PREDICTED SEA LEVEL RISE IMPACTS ON THE NESTING BEACHES OF OLIVE RIDLEY TURTLES IN LOS CABOS, MEXICO

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Introduction

Baja California Sur, México represents the northern-most region where olive ridley turtles (*Lepidochelys olivacea*) nest in the Pacific, making it a critical area. The Campamento Don Manuel Orantes Turtle Program (Municipality of Los Cabos) protects 180 kilometers of beaches. Short-term threats such as beach development and construction of marinas combined with long-term threats such as sea level rise could contribute to a decline or elimination of suitable nesting habitat for olive ridleys here.

The goals of the study were to measure the physical characteristics of sites where Olive Ridley females place nests on the study beaches, as well as predict the impact of sea level rise on those nest sites.

Two university students enrolled in The Science Exchange internship program worked with technicians from the municipality for six weeks during the summer of 2005. We collected data on 56 nests laid on twelve beaches over 32-km to determine the mean distance from nest to mid-tideline, slope of the track, sand grain size of the nest site, elevation of nests, and then compare the findings to known studies.

Results could help with placement of hatcheries and protected beach zones, as will as predicting areas of beach loss with sea level rise.

↑32-km of study beaches in pink

Methods

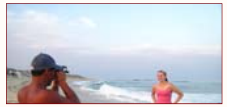
•Slope represents the physical effort to reach a preferred nesting site. Slope of the track was taken with an inclinometer from the exit point at mid-tide line directly to the nest every 30 m to capture irregular beach topography.

•Distance between the same two points also represents effort to find a "high and dry" spot and was taken with a tape measure.

•Nest elevation is related to the moisture content of the sand. Elevation was calculated with trigonometry based on slope and distance (see example to the right).

•Sand grain size can have an effect on the effort to build a nest with the flippers, moisture content of the nest, and other factors. Sand grain size was sampled at the top of the nest and divided into 7 visual categories at the end of the study.

•Sea level rise was assumed to be .6 m over the next 100 years (Fish et al. 2005)



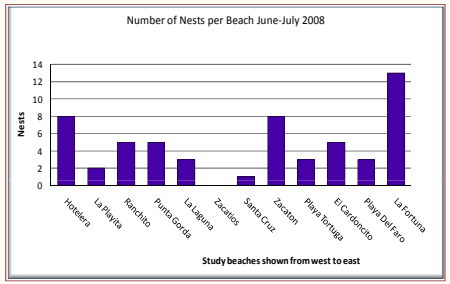
↑Use of Inclinometer to measure the angle of track

↑54 sand samples labeled, and visually divided into categories

Results

Nest Site Characteristics

La Fortuna beach supported the most nesting during the study period, followed by Zacatón and Hotelera (a highly developed resort beach).



The average distance from waterline to nest was 27.1 meters (see table). Lopez et al. (2004) found an average distance of 17.6 meters in a nearby Cabo Pulmo study of olive ridleys nests.

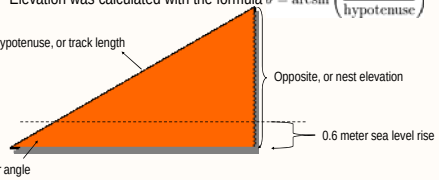
Turtles nested in all sand grain sizes, with most nests in medium grains (between category 3 and 4). The olive ridleys at Cabo Pulmo also preferred "medium grains" (Lopez et al. 2004).

The mean slope from waterline to nest was 6.7%, which is similar to the 9% preferred slope for loggerheads in Florida (Wood et. al. 2000).

The mean elevation of nests was 2.3 m above sea level, higher than the 1.1 m elevation of other hawksbills studies (Horrocks and Scott 1991).

	Distance to nest from sea (m)	Avg. Slope to nest from sea (degrees)	Elevation of nest (m)	Sand Grain Category
Mean	**27**	**6.74**	**2.4**	**3.7 or medium**
Standard Deviation	(+/-) **10.7**	(+/-) **2.7**	(+/-) **1.5**	(+/-) **1.6**
Range	**8-50**	**3.02-10.62**	**(-)0.57-6.2**	(1=ultrafine/7=pebble)

Elevation was calculated with the formula $\theta = \arcsin\left(\frac{\text{opposite}}{\text{hypotenuse}}\right)$



Sea Level Rise Impacts

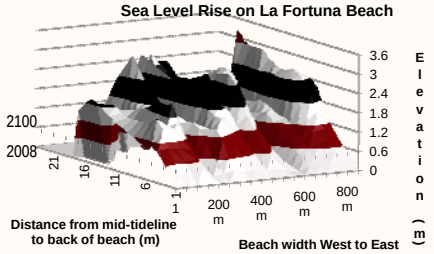
Assuming a 0.6meter sea level rise (Fish et al. 2005) 14% of the nests studied in this period would have been inundated.

Beach	Nest #	Elevation (m)
Hotelera	29	**0.26**
Hotelera	33	**-0.57**
Hotelera	35	**0.96**
La Fortuna	40	**-0.55**
La Fortuna	49	**0.97**
Punta Gorda	41	**0.18**
Punta Gorda	47	**0.99**
Zacaton	1	**0.76**

Black highlighted nest s would be underwater, gray would be In danger of inundation.

↑Olive Ridley laying eggs.

Using the beach with the most nests during the study period, La Fortuna, a snapshot slope profile from the summer of 2008 was graphed, and then 0.6 m elevation subtracted to simulate sea level rise in 2100 (Fish et al. 2005). Assuming current topography, at least 6 meters of the beach width would be underwater, decreasing the overall beach area by more than 6000 sq meters and increasing the slope of the initial ascent.



Recommendations

Conservation recommendations to protect Baja California Sur's important nesting beaches from sea level rise include continued translocation nests. The main purpose of translocation currently is protection from poachers and predators, but with sea level rise and rising sand temperatures, in addition to beach development threats, the program will become more important.

Where to put the nests? Most researchers assume that females choose nest sites for a reason. In order to replicate olive ridley females preferred nest sites, our study and others indicate olive ridley hatcheries should be located in areas with moderate slopes (7% in our study), medium sand grains, half way up the beach from the tideline (27 m in this study). In addition, technicians should carefully monitor the sand temperature and humidity in the hatcheries, as Baja California air temperatures are expected to rise in the future.

Because of predicted sea level rise, and the expected inundation of nesting areas, the Mexican government should strictly enforce the no-development rule in the protected "federal zone" (20 m from mean high tide). Proactive planning should limit further development of these sensitive coastal areas, above 20 m, thus allowing for beach accretion and erosion to happen naturally. This protects not only turtle nest sites from sea level rise, but human life and property, and will help maintain the beaches that attract million tourists a year.

Improvements to our methodology would include more frequent profiling and capturing stochastic storm events that can drastically alter beach topography. We recommend measuring sinuosity of the track, as well as the straight line slope from sea to nest (for the purposes of calculating elevation in this study) as an indicator of crawl effort. Sand should be sieved to quantify size.

Literature Cited

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