Predicting the Effects of Sea Level Rise on Three Sea Turtle Nesting Beaches in Costa Rica

Lizette Guzman-Zaragoza[1], Alyssa Giffin[1], Kristen Zemaitis[1], Katherine Comer Santos[1], Catalina Gonzalez[2], Manuel Sanchez[3], Lotti Adams[4], Emma Harrison[5], Randall Arauz[6], Mariana MPB Fuentes[7], Marianne Fish[8], Beth Whitman[9] and Rebecca Lewison[10].

[1]The Science Exchange Sea Turtle Internship Program, San Diego, CA, USA; [2]Sea Turtle Conservancy, Tortuguero, Costa Rica; [3]Osa Conservation, Puerto Jimenez, Costa Rica; [4]PRETOMA, Guanacaste, Costa Rica; [5]Sea Turtle Conservancy, San Jose, Costa Rica; [6]PRETOMA, San Jose, Costa Rica; [7]James Cook University, Townsville, Australia; [8]World Wildlife Fund, Vancouver, Canada; [9]Florida International University, North Miami, FL, USA; [10]San Diego State University, San Diego, CA, USA .

Introduction

Sea level rise, exacerbated by rapid climate change, is predicted to increase by approximately 0.6 m in the next 90 years according to the Intergovernmental Panel on Climate Change (Solomon et al. 2007). An increase could affect the availability and quality of sea turtle nesting habitat (Fuentes et al. 2012). This investigation took place at Pejeperro Beach (Osa Peninsula), San Miguel Beach (Guanacaste), and Tortuguero Beach (Caribbean) in Costa Rica in July and August of 2012. They are monitored by collaborating organizations for nesting of five out of seven of the world's endangered sea turtle species: greens, olive ridleys, leatherbacks, hawksbills, and loggerheads.

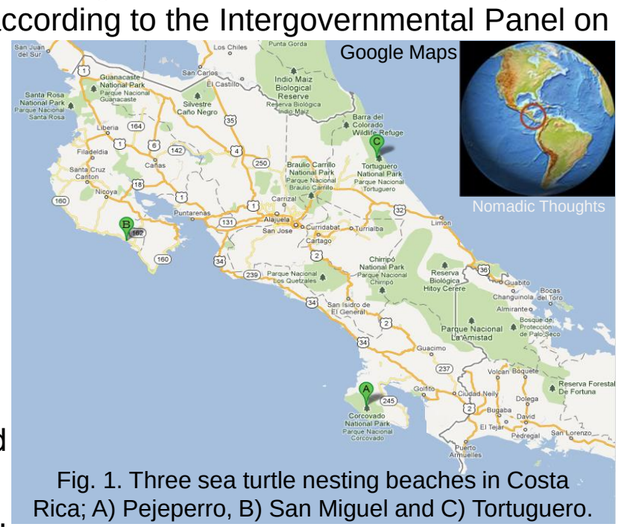


Fig. 1. Three sea turtle nesting beaches in Costa Rica; A) Pejeperro, B) San Miguel and C) Tortuguero.

Methods

Data were collected following the World Wildlife Fund (WWF) Guidelines for Monitoring Beach Profiles manual (Fish 2011). At each beach, slope data were collected with an abney level along sixty 5m-wide transects from the shore through the vegetation in three separate 100-m long zones. These zones represented zero, low, and high sea turtle nest density areas according to the expert opinion of the supervisors. The surveys were taken at the beginning of the study and at the end to calculate natural rate of change. To predict the possible beach area loss from sea level rise in the year 2100, we took the average of the first and second survey elevations of each sample point and subtracted 0.6 m to simulate flooding of the beach.

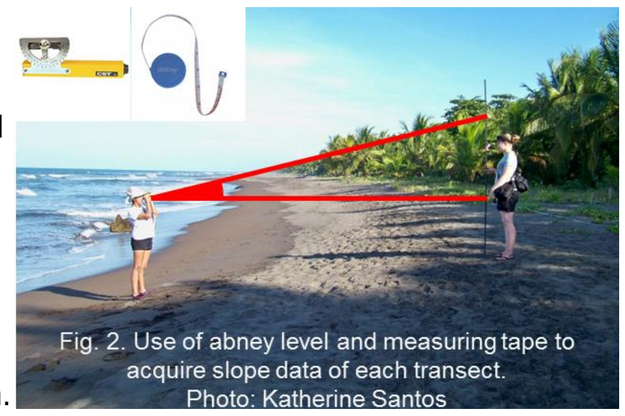
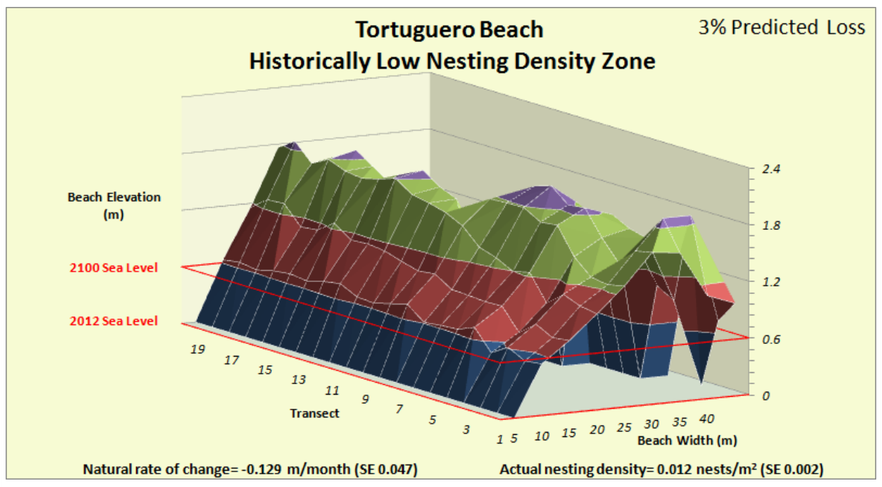


Fig. 2. Use of abney level and measuring tape to acquire slope data of each transect. Photo: Katherine Santos

Results and Discussion

Only a few of our 1279 sample points were flooded in our simulation, resulting in a predicted loss of 6% of the sampled beach area at Tortuguero (3% from the low nest density zone and 3% from the high nest density zone). The site with the most dramatic loss was at Pejeperro Beach, with a predicted 14% of the high nest density zone potentially being underwater by 2100. In this zone, 13 out of 20 transects are predicted to shrink five meters in width starting at the mid-tide line toward the back of the beach because there is a gradual slope with low elevations. The surveyed beaches are steeper and less prone to sea level rise than others in the literature. There was a predicted loss of 21% of suitable nesting habitat at La Fortuna beach in Baja California Sur, Mexico, using the 0.6 m rise scenario (Soares et al. 2010). A Barbados study modeled a 26% beach area loss over 11 beaches with a 0.5 m sea level rise (Fish et al. 2012).



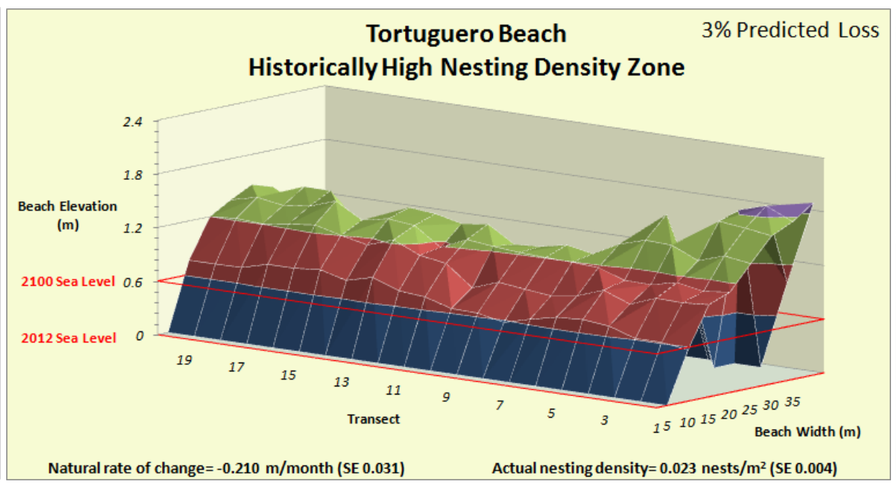



Fig. 3. Tortuguero Beach. Photo: Katherine Santos.

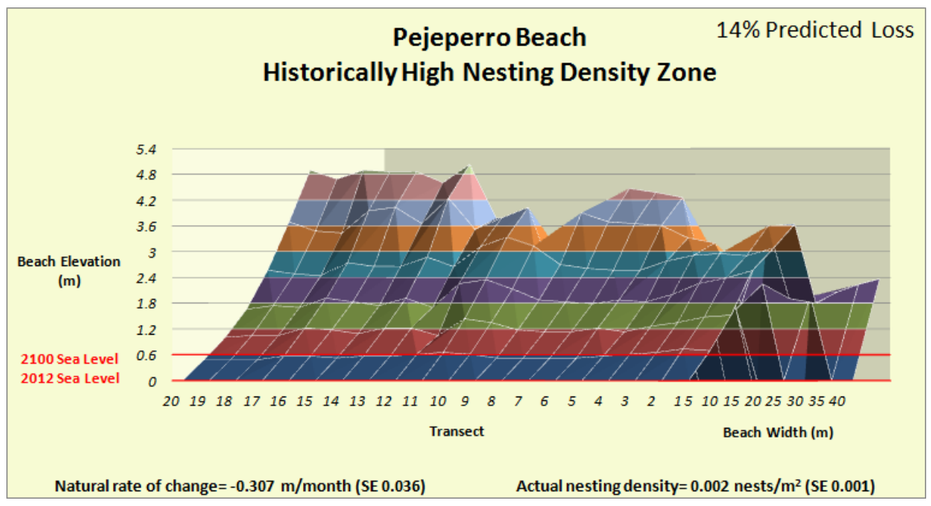



Fig. 4. Pejeperro Beach. Photo: Emily Kuzmick.

Sea level rise combined with other climate change consequences such as an increase in the frequency and strength of storms and rising sand temperatures (Fuentes et al. 2012), will likely have an impact on the availability of suitable nesting habitat for sea turtles in our study areas. In addition there are site-specific threats such as beach pollution, sand mining, poaching, beach lighting and beach front development at these important nesting beaches.

The following are some recommended adaptation measures to combat sea level rise effects (Fish and Drews 2009):

- Monitor sea turtle nesting and protect suitable nesting habitat from other threats.
- Relocate nests that are prone to inundation to safer sites.
- Establish (or enforce existing) setback regulations that prohibit construction within a set distance from the high tide mark.
- Take beach profiles at set transects over time to calculate an estimate of the rate of erosion/accretion.
- Remove permanent shoreline-hardening structures, such as sea walls, to allow natural beach movement landwards.

Literature Cited

Fish MR. 2011. Temperature monitoring manual. Guidelines for Monitoring Beach Profiles. WWF report, San Jose, 16 pp. http://awsassets.panda.org/downloads/beach_profile_monitoring_manual.pdf

Fish MR, Cote IM, Horrocks JA, Mulligan B, Watkinson AR, Jones AP. 2012.Construction setback regulations and sea-level rise: Mitigating sea turtle nesting beach loss. Ocean & Coastal Management, 51, 335 pp.

Fish MR, Drews C. 2009. Adaptation to climate change: options for marine turtles. WWF report, San Jose, 20 pp.

Fuentes MMPB, Fish MR, Maynard JA. 2012. Management strategies to mitigate the impacts of climate change on sea turtle's terrestrial reproductive phase. Mitig Adapt Strateg Glob Change, 17, 51-63 pp.

Soares D, Maxey S, Tiburcio Pintos G, Acevedo Ruiz E, Castillo Leggs V, Marquez Almanza P, Marron Fiol JC, Soares D, Santos K. "Predicted sea level rise impacts on the nesting beaches of olive ridley turtles in Los Cabos, Mexico." Poster presentation at the International Sea Turtle Symposium, Goa India. April, 2010. NOAA technical memorandum.

Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M and Miller HL (eds.). 2007. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and NY, USA 996 pp.

Contact Information

Lizette Guzman-Zaragoza
San Diego, CA 92115 USA
(209) 917 0022
LizetteGuzman11@yahoo.com

Katherine Comer Santos
San Diego, CA 92111 USA
(619) 519 9876
science_exchange@hotmail.com

The Science Exchange, 1 877 519 9876, http://www.thescienceexchange.org