

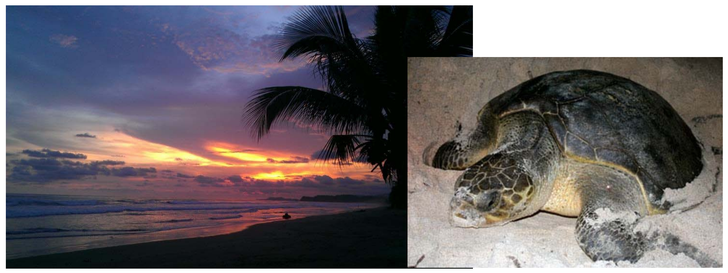

Sea Turtle Nesting in Guanacaste, Costa Rica: Effects of Temperature and Sea Level Rise

Kristen Zemaitis and Jodee Hunt

Biology Department, Grand Valley State University


Abstract

Climate change is altering sea level in coastal ecosystems, which will increase an additional 0.6 m by 2100, detrimentally affecting the availability and quality of sea turtle nesting habitat. I used a World Wildlife Fund protocol to monitor temperature and slope of beach habitat used by nesting sea turtles, including green (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*), and hawksbill (*Eretmochelys),* on San Miguel Beach, Guanacaste, Costa Rica. During July and August, 2012, I measured beach slope with an Abbney level in transects 5m apart located in three 100 m sections of beach (N = 20 per section). To model the inundation resulting from predicted sea-level rise, 0.6 m was subtracted from elevation values, resulting in a loss of 3% of the Guanacaste beach area. Beach topography is unstable within and among nesting seasons, and modeled to change in complex ways in response to storm events and human disturbances like tourism, off-road vehicle use and beachfront development. These combined effects will harm sea turtles relative to their body size and timing of nesting. Current beach temperatures support normal sea turtle development, but if the current trajectory of temperature increase continues, feminizing effects will occur by 2100, and lethal temperatures will be reached soon thereafter. If beach temperatures increase faster than modeled in the current study, feminizing and lethal effects will occur even sooner.



Methods

My research was conducted during the initial two months of Olive Ridley turtle nesting using the World Wildlife Fund's protocol for monitoring temperature. I selected three 100m wide zones on the beach: Zone 1 (high nest density), Zone 2 (low nest density), and Zone 3 (no turtle nests), and divided each into 20 transects, each 5m wide. Transects extended from mid-tide line up slope to the limit of turtle nesting . Within each zones I buried a HOBO pendant data logger at 50 cm(nesting depth) to record temperatures throughout the day. Using a topographic abney level and meter tape, I recorded the slope of each of the 60 transects the first and last weeks of study to monitor the change in elevation. I recorded the angle of elevation every 5 m from the mid-tide line to the line of vegetation. To monitor temperatures, I selected four random transects within each of the three zones, sampling every 5 m weekly with a 50 cm compost thermometer. Data collection occurred during low- or mid-tide to avoid losing equipment in the ocean surge. I used a Stainless steel sieve set (1mm, 3mm, 5mm) for determining the size of sand grains. The size of sand grains help determine how the sand holds moisture and temperature. I determined percent moisture content in sand samples collected near the HOBO data logger using a scale and stove (to dry samples) . I modeled projected sand temperature for the transects for the year 2100 using the AOGCM model (IPCC and EPA 2007).

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Results and Discussion

Current sand temperatures do not reach lethal levels of 34°C. The mean baseline sand temperature (29.71°C) does not predict complete feminization of embryos, but this temperature is from the sand at nesting depth, not from an actual nest. Temperatures within the nest, especially towards the center of the clutch, will likely be higher due to incubation and embryo metabolism. Higher temperatures might feminize entire clutches if nest temperatures exceed 30.5°C during embryonic development. In other cases, eggs located in the center of the nest may be much warmer than those on the outer edges of the nest, resulting in both male and female hatchlings from the same nest.

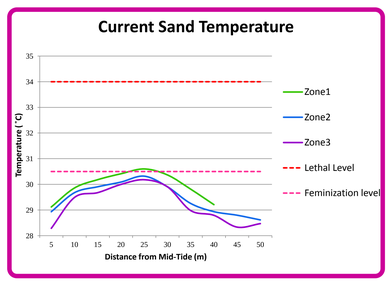

Figure 1: Current sand temperature at 50cm in Playa San Miguel, Costa Rica

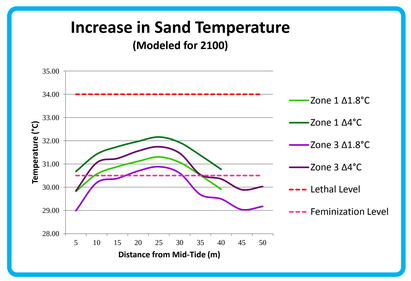

Figure 2: Predicted increases in sand temperature at 50cm in Playa San Miguel, Costa Rica for the year 2012.

If the temperature increases 1.8°C by the year 2100, the average baseline sand temperature will increase from 29.71°C to 30.14°C. This temperature does not finalize complete feminization; however it is very close to that point. It is likely that there will be an increase in the percentage of female hatchlings and a reduction in the percentage of male hatchlings which will lead to negative issues in the future such as the lack of mates available and lower reproduction rates.

If the temperatures increase more than the minimum estimate of 1.8°C, and instead increase by 4°C by the year 2100, the average baseline sand temperature will be 31.27 which is above the feminization level. Although temperatures are not predicted to reach the lethal levels of 34°C by this time, it is likely that a portion of the nests will reach this temperature due to incubation and metabolic rates of the developing embryos which will be fatal.

During the two months of the study, beach slopes changed. Steep slopes, avoided by nesting turtles, became steeper (Fig. 3). Slopes of areas used by nesting turtles (Zones 1 and 2) changed less dramatically and retained a gentle slope (Fig. 4). Olive Ridley turtles, which were the only species of sea turtle nesting on the San Miguel beach during my research, generally prefer more gentle slopes compared to other sea turtle species. Several Olive Ridley females attempted to nest in Zone 3 but aborted and retreated back to the sea after experiencing difficulty with the steep slope and erosion-exposed roots . Slopes changed because of tidal fluctuations and large waves that form during violent winter storms along the coast. Even if all greenhouse gas emissions ceased today, their negative effects on the atmosphere would continue. Climate change and global warming will lead to a rise in sea level, inundation of coasts, increasingly severe tropical storms, and the death of plant and animal species due to habitat changes or loss (Peloso 2010). The minimum sea level rise predicted for the year 2100 is 0.6 m, which would result in a 3% loss of nesting habitat on the San Miguel beach, steeper beach slopes, and more erosion along the vegetation edge, where trees and shrubs are already dying from beach erosion. Such changes have already created ledges that sea turtles cannot climb over, thereby preventing successful nesting.

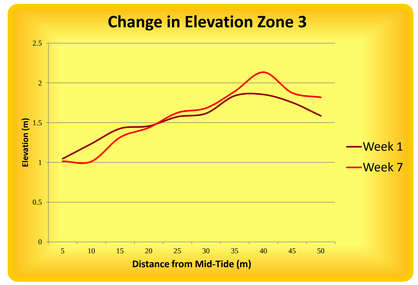

Figure 3: Change in elevation of zone 3 over 7 seven weeks.

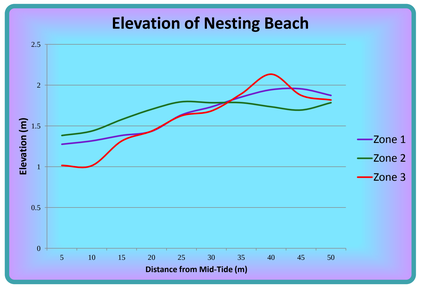

Figure 4: Variation in elevation of zones 1, 2, and 3 at week 7.

Acknowledgements.

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Grand Valley State University
Biology Department