FAQs
ABOUT SEA TURTLES

Researchers watch as a satellite-tagged leatherback hatchling dives into the ocean. Tags like these have helped researchers learn about sea turtles' diving abilities.
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How Deep Do Sea Turtles Dive?

By George Shillinger

Sea turtles spend most of their lives underwater. Hard-shelled species generally stay close to shore in shallow waters, but leatherbacks mostly stay in the open sea, diving deep and often while migrating over vast distances. Some hard-shelled turtle species can dive to beyond 300 meters (980 feet), but leatherbacks are the true record holders. They can descend to below 1,000 meters (3,280 feet), deeper than any other reptile, where pressures are intense (more than 100 atmospheres) and temperatures can drop to less than 5 degrees Celsius (41 degrees Fahrenheit). Among air breathers, leatherbacks share those depths with sperm whales and elephant seals, which are capable of reaching depths of more than 2,000 meters (6,560 feet)!

All sea turtles have special adaptations that allow them to hold their breath underwater for extended periods, as described in the article on the opposite page. And even among sea turtles, leatherbacks are especially adapted to store oxygen in their blood and tissues to help them dive. Beyond their breath-holding abilities, leatherbacks have also evolved unique physiological adaptations that allow them to brave the extreme conditions of the deep sea. Those adaptations include:

- **Compressible carapace:** The thick, leathery shell of a leatherback can compress during descent and expand during ascent, unlike the shells of hard-shelled turtles.
- **Nitrogen absorption:** Leatherbacks can absorb nitrogen through their carapace, thereby avoiding decompression sickness while diving.
- **Thermal inertia:** Their giant size means that leatherbacks cool slowly. Their black color also helps them recuperate heat more rapidly when basking on the surface after a dive.
- **Countercurrent heat exchange:** A leatherback's arteries, which carry warm blood, lie close to the veins returning colder blood to the core, so that heat is conserved.

There is now an array of sensor-equipped satellite tags, animal-borne cameras, and multisensor recorders that help scientists understand those enigmatic underwater behaviors. While using early satellite tag technology in the 2000s, I was astounded to see leatherbacks diving to depths that maxed out our sensors at 1,210 meters (3,970 feet)! But now we know that leatherbacks routinely dive into the bathypelagic zone (1,000–4,000 meters' depth, or 3,280–13,120 feet). But why?

During 2004 to 2008, our team equipped 35 adult eastern Pacific leatherback turtles with satellite relay data loggers integrated with thermistors and pressure sensors, with the goal of better understanding the whys behind leatherbacks' deep-diving behavior. From 42,234 recorded dives, we observed that during the day the leatherbacks dove deeper and shorter than at night, when their dives were shallower and longer. Those observations pointed to a few possible explanations. One is that the turtles may be searching for prey during the daytime and feeding at night, when their prey also migrate closer to the surface. Another is that the turtles may be staying near the surface during daytime to warm up via solar radiation. We also observed that the turtles dove deeper when warmer water allowed them to, suggesting that temperature regulation is an important factor influencing their diving behaviors.

Not only are adult leatherbacks deep and frequent divers, but juveniles are too! A team of scientists from Upwell and Florida Atlantic University observed that among dozens of individuals studied, several dove over 40 meters (130 feet), including one to over 100 meters (330 feet) shortly after being released. As a group, those young animals spent more than 70 percent of their time underwater and made routine dives to beyond 70 meters (230 feet).

From a conservation perspective, understanding diving behavior in sea turtles is important because the threats they face occur throughout the water column. Impacts can come from deep-set longlines (30–100 meters deep, or 100–330 feet), to ghost nets at any depth, to boat strikes on the surface. By integrating turtle movement datasets (both horizontally and vertically) with those on anthropogenic threats, such as datasets on fisheries, vessel traffic, or offshore development activities, we can develop new tools that identify areas of highest risk to inform targeted conservation strategies.

How Long Can Sea Turtles Hold Their Breath?

By Sarah Milton

How long can you hold your breath? A minute? Maybe two? Even the current world record for underwater breath holding by a human, an astounding 24 minutes and 37 seconds, pales in comparison to sea turtles' breath-holding abilities. Because sea turtles are ocean-dwelling air breathers, it's clear that they must hold their breath for at least several hours in order to forage for food, avoid predators, and sleep underwater. But they may be able to go much longer—several days or even months.

In the early 1970s, scientists learned from the Seri indigenous people and from other Mexican fishermen about green turtles that were believed to hibernate underwater in the Gulf of California during the winter, maybe for months. Shortly thereafter, turtles were pulled up when Port Canaveral (Florida, U.S.A.) was dredged, and the stained condition of the turtles' shells suggested they had been buried in the mud for days at least. However, there was no proof of how long those animals were really submerged.

More recent studies have sought to better understand sea turtles' breath-holding limits in laboratory settings and in the wild using time-depth recorders. The studies have found that under most conditions, sea turtles will dive for 20 to 40 minutes while foraging and up to several hours when sleeping. Additionally, when the water gets cold, some turtles are able to remain underwater for much longer. The longest recorded submersion by a wild sea turtle was when a loggerhead turtle stayed submerged for seven hours while overwintering in Greece. But how do they do it?

How long air-breathing animals can stay underwater is a function of three factors: (1) how much oxygen they can store in their blood and muscles, (2) how fast they use the oxygen when diving, and (3) how tolerant they are to low oxygen. Sea turtles have several adaptations that help them stay underwater for long periods of time, including:

- **Oxygen storage:** Sea turtles have high concentrations of hemoglobin and red cells in their blood and myoglobin in their muscles, enhancing oxygen storage during dives. The turtles can also move the oxygen into their bloodstream even when lung oxygen levels are very low.
- **Low metabolic rates:** All sea turtles, except the leatherback, are cold-blooded, with metabolic rates only about 10 percent of ours. As a result, they use oxygen more slowly. Cold temperatures further slow their metabolic rates, helping them stay submerged for even longer.
- **Bradycardia:** Sea turtles decrease their heart rate while diving. In a study of diving leatherbacks, heart rates decreased about 30 percent for dives of less than 10 minutes. One turtle's heart rate declined from 27 beats per minute at the surface to 3.6 beats per minute during a 34-minute dive. Some turtles' heart rates briefly go as low as 1 beat per minute during dives.
- **Peripheral vasoconstriction:** Green turtles can shunt blood away from less important organs and tissues to conserve oxygen during dives up to half an hour long, but they appear unable to maintain the vasoconstriction for longer. Though turtles' vasoconstriction abilities are not as developed as those of diving marine mammals, the combination of lower heart rates and altered blood flow still helps reduce turtles' metabolic rate.
- **Hypoxia tolerance:** Although most dives are relatively short and the turtles don't use all their stored oxygen, they also have a much better ability than mammals to survive low oxygen. Their brains are adapted to prevent the damaging effects that happen when we run out of oxygen (as might happen during a stroke), so they can potentially live up to a few hours without oxygen.

Understanding how and for how long diving sea turtles remain submerged is important for conservation efforts, because turtles face threats of drowning when caught or entangled. As a practical example, when turtle excluder devices (trap doors in shrimp nets that allow large animals such as turtles and sharks to escape but not small fish and shrimp) were first being developed, one argument against them was that shrimp net tow times were only 30 minutes and turtles could hold their breath for hours, so surely the fisheries were not responsible for the many drowned turtles along the coast each summer. But a sea turtle that is struggling and swimming frantically to escape a net will have an elevated heart rate and will use up its oxygen stores very quickly and indeed can drown. Continuing research into sea turtles' breath-holding abilities may help further elucidate species-specific differences and provide a more definitive answer to the question of how long sea turtles can hold their breath; that research may even provide clues as to how the human brain might survive longer without oxygen. •