FAQs ABOUT SEA TURTLES

Sea turtles can elicit tricky questions from those curious about their mysterious lives and natural histories. And even sea turtle specialists can struggle to answer some of the most seemingly basic questions about sea turtle biology and conservation. If you are among the many specialists who have stumbled to concisely answer things such as "How many sea turtles are there?," "How old do turtles get?," or "Where do baby turtles go?," then this feature is for you. Our hope is to set the record straight about often-asked questions with answers written by top experts who will prepare you to respond like an expert yourself. Moreover, we hope that for those questions about sea turtles that may still have no firm answers, this series can pique SWOT readers' curiosity and drive them to conduct the research needed to solve the mysteries.

WHAT DOES CLIMATE CHANGE MEAN FOR SEA TURTLES?

By Jeanette Wyneken

The planet's climate changes; it has done so throughout Earth's history. Those environmental changes can affect all life stages of marine turtles, including egg survival and the reproductive success of adults, in addition to affecting food quality and availability.

Some climate models predict that many marine turtle nesting sites could become warmer, drier, and subject to more severe storms as climate change progresses. Dry sand can increase unsuccessful nesting attempts (false crawls), cause nest chambers to collapse while being excavated, and dehydrate and destroy nests. Conversely, wetter sand caused by storms and wave runup can suffocate sea turtle embryos or lower hatching success. Sea turtle eggs incubate more rapidly at warmer temperatures up to a point, but as the upper thermal limit is approached (~34°C [~93°F] for most species) development slows, and higher heat can cause embryos to perish. Temperature also affects sex ratios, with warmer incubation resulting in a preponderance of female hatchlings, a demographic problem that could become catastrophic over time if insufficient numbers of males are produced.

Warming seas and estuaries are likely to undergo ecological shifts as well, such as losses of basic or intermediate links in food chains; these losses could in turn affect the habitats used by juvenile turtles and alter how they move from one developmental habitat to another as they mature. Those same factors may also have an impact on the abundance, quality, and distribution of adult turtle feeding grounds. However, changes in sea level and storm severity are the climate components most likely to have direct, near-term effects on sea turtle reproduction, causing nest inundations and the loss of turtle nesting sites to rising seas. Researchers are already beginning to see such effects at many armored beaches in Florida, U.S.A., and elsewhere (see *SWOT Report*, vol. XII, pp. 12–13, "Coastal Armoring and Rising Seas Put a Squeeze on Turtles").

The effects of climatic shifts seem dire for sea turtles. Yet history across geological time can provide perspective and even some hope. Turtles appeared on Earth about 220 million years ago, with several marine lineages persisting for millions of years and through many major climate change events, including the Mesozoic and Cenozoic interglacial and glacial periods. Today's seven species of marine turtles arose ~20–70 million years ago; the oldest ones arose around the time of the K–T or Cretaceous–Tertiary mass extinction event caused by an asteroid some 66 million years ago. Their ancestors evolved from stock that lived in much warmer times, compared with more recent millions of years characterized by cooler seas and beaches. What extant turtles now face is a different (generally warmer) thermal trajectory accompanied by a more rapid onset. The question is whether ancestral resiliencies that allowed sea turtles to thrive to the present will be sufficient to carry them past the current threat posed by climate change.

AT TOP: **Galápagos Islands, Ecuador** – Although the Galápagos is at the equator, the oceanography, especially in the western islands, brings cold waters and extreme climate conditions for both mammals and reptiles. On a remote beach on Fernandina Island, green turtles emerge from the cold waters to bask in the warming sun while at the same time sea lions seek respite in the cool surf from the terrestrial heat. This photo highlights the extremes a marine reptile and marine mammal have to go to so that they can survive the Galápagos Islands unique and challenging climatic conditions. © Thomas P. Peschak

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WHY DO SEA TURTLES BASK?

By George Balazs and Roderic Mast

Of the seven species of ocean turtles, only the green is known to emerge from the sea to bask, or, as defined by Merriam-Webster, "to lie or relax in a pleasant warmth or atmosphere." Greens of both sexes and all sizes and life stages exhibit this fascinating behavior, but it only occurs at a few well-documented locations in the Pacific, including the Galápagos, Mexico's Socorro Island, Australia's Wellesley Islands, and—most notably—the Hawaiian archipelago.

In Hawaii, basking occurs by day or night on shorelines where nesting occurs or adjacent to algal foraging pastures; turtles have also been observed basking on floating objects. Turtles may crawl ashore on their own or passively surface to bask as a result of falling tides in shallow bays. Basking has even been documented in captive animals at Hawaii's Sea Life Park, where turtles emerge onto artificial nesting beaches. Basking turtles often cluster together, suggesting that the behavior may have a social function; there may also be a genetic component involved. Substrates on which turtles bask include black to light-colored sand of varying particle sizes, rocks and old lava flows, limestone benches and the tops of offshore coral heads, shipwrecks, and even beach lounge chairs!

In the Galápagos and northwestern Hawaiian Islands, green turtle basking has been known for centuries from the logbooks of early European voyagers. But in the main Hawaiian Islands, basking didn't exist before the 1990s; then the behavior began to spread rapidly in both scope and magnitude, concomitant with sharp increases in turtle populations tied to the 1970s ban on commercial harvest. Now a normal and iconic feature of Hawaiian beach landscapes, basking greens (locally called *honu*) have grown accustomed to people being close to them, and honu has facilitated an array of life history research projects about the phenomenon. Not surprisingly, human conflicts have erupted over the need to manage touristic "turtle viewing" on beaches often shared with bathers, surfers, fishers, and others. (See *SWOT Report*, vol. XII, pp. 38–39, "Trapped in the Crossroads of Honu Conservation.")

Not unlike other ectotherms, from freshwater turtles to snakes, lizards, and more, greens bask to optimize body temperature; a major thermal ecology study has gone deeper to suggest why. For instance, elevated body temperatures can mobilize stored fat and theoretically accelerate egg maturation in nesting females; warmer body temperatures can also speed and promote digestion in all sizes of turtles. Beyond warmth, basking may also be a means for females to avoid unwanted copulation attempts and for both sexes to stay out of harm's way from predators like tiger sharks. And, intuitively, basking serves to conserve energy, since a turtle out of the water doesn't need to periodically rise to the surface to breathe as it would when resting in underwater refugia. Another hypothesis, now supported by research, is that carrying capacities of certain foraging pastures in Hawaii are being exceeded as a result of the increased turtle population in recent decades, so basking may result from suboptimal nutrition. Further research will help shed light on this unique behavior of Pacific green turtles.

The first published photo of "a green turtle asleep on a sandy beach" in the northwestern Hawaiian Islands appeared in a 1925 issue of *National Geographic Magazine*. The caption provided what is possibly the most concise answer as to why green turtles bask: "These grotesque creatures browse in submarine fields of algae until hunger is satisfied, and then crawl heavily out to sprawl in the sand, safe from enemies in the sea."

HOW DO SEA TURTLES NAVIGATE IN THE OCEAN?

By Catherine M. F. Lohmann and Kenneth J. Lohmann

Sea turtles live life on the move. Most migrate to open-sea nursery habitats as hatchlings and then migrate back to coastal waters as juveniles. Some migrate seasonally. Adults migrate repeatedly between feeding and breeding areas. So the question naturally arises: How do turtles guide their journeys across vast expanses of water without landmarks or a GPS? Thirty years of work with turtles along the eastern U.S. coast has provided a framework for understanding those remarkable travels.

A sea turtle's first migration seems a straightforward task: swim toward the open ocean and away from shore. Hatchlings start this trip in the dark; they cannot see the direction of the open ocean, but they can use wave direction to find it. When hatchlings enter the sea, they dive beneath the surface and use water motion to determine the direction that waves are moving. They then swim directly into the approaching waves and thus inevitably swim away from land and toward open water.

Sea turtles can also maintain a course in one direction using biological compasses based on the sun or Earth's magnetic field. For young turtles, however, a compass alone is not enough to keep them safe within the boundaries of their nursery habitat. Fortunately, Earth's magnetic field provides turtles with a map. Several magnetic features vary geographically so that most locations have unique combinations of magnetic characteristics. Essentially, every place has its own magnetic address.

Hatchling loggerheads emerge from their nests programmed to recognize specific magnetic addresses in the ocean and to swim innately in directions that keep them safe; thus, for example, Florida turtles do not stray too far north into fatally cold waters. As the turtles age, they move beyond those innate responses and learn to use the spatial patterns of Earth's magnetic field as a map, thereby allowing them to sense their current magnetic addresses and set course for the magnetic addresses of their destinations. It seems likely that once juvenile turtles return to coastal waters, they can use their magnetic map to guide travel between different feeding sites, such as during the seasonal migrations of turtles along the U.S. coast. Sea turtles also use magnetic cues to migrate to their natal beaches; as hatchlings, they are thought to learn or imprint on the magnetic address of the beach where they hatched and, as adults, swim back to it years later to breed.

The remarkable magnetic navigation of turtles has important conservation implications. Conservationists need to ensure that turtles can imprint on their natal beach in a natural magnetic environment, and they need to understand that turtle populations are probably not interchangeable. Animals programmed to migrate in the Atlantic Ocean are unlikely to navigate appropriately in the Pacific and vice versa. If researchers keep such needs in mind, it seems likely that the same skills that guided turtles for the last 120 million years will keep them on track for the next 120 million. •