Quantification and recommended management of man-made marine debris along the sea turtle nesting beach at Playa Caletas, Guanacaste, Costa Rica

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Introduction and Purpose

From causing entanglement (Fig. 1), severe lesions, digestive tract obstruction through ingestion, to interference with nesting and emergence, marine plastic pollution is causing deleterious effects to populations of endangered sea turtles worldwide (Carr 1987; Bugoni et al. 2001; Wabnitz and Nichols 2010). Although marine debris survey data have been collected and assessed in the past few decades (Barnes 2009), this is the first marine debris survey of Playa Caletas.

Figure. 1 Rescued nesting sea turtle who suffered neck lesion from plastic rice sac entanglement at Playa Caletas Pretoma site

Up to 80% of waste that ends up in the ocean to become marine debris consists of short-lived plastic products permanently discarded within one year of manufacture (Wabnitz and Nichols 2010). For many years, observations of large amounts of man-made marine debris, specifically plastics, have concerned Pretoma workers at Playa Caletas, a sea turtle nesting site in Costa Rica (Fig. 2). Four out of the seven species of sea turtles use this beach as a nesting habitat.

Figure 2. Playa Caletas is an isolated, dark sand beach 7 km away from the nearest town, San Francisco de Coyote. The beach is located on the Nicoya Peninsula in the Guanacaste region of Costa Rica.

Questions

Several research questions were addressed:

(1) What are the characteristics of the man-made marine debris in terms of size (micro, macro, large) and type (bottles, wrappers, etc.)?

(2) How does the density of debris relate to precipitation events?

(3) How is the density of debris distributed spatially?

(4) How can managers use this information to improve sea turtle habitat?

Julia and some of the Pretoma 2011 volunteers

Julia Ramos counting buckets of marine debris during a day's work

Methods

Transect Surveys: Debris Sampling

Sampling was conducted at low tide over 22 days in mid-July through August during the 2011 olive ridley/green nesting season. Four, 5.0-m wide random transects were assessed for presence of marine debris from each of Pretoma's previously defined 55 sectors (Fig. 3), resulting in a 20% beach coverage (n=220).

Figure 3. The 55 sector boundaries of Playa Caletas, Guanacaste, Costa Rica (Google Earth)

For each transect, we recorded debris quantity and characterization, the length from water's edge to first barrier, substrate type, land use, time, current weather, and description of the weather within the 12 hours prior to sampling.

Marine Debris Quantification

All debris items were counted, measured and recorded. For large debris, the item's status (sunken, stranded, etc.) was additionally recorded.

After removing macro and large debris items, man-made micro debris was sieved and identified in 11 previously selected transects within 0.0019 m^3 volumes.

Debris Size Category	
Large	≥ 30.0 cm
Macro	1.0 cm≤ x ≤ 30.0 cm
Micro	5.0 mm≤ x ≤ 1.0 cm

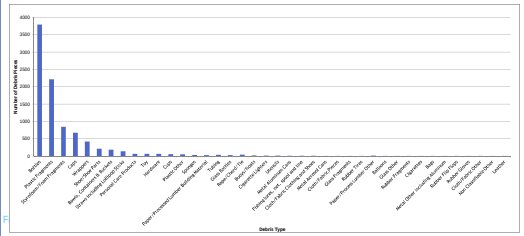
Debris Density

Densities were calculated for each of the three size categories per transect by dividing the total number of debris by the area (macro and large) or volume (micro) of the sampling location.

Results

1. Characterization of Man-made Marine Debris

A total of **6,116** pieces of debris found and **~98.2%** of all marine debris was classified as plastic (Fig.4). The top seven items most frequently found: "plastic bottles," "plastic fragments", "Styrofoam/foam fragments", "plastic caps", "wrappers", "shoe/shoe parts", and "bowls, containers and buckets". Mean macro debris density was 0.14 pieces/m^2, large debris was 0.01 pieces/m^2, while micro debris was 48.48 pieces/m^3 .



The abundant presence of personal bottles (17.8-25.5 cm), caps, wrappers, etc. provides supporting evidence that most debris arriving on beaches from the ocean are short-lived plastic products.

The presence of **melted macro debris** is an indication of trash burning, a common practice in places with no trash collection service, such as Playa Caletas. Locals in San Francisco de Coyote report that many people burn their trash right next to the Rio Bongo. After storms, sediment and plastic pollution from the river can be observed traveling from the river onto the beach.

2. Precipitation events related to debris

There was an observed trend of increased density of macro debris:
Days affected by precipitation: mean of 0.257 pieces/ m^2; Dry days: mean of 0.169 pieces/ m^2
However, it was not significant (p=0.43).

3. How was debris distributed spatially? 4. How can managers use the information to improve sea turtle habitat?

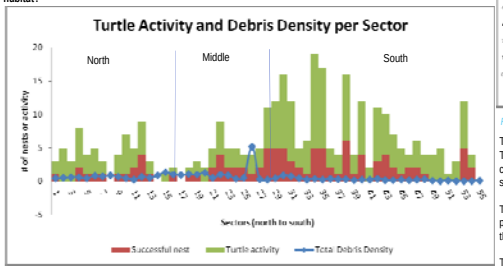


Figure 5. Debris density per sector with the number of turtle activities (nests, aborted nests, false crawls, poached, predated) and successful nests per sector and per geographic area (north, middle, south).

Debris density was high in the north and peaked at sector 26 in front of the camp, decreasing towards the river. Areas of high frequency female sea turtle activity occurred in sectors 26-43 (in the middle to south regions) as well as at the mouth of the river in sectors 52-55 (in the south region).

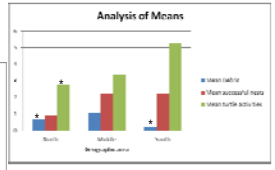


Figure 6. ANOVA results from the north, middle and south groupings

Through separate ANOVA tests we found that:
The density of both macro sized debris alone or macro combined with large sized debris in the south area was significantly lower than the other two areas ($p < 0.01$).

The frequency of all sea turtle activities (indicating female presence on the beach) in the north area was significantly lower than both the middle and the south areas ($p < 0.05$).

The "successful nest" (or potential hatchling presence on the beach) frequency in the north area was again significantly lower than both the middle and the south areas ($p < 0.05$).

However, we cannot directly relate sea turtle activity to marine debris presence because we lack turtle activity and nesting success densities in the exact areas and time where debris density was recorded. A MANOVA or logistic regression could be used to better relate the trends.

Recommendations

Suggestions for Future Surveys

We recommend repeating this debris survey at Caletas following the protocol of repeated, random transects found in the NOAA Marine Debris Shoreline Survey Field Guide (Opfer et al. 2012). Researchers should focus on 4-5 study areas 100-m wide, with 4 random 5 m-wide transects in each with the goal of covering a minimum of 20% of the study areas. Future researchers could select the 4 to 5 study areas based on historic high or low sea turtle activity and simultaneously sample debris density and sea turtle nesting density to test a more direct relationship between marine debris and sea turtle nesting activity. This involves GPSing the areas of the turtle sectors that Pretoma monitors to calculate density.

Careful removal of debris (not possible in this study) should take place during future studies in order to: minimize the occurrence of recounting debris, increase preciseness of locating debris hotspots, as well as lessen the effect of marine debris on the sea turtle nesting habitat.

Because 74% of the debris was found above the wrack line, teams should survey during medium tides only, include the vegetation line, and repeat sites weekly or every other week.

We recommend repeating a minimum of 4 transects (one in each study area) before and after storm events using predefined "drying out" periods.

Debris and turtle density surveys over an entire nesting/hatching season and over several years could allow a comparison between multiple seasons and years, as well as with other beaches.

Conservation Recommendations

The government should provide a trash collection service for San Francisco de Coyote that would facilitate the removal of surveyed marine debris as well as all other community trash. Alternatively, locals could be hired to help haul off debris for recycling and proper disposal. This tactic would also increase local interest in the project as well as provide some income that is tied to a sea turtle conservation project, which is a successful model in countries faced with poaching cultures (Marcovaldi and Marcovaldi 1999). Beach cleanups should be scheduled on days after heavy storms and should target Zone 3, near the vegetation line at highest elevation.

Education and plastic alternatives are key to changing the plastic consumer culture. Costa Rica with its heavy dependence on eco-tourism, and its environmentally- conscious, educated, and resourceful population could become a pioneer in developing "plastics solutions" for the rest of the world to follow.

Literature

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