long-term data about the movements and dispersal of young, oceanic-stage turtles.

The turtles’ tracks, combined with ocean modeling, confirmed that the young turtles were indeed living offshore, remaining mostly at the surface, and traveling within the large ocean currents that make up the North Atlantic Subtropical Gyre (NASG). But, unexpectedly, many of those turtles left the major ocean currents that make up the NASG and traveled to the Sargasso Sea, an area in the interior of the North Atlantic named for the Sargassum that collects in the region.

This travel makes sense; if small turtles are living on a mat of algae, they can easily find food, blend in with the brown algae to hide from predators, and hang out in a nice warm habitat. They bask at the sea surface while conserving energy by floating with the Sargassum—their “mobile home.” For little cold-blooded animals, having this thermal benefit in a safe, food-rich habitat where they can grow and thrive is likely key to their early survival.

Yet not all tracked turtles entered the Sargasso Sea; some turtles remained in the currents as expected, heading to the Azores in under 200–300 days from offshore of their south Florida natal beaches. The Sargasso Sea is emerging as an important developmental habitat for North Atlantic loggerheads and other species of sea turtle. The currents that make up the NASG may act as an enormous playpen for the young turtles, thus keeping them within the confines of the North Atlantic Ocean and the Sargasso Sea.

Follow-up studies in the Gulf of Mexico and the South Atlantic using passive oceanographic drifters—a fancy term for floating buckets with GPS satellite tags on them—demonstrated that young loggerheads are not always passive drifters being pushed around by ocean currents as was historically assumed. In fact, young (3- to 12-month-old) satellite-tracked loggerheads were observed to actively

A loggerhead hatchling begins its journey to sea. So little has been known about the early part of sea turtles’ lives that this period is often called the “lost years.”
© KATE L. MANSFIELD

orient and actively swim in very different directions and with more velocities than the passively drifting buckets. Some loggerheads tagged in the Gulf of Mexico off of the coast of Louisiana, U.S.A., left the Gulf, traveled into the western North Atlantic, and connected with the NASG currents, whereby after less than a month and a half they were off the Grand Banks near Nova Scotia, Canada.

The South Atlantic has a similar gyre system to the north, called the South Atlantic Subtropical Gyre (SASG). Unlike in the Gulf Stream in the North Atlantic, the currents making up the SASG seasonally shift in their location off the coast of Brazil, which is home to the South Atlantic’s main loggerhead nesting beaches. Hence, turtles emerging from nests early in the South Atlantic hatching season will experience different currents (and modes of dispersal transport) than will turtles that hatch later in the season.

Young, oceanic-stage turtles that were satellite tracked early in the hatching season traveled to the south, whereas late-season tracked turtles traveled to the north, crossed the Equator, and entered the North Atlantic and Caribbean waters. Similar to loggerheads tracked from the Gulf of Mexico, Brazilian loggerheads connected with other regions and water bodies. However, none of the turtles tracked in the South Atlantic entered the center of the Gyre (like the turtles observed in the North Atlantic that traveled to the Sargasso Sea).

This is an exciting time. Newer, smaller tags are becoming available, allowing us to satellite-track younger turtles for longer distances. As more turtles are tagged in more regions and more oceans, we are finding that we can’t assume that baby turtles in different oceans are behaving in the same way. Where do the baby turtles go? The answer depends on where in the world the question is asked. What we do know is (a) that little sea turtles are surface-dwelling oceanic creatures that actively orient and actively swim and (b) that we have a long way to go until we fully understand the sea turtle lost years. ■