The Abundance and Composition of Sediment Plastics at Kamilo Beach

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Introduction

Kamilo Beach, located on the southeast coast of the island of Hawaii, is well documented for collecting marine debris. Hawaiians would travel to Kamilo in search of giant logs, originating from the Pacific Northwest, to construct their voyaging canoes (Weiss 2006). The beach is still collecting marine debris originating throughout the entire Pacific but nnlike the natural debris collected by Hawaiians, today's debris consists primarily of plastics. Plastic production worldwide has been increasing rapidly since its industrialization with over 245 tonnes of plastic consumed annually (PlasticsEurope 2008). Many of these plastics eventually reside in our oceans. Plastics are designed to be lightweight, durable and strong (Derraik 2002). These same characteristics resist plastics to degradation and prolong their lifespan (Derraik 2002). Large pieces of plastic may succumb to the effects of photdegradation, biodegradation and hydrolysis among other factors and begin to fragment (Andrady 1990). The process of environmental degradation, as shown by Andrady (1990), is slowed in marine environments compared to land, further prolonging the life of plastics in our oceans. Fragmented plastic can be ingested by marine life leading to unknown problems. Carpenter et al. (1972) showed that 8 of the 14 species of fish they tested ingested plastic spherules. Auman et al. (1997) found plastic in 245 out of 251 Laysan Albatross chicks. Microscopic plastics can be ingested by detritivores, deposit feeders and filter feeders (Thompson 2004). Some of these fragmented pieces of plastic land on beaches such as Kamilo where they become part of the sediment. Little is known about the effects of plastic to the dynamics of beaches and the organisms that inhabit them.

Project Summary

The proposed study will first answer the question of how much of the sediment at Kamilo Beach is plastic. The amounts of plastic are known to be significantly higher than most Hawaiian beaches and will be compared to our control beach Waikapuna. This study can be replicated in the future to monitor the increase or decrease in sediment plastics at Kamilo. Next the plastics will be sorted using sieves to separate the fragments into different size classes. Using Fourier Transform Infrared (FTIR) Spectrometry, samples of each size class will be analyzed to reveal the composition of the plastic. We will compare the types of plastics within each size class, compare the types of plastics between size classes and draw conclusions based on the data we find.

Few studies have directed their research towards beach sediment plastics. Even fewer studies have focused on beaches in the Hawaiian Islands. The small size of the plastic fragments in comparison with large debris such as fishing nets, bottles and intact bags may be to blame for the lack of their scientific research. Corcoran et al. sampled 18 beaches on the Hawaiian island of Kauai to study the compositions, surface textures and plastics degradation of beach particles between the size of .8mm and 6.5mm. Their results regarding composition showed that of the 18 samples collected, 17 were polyethylene and 1 was polypropylene (Corcoran 2009). McDermid et al. collected debris throughout the Hawaiian islands, sieving for debris between 1 and 15mm. 72% of their debris was plastic with 87% plastic fragments and 11% being pre-production pellets (McDermid 2004).

Thompson et al. analyzed microplastic polymers from beach sediments in the United Kingdom and found 9 distinct polymers. They also sampled pelagic microplastics and concluded that there was no significant difference between the pelagic and sediment microplastics (Thompson 2004).

Currently, research on the effects of plastics on beaches is significantly lacking. Plastics have been shown to be ingested in the water column (Thompson 2004) but little is know about their effects on beach organisms. Toxins associated with plastic debris may be affecting beach organisms. Mato et al. (2001) showed the polypropylene pellets could absorb and transport PCBs, DDE and nonylphenols. Ryan et al. (1988) demonstrated that PCBs, associated with plastic particles, could be absorbed in the gut cavity of great shearwaters. The effects of these toxins and additives on beach sediment organisms remain unstudied (McDermid 2004). Before these topics can be researched, it is imperative to have research on the amount of plastic in beach sediments, the types of plastics comprising those sediments and any correlations on the distribution of types of plastics and grain size.

Objectives

1. Quantify the amount of plastic fragments at Kamilo and Waikapuna by both weight and volume.
2. Evaluate size distribution of plastic fragments.
3. Compare types of plastics comprising each size class
4. Compare types of plastics between each depth class

Methods

Samples will be collected from Kamilo beach as well as Waikapuna beach as a control beach. Sampling will take place over a one to two day period.

1. Sampling. Samples will be collected along a transect of the beach. The transect will be divided into four points. A sample will be taken at each point as well as 1 meter above the point and 1 meter below. This totals to 12 samples collected from each beach. The samples will be taken using two inch diameter sediment cores with a depth of 18 inches.
2. Sorting samples. Each sample will be sorted using sieves, separating the sediment and plastic into different sizes. The plastic will then be visually sorted from the sediment in larger grain sizes or separated using floatation methods. Microplastics, small enough to pass through the smallest grain size, will be separated using a high density salt solution to float the particles which can be collected and filtered.
3. Analyzing the Samples. Plastic pieces of each size class will be randomly sampled for analysis of their plastic footprint. Using a Fourier Transform Infrared (FTIR) Spectrometer, the plastic will absorb and reflect light with different signatures for various plastic types. The machine will detect these

signatures producing a confidence percentage for the composition of the object.

4. Statistical Analysis**.** The percent plastic between the two beaches (Kamilo and Waikapuna) will be compared using a two-sample T-test. This will simply prove if one beach has a significantly higher percent plastic. ANOVA will be used to compare the types of plastics in each size class. To compare types of plastics between each size class, either ANOVA or correlation and regression will be used, depending on the data.

Results

After analyzing data, I will be able to

1. generate a percentage of what portion of the beach is plastic for both Kamilo and Waikapuna using both weight and volume.
2. show the distribution of each size class.
3. produce percentages of types of plastics for each size class. Using these figures, the distribution of types of plastic within each size class can be compared as well as the distribution of types of plastics between size classes.

Timeline

September 17-18: Collection of samples at Waikapuna and Kamilo.
October 15: Sorting of samples completed
November 15: Analysis of samples complete
December 1: Outline of paper and introduction complete
December 15: First draft of paper complete
January 15: Paper finalized

Budget

$200 for supplies for using the Fourier Transform Infrared (FTIR) Spectrometer.

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