Quantifying the risk that marine debris poses to cetaceans in coastal waters of the 4-island region of Maui, Hawai‘i

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Abstract

Here we present results from the first study to quantify the risk marine debris poses to 5 cetacean species commonly sighted in the leeward waters of Maui, Hawaii by assessing the overlap of cetacean and marine debris densities.

Entanglement and ingestion of marine debris poses considerable threat to biodiversity and has been identified as a stressor for a variety of marine life. Maui County provides important habitat for a variety of marine mammals and is located within the boundaries of the Hawaiian Islands Humpback Whale National Marine Sanctuary. The low recovery probability of marine mammals that have ingested or become entangled in marine debris makes these interactions difficult to quantify.

To assess the risk of entanglement and/or ingestion, line transect surveys were conducted from April 2013 to April 2016, and the locations of all floating debris and cetaceans sighted were recorded. Localization of entanglement and ingestion risk was observed by mapping the overlap of debris and cetacean sightings within the survey area. The area of overlap varied between species but was largest for humpback whales, which account for the largest proportion of reported entanglements in the 4-island region of Maui.

Identifying areas of high debris-cetacean density overlap can facilitate species management and debris removal efforts.

Methods

Survey Effort

- A total of 215 surveys were completed from April 1, 2013 to April 15, 2016 covering 29,810 km of combined on- and off-effort survey distance. A total of 45 bottlenose dolphin, 11 spinner dolphin, 22 spotted dolphin, 6 false killer whale, and 336 humpback whale pods were sighted along with 1027 pieces of marine debris.

Marine Debris

- Kernel density estimates of debris showed a trend of higher accumulation between the islands of Maui, Lanai, and Kaho'olawe in the area where the Au'au, Kealakahiki, and Aialakai channels meet, as well as southwest of Lanai.
- Of the 1027 pieces of marine debris, 88% (n=904) were considered to pose an ingestion risk, while 12% (n=123) were considered to pose entanglement risk.

Results

Overlap Between Marine Mammals and Debris

- The highest-risk area across all species, except spinner dolphins, was the area centered between the islands of Maui, Lanai, and Kaho'olawe. The area we have identified as highest concern warrants further study, aimed at reducing the risk to cetaceans by reducing debris input and mitigating the impact of existing debris.
- The endangered false killer whales should be a priority species for additional research as their abundance, biology, and ecology in Hawai‘i remains poorly studied.
- Numerous species of sea turtles and Hawaiian monk seals are endangered species not included in this study that would additionally benefit from a reduction in marine debris in Hawaiian waters.
- The origins of debris presented here should be considered when determining the focus of conservation efforts to reduce debris accumulation. Additional research should focus on the cause and distribution trends of marine debris within the 4-island region of Maui, Hawai‘i.

Discussion

Background

Debris items, particularly plastics, threaten marine organisms either indirectly by altering habitat or directly through fatal interactions. Ingestion of debris is often an underreported metric as it typically requires recovery and necropsy of dead animals. However, debris entanglement and ingestions have been documented for cetaceans in Hawaiian waters with 55 entanglements with marine debris reported from 2007 to 2012 (Bradford & Lyman, 2015).

Two of these instances involved Hawaiian spinner dolphins, one of which had a plastic ring/band around its rostrum preventing the mouth from opening.

Another instance involved a juvenile humpback whale entangled in over 21 different types of rope and netting.

Study Area: The study region covers an area of 1004 km² within the Maui 4-island region, Hawaii and was surveyed between April 1, 2013 and April 15, 2016. Water depths range from 7 to 652m with drowned reef features and sandy, flat concentric basins making up the bottom topography.

Data Collection: Systematic surveys were conducted on an 8m research vessel, using line transect sampling. Observations were made by the captain and two observers, scanning equal sections of water, with a four-cam recording data. Cetacean sightings of bottlenose dolphins, Hawaiian spinner dolphins, pantropical spotted dolphins, false killer whales, and humpback whales were recorded. For each encounter, the species, group size, and GPS location were recorded. Marine debris, all floating debris items encountered were recorded. The item was collected, if possible, and GPS location and material type were recorded.

Data Analysis: Analysis was conducted in ArcGIS. The study area was divided into 1 km x 1 km grid cells, and cells with no survey effort were dropped from the analysis.

- Estimating density of debris and cetaceans: The ‘point density’ tool in ArcMap was used to calculate (1) debris sightings per km² and (2) cetacean sightings per km.
- Assessing overlap between debris and cetaceans: Weighted density of debris was overlapped with weighted density of each cetacean species. Then the product of these densities was calculated for each cell. This was converted into a point data layer to represent co-occurrence, or exposure from each species to debris.
- Calculating relative risk: Areas of high risk were predicted for each cetacean species by estimating kernel density from the exposure point data layer. The resulting estimates were binned into natural breaks and represent the high and low risk areas for each cetacean species.

References


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