It is late summer, and on the narrow sandy strips that surround the salt marshes, estuarine bays, and creeks of the eastern United States, hatchling diamondback terrapins — _Malaclemys terrapin_ (Schoepff, 1793) — begin emerging from their eggs 12-17 cm below the surface. Eggs placed here approximately 60 days earlier have developed into 25- to 30-mm ornately patterned hatchlings, which have already survived the most severe gauntlet of their lives. First, the nest had to be located out of reach of spring and autumnal tides, which otherwise would have drowned the developing young.

Also, the nest had to be free from the killing roots of beach grasses, which can penetrate or surround the eggs and drain them of moisture and nutrients. Finally, the nest has had to escape detection by predators such as raccoons, foxes, otters, skunks, and crows, which destroy as many as 95 percent of the nests in some areas. Having completed the nest stage of the life cycle, the hatchling terrapin has already survived the most critical stage of its long life.

Nest location and temperature affect more than just the survival chances of the offspring. During the middle third of the incubation period, the temperature of the nest influences the determination of sex of the developing embryo — a phenomenon known as temperature-dependent sex determination (TSD). This unusual form of sex determination is characteristic of most species of turtles and all crocodilians, although it does not function in the same way in all species. In terrapins, warmer incubation temperatures produce females and cooler temperatures produce males. When incubated at a constant temperature, there is a pivotal temperature range of only 2°C, indicating that small differences in nest temperatures can change sex ratios in natural nests.

There are several ecological consequences of TSD for terrapins.
First, most siblings hatching from a single nest are the same sex; rarely do nests produce both males and females. Second, annual variation in weather conditions can affect the sex ratio of a population — in warm years, sex ratios tend to be female biased; in cool years, male biased. Third, the variation of physical features from one nesting area to another results in the production of more males on some beaches and more females on others. Interestingly, when averaged over several years, the overall sex ratio of hatchlings is about 1:1. This suggests that variation in the thermal environment tempers the apparent tendency for sex ratios to become skewed because of TSD.

Hatchlings emerge from their nests in late summer or early fall. In more northern climes, some hatchlings overwinter in the nest and emerge in early spring. On leaving the nest, diamondback terrapins enter a very secretive period of life, about which very little is known. Juvenile terrapins have been discovered under mats of flotsam that wash ashore, and deep in salt marshes where they can remain undetected by avian and fish predators, but these sightings are rare compared to sightings of older terrapins.

By the age of 3 years, juvenile terrapins measure 80–100 mm in plastron length, and become more visible foraging among shoreline vegetation for small mollusks, crustaceans, and occasionally fish in the shallow water. Despite popular belief that terrapins are scavengers, they are actually quite active predators. Prey varies from one part of the range to another, and also varies with the size and sex of the terrapin. In South Carolina salt marshes, terrapins feed primarily on snails and small crabs. In the upper reaches of Chesapeake Bay, terrapins feed on soft-shell and razor clams, blue crabs, and isopods. Larger individuals with more powerful jaws can crush harder mollusk shells and feed on larger prey items. Interestingly, terrapin populations that feed on mollusks with harder shells exhibit wider heads and more developed jaw musculature than other populations. Thus the availability of different food items can result in morphological divergence among populations.

The size and age at which sexual maturity is reached varies between the sexes as well as geographically. Mature females are considerably larger than males, most likely because of the fecundity advantage that this provides. As one moves north through their range, female terrapins grow larger and mature later. In Florida, females mature at 4–5 years of age, with plastrons of 140 mm; in Maryland they mature at 8–13 years of age, with plastrons of 170 mm; and in Massachusetts they mature at 10–15 years of age, with plastrons of more than 180 mm. Males are also larger the farther north they live, but the increase is not as pronounced as it is in females.

Perhaps one reason for the increase in size of female terrapins with increase in latitude is so that they can produce larger clutches, compensating for the fact that they are able to produce fewer clutches farther north because of the shorter nesting season.
The nesting season in Florida is about 4 months long during which time females can produce up to four clutches of seven eggs each. In Maryland females lay up to three clutches of an average of 13 eggs each, and in Massachusetts females lay up to two clutches of an average of 14–15 eggs each. Size at maturity may also be influenced by water salinity. Females in the coastal regions of New Jersey are significantly smaller than females in more inland waters of Chesapeake Bay where salinity levels are much lower, despite the fact that New Jersey is considerably farther north.

The variation in these and other traits across its range makes the diamondback terrapin an interesting subject for studying how environmental conditions influence evolution.

Although no documented records of terrapin longevity are available, there is evidence that adult females in undisturbed populations may live for 50 years or more. Unfortunately, terrapin populations throughout their range are threatened by human activities such as destruction of habitat, unregulated harvest, and accidental harvest as by-catch species.

Conservation and management

In the late 1800s and early 1900s, the terrapin was the target of important commercial fisheries, which harvested it as the key ingredient in turtle soup, which was flavored with a splash of sherry. During the depression, when lucrative exploitation had already dramatically reduced terrapin populations throughout their range, the turtles sold for $1 per inch of plastron length. Population numbers became so low and prices became so high that the demand for terrapin flesh dwindled and the industry collapsed. Since that time, terrapin populations appear to have recovered throughout their range. However, new threats are currently jeopardizing terrapins and causing decline and local extirpation in many populations.

The primary cause of the current decline in terrapin populations is commercial crabbing. Attracted to the bait (primarily fish and soft-shelled clams) used in submerged crab pots, terrapins are trapped and drowned before the pots are checked. One terrapin dies in every six or seven pots per day, a rate which can decimate a population in less than 10 years. Even more dramatic are "ghost" pots that have been abandoned or lost, and continue to catch turtles over prolonged periods of time. I found one ghost pot that held more than 50 dead turtles. Crab pots may, in part, be responsible for the female-biased sex ratios that are seen in many populations. Female terrapins with plastrons of more than 150 mm are too large to fit in crab pots; males never reach this size and remain vulnerable for their entire lifetime.

Thankfully, a by-catch reduction device (BRD) is now available which greatly reduces the number of terrapins that get caught, while having no impact on the crab catch. Currently, initiatives need to be taken to require the use of BRDs where crabbing activity threatens terrapin populations. Maryland and New Jersey now require BRDs in some areas where terrapins are prevalent, although compliance with these new regulations is not well enforced.

Another threat to terrapin populations is continuing commercial harvest. This is particularly problematic because catch reports are inaccurate and actual harvest numbers are unknown. Unmonitored harvest occurs in areas where regulatory agencies have made little effort to estimate population sizes.
or to determine what catches (if any) constitute a sustainable harvest. In Maryland, for example, the only terrapins that are of a legally harvestable size are the sexually mature, reproductive females — clearly a doomed management strategy. Although the demand for terrapin flesh currently appears to be relatively low, a rising demand for turtle flesh in some places, particularly China, may increase the harvest pressures. Additionally, the growing popularity of keeping terrapins as pets may also increase the commercial harvest of this species. The fidelity that terrapins maintain to specific areas, particularly nesting areas, suggests that heavy fishing pressure could rapidly extirpate a population.

Terrapins are also adversely affected by motor vehicles. Motor boats are a major cause of mortality for adult females in Maryland, and nearly 20 percent of terrapins have scars from propeller impacts. In New Jersey the leading cause of mortality is cars that hit females while they are searching for nesting sites. Each year hundreds of females are killed in this manner. Motor vehicles are also a threat to hatchlings. The use of all-terrain vehicles was restricted on Cape Cod (Massachusetts) when it was discovered that hatchling terrapins moving from the nest to the salt marshes were being run over.

Perhaps the biggest problems facing terrapins is loss of nesting habitat. As the demand for waterfront homes increases throughout much of the terrapins’ range, shorelines are altered to accommodate development. Stabilization techniques such as bulkheads, rip-rap embankments, and jetties are used to protect investments from the perennial erosion that occurs along shorelines. These obstructions destroy or prevent access to nesting areas critical to the successful completion of the diamondbacks’ life cycle. Sadly, because they do exhibit such strong fidelity to nesting beaches, I have observed females nesting at the base of recently built bulkheads and rip-raps because they can no longer access the beach. These nests will certainly drown. Even planting beach grasses to prevent erosion may alter the nesting habitats in ways that can adversely affect the survival of nests. These types of shoreline alterations continue without any recognition of or consideration for the terrapins and other organisms that use these habitats. Even if the nesting needs of terrapins were taken into consideration, a lack of nesting evidence where populations have already been extirpated by commercial exploitation or crabbing might falsely suggest that such areas are not suitable for nesting; subsequent shoreline alteration prevents these
populations from ever being re-established. Finally, because of TSD, diamondback terrapins may need a variety of different nesting areas to ensure balanced sex ratios. Nonetheless, shoreline development continues unabated without consideration for the complex needs of terrapins.

Perhaps one of the most exciting potentials of terrapins is that they could serve as an indicator species for the preservation of these vital shoreline habitats. Many other vertebrate and invertebrate species are also adversely affected by the loss of shoreline; however, the impact on these species is much more difficult to document.

**Conclusion**

The diamondback terrapin is truly a unique and interesting species. Considered by many to be one of the most beautiful and variable species of turtles, it is one that requires detailed attention if we are to prevent reductions in populations. Currently, terrapins are poorly understood in many areas where they occur, and efforts to learn more about their ecological needs and interactions with humans are limited. Greater recognition of the presence of terrapins in salt marshes and their role in salt-marsh ecology will help raise awareness. Until then, efforts must be undertaken to prevent the loss of terrapins by non-natural causes and to preserve terrapin habitat.