Sea Turtles and global climate change

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How will climate change affect sea turtles?

"Sea turtles face many threats over their long lives: hunting, accidental capture and drowning in fishing nets, loss of feeding grounds due to pollution and seabed destruction, and loss of nesting beaches due to coastal development. But these threats may soon be eclipsed by sea level rise and the loss of entire coastlines, a reality already facing many tropical island nations, impact of Climate Change."

Climate Change is the environmental problem of the century. The Earth's climate is warming quickly, by geological standards. Climate change will affect weather patterns, cause polar ice caps to melt, and ultimately result in sea levels rising. There are other lesser-known and perhaps related phenomena—the consequences of which could be enormous—such as changes in ocean water quality. Given what we know of sea turtles' ecological roles, at best we can only speculate about the long-term impacts of the changing climate on sea turtle survival, but we can identify some venerable parts of their lifecycle where climate change will likely impact. Not surprisingly, in 2005 the IUCN Marine Turtle Specialist Group (MTSG) identified climate change as one of five key hazards to sea turtles worldwide, making the issue a high priority for further study.

During the next 20 years, the predicted rise in sea level of up to 12 cm., combined with the increased frequency and intensity of storms and higher air and water temperatures (estimated at an average 4°C rise), will impact sea turtles in both their foraging areas and at their nesting beaches.

Five species of sea turtle are known to nest in Trinidad and Tobago: the leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), and loggerhead (*Caretta caretta*) (Gyan, 1987; Chu Cheong, 1990). Only the leatherback nests in relatively large numbers. High density nesting beaches are found on the north and east coasts of Trinidad and on a few beaches in Tobago (Bacon, 1970; Gyan, 1987; Chu Cheong, 1990). Nesting by other species is reported to be largely centered along the north and east coasts of Trinidad and Tobago, as well as on the Bocas Islands (Gyan, 1987).

The leatherback turtle (*Dermochelys coriacea*) is the most common species and nests in considerable numbers. The leatherback rookery in Trinidad is the largest in the Caribbean, and is thought to be one of the largest in the Atlantic Ocean. Hawksbill (*Eretmochelys imbricata*) and green turtles (*Chelonia mydas*) nest in smaller numbers, and, according to local fishermen, have decreased in number over the last 30 years.

Literature reports that olive ridleys (*Lepidochelys olivacea*) and loggerheads (*Caretta caretta*) also nest on Trinidad's beaches, but as a rare occurrence (Bacon 1969; Fournillier and Eckert 1997; Livingstone 2004). All five turtle species nesting in Trinidad are listed as endangered or critically endangered on the IUCN red data list of threatened species (IUCN 2004).

In the foraging areas of the Bocoo Reef in Tobago—seagrass beds, coral reefs, and the open ocean—increasing storm frequency and intensity will add to the turbidity or murkiness of the water. Combined with greater water depth, this turbidity will disrupt the growth of seagrasses, sponges, corals, mollusks, and crustaceans on which sea turtles feed, in turn affecting the frequency of sea turtle reproduction, which is linked closely to food availability.

In Trinidad and Tobago sea turtles are perhaps most vulnerable to climate change at their nesting beaches. The females require nesting sites that are accessible from the sea and stable for digging; the sites must also be suitable for incubation of the eggs, and adjacent to ocean currents to facilitate hatchling dispersal. These beach characteristics must coincide and be stable through time, because nesting sites are used by successive generations. An increase in storm intensity and frequency will likely alter the topography of beaches through erosion. As primary nesting beaches erode, turtles will be forced to use sub-optimal nesting sites where incubation may not be as successful. Further, as the sea level rises, some nesting areas will be lost altogether. The combined impacts will cause a reduction in hatchling production, affecting the viability of turtle populations decades later.

Before this occurs, however, several less obvious impacts of climate change will add to the pressure. When deposited on the beach, sea turtle eggs are subject to changes in beach conditions—temperature, moisture, and oxygen availability—during development. As the atmospheric temperature increases, so will that of the sand surrounding the eggs, and too much exposure to temperatures over 34°C can be lethal to embryos. At sub lethal levels incubation temperature determines the sex of sea turtle hatchlings; hence, studies suggest, as beach temperatures rise, more females will be produced. The effects in Trinidad and Tobago needs to be confirmed as the only study by the IMA is non conclusive.

Beach sand moisture content of 2 to 12 percent provides adequate hydric conditions for egg development. As beaches are eroded by storms, waves inundate beaches, and sea spray splashes ashore, salinity will build up in the nesting beaches. Higher sand salt content reduces available moisture and can cause eggs to dehydrate and die.

The increase in tidal height may also flood eggs from underneath. If the sand is saturated by storm-driven waves or subsurface flooding and does not drain adequately, the embryos will drown.

It is not clear precisely how great the effects of climate change on sea turtle reproduction on the beaches of Trinidad and Tobago will be but conservation groups such as the Turtle Village Trust has identified this research as a priority.

The majority of the world's turtles have environmental sex determination (ESD) With ESD, the incubation temperature of the eggs during the first trimester of development determines the sex of the hatchling. Eggs incubated above a pivotal temperature of about 30° C develop into females and those below about 30° C develop into males. Another group of turtles exhibit a pattern in which females are produced at relatively warm or cool incubation temperatures while males are produced at intermediate temperatures (Ewert and Nelson, 1991).

Theoretical ecologists have speculated that such a system would be expected to evolve under conditions in which the fitness of offspring varies according to their sex. If female offspring grow faster and mature earlier under warmer conditions, then mothers of offspring in those environments would benefit by producing more females. Alternatively, if male offspring are more successful in cooler environmental conditions, then mothers of offspring in those environments would benefit from production of males. If the mother cannot predict the quality of the environment for her offspring, then conventional wisdom suggests that it is better to allow the environmental conditions to "choose" the sex of her offspring. A required extension of this scenario is that incubation temperatures will be a reflection of continuing environmental conditions, thus promoting the development and survival of one sex or the other.

ESD might be expected to cause wide variation in sex ratios of turtles and it is true that hatchling sex ratios can range from all male in some years to all females in others. Nests constructed under the shade of shrubs and trees often produce males while those deposited in the open typically produce all females. Intermediate nests can produce mixed sex ratios. However, over long periods of time, the hatchling sex ratios of most well-studied turtle populations averages 1:1. It is important to emphasize that a variety of factors including differential mortality, differences in timing of maturity, and differential emigration/immigration of the sexes can lead to strongly biased adult sex ratios (Lovich and Gibbons, 1990). In fact, many well studied turtle populations tend to show that male-biased sex ratios are the norm for adults.

Prior to recognition of ESD in turtles, conservation biologists routinely employed high incubation temperatures in sea turtle captive propagation programs because incubation time also decreases with increasing temperature. The result was production of all females (Morreale et al., 1982). A recent proposal to use ESD as a conservation tool to produce more females of endangered turtle species has been criticized because of potentially negative impacts on population structure and mating systems (Lovich, 1996).

Previously, some scientists have suggested that global climate change has the potential to eliminate the production of male turtle offspring if mean global temperatures increase 4° C, and increases of less than 2° C may dramatically skew sex ratios (Janzen, 1994). Thus, turtles appear to be good environmental sentinels for monitoring the biotic impacts of predicted global climate change. According to scientists from the University of Exeter published in the journal Global Change Biology (2007), an increase in temperatures of just one degree Celsius could completely eliminate the birth of male turtles from some beaches. A rise of two degrees Celsius would lead to extreme levels of infant mortality and declines in nesting beaches across the USA and the Caribbean. This research analysed 26 years of turtle nesting and climate data and compares the findings with models for future temperatures. The study showed just how vulnerable marine turtle populations are to changes in temperature. It expressed concern that populations that are already predominantly female could become 100% female if temperatures increase by just one degree. This is a major issue for nesting populations further south, in Florida and the Caribbean, for example, where males are already in short supply.

The research team recommends that conservation efforts are focused on protecting northern breeding grounds. It highlighted that in Florida and the Caribbean, 90% of hatchlings are female, in North Caroline 42% are male and scientists believe some of these males currently travel south, bolstering southern populations. A decline in male turtles populations, as a result of global warming, could potentially impact marine turtles across the region. This report is an important step in identifying essential thermal habitat for marine turtles, the research team recommends that conservation efforts should highlight the need to establish measures to specifically monitor and protect male-producing beaches by natural or artificial means.

In the face of climate change, and given the fact that Trinidad and Tobago is the largest accessible hatchery, it's essential that we identify the hatchling ratio and prioritize the protection of sites especially those that produce males not only for local breeding success, but to help support potentially vulnerable populations in other areas.

Although the scenario of turtle extinctions as a result of climate change may seem far-fetched, other scientists believe that the disappearance of dinosaurs may be linked to ESD and rapid climate change.

Even if turtles survive the possible effects of global climate change on sex ratios, they will still have to contend with other predicted changes. As "cold-blooded", or ectothermic, animals, digestion rate, growth, reproduction and activity are all closely related to temperature. In addition, changing water levels in sea, rivers and wetlands could have major impacts on access to suitable nest sites and habitat. Their conservative evolutionary history suggests that they will not be able to "adapt" to rapid changes. It is still not clear precisely how great the effects of climate change on sea turtles will be. Comprehensive long-term data sets are needed to fully research the matter.. Until then, how the turtles will respond to climatic change remains a matter of speculation. Will sea turtles respond in concert with changing environmental conditions, or will environmental change outpace their ability to adapt to change? The answers to these questions will determine the long-term survival of these remarkable species.

Turtles may have outlived the dinosaurs, but it remains to be seen if turtles can survive in tomorrow's world.

WHAT IS NEEDED (IUCN Marine Turtle Specialist Group (MTSG))

- Comprehensive long-term data sets are needed to fully research matters.
- Monitoring Programmes (Natural and Artificially)
- Continued Beach monitoring programmes
- Monitoring existing & secluded beaches
- Education and Awareness Programmes

How to save species?

- Wildlife refuges?
- Gene banks/ Research Facility?
- Captive breeding programs?
- Reintroduction Programmes?

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