Impact of Marine Debris Among Different Coastline Types in Grenada, West Indies

Impacto de los Desechos Marinos entre Diferentes Tipos de Costas en Grenada, las Antillas

Antillas Effects de Débris Marins Entre Différents Type de Côtes en Grenade, Antilles Occidental

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EXTENDED ABSTRACT

Introduction

The accumulation of anthropogenic debris in the world's oceans is a global and growing problem. Every coast is affected by marine debris, whether from deposits on shore from local human population, or from trash washing onto the shore from the ocean. Ocean currents transport garbage around the globe, therefore garbage can end up in areas it did not originate from. Currently, there is little to no data assessing the state of marine debris in Grenada.

Marine debris poses multiple potential risks to marine life. Marine mammals, turtles, crustaceans, seabirds, corals, and fish can become entangled in ghost fishing nets, plastic bags, monofilament fishing line, and plastic six-pack rings which can cause early mortality (NOAA 2014). Ingestion of marine debris has been proven to be the cause of death in multiple marine species because of gut obstruction and malnutrition (Bjorndal, Bolten and Lagueux 1994, Ryan 1989). Understanding the sources of marine pollution in Grenada can hopefully help in mitigating the problem, which in turn will protect the marine organisms living around the island.

To address this issue, we focused collected are three different site types which are commonly found in Grenada:

i) Recreational beaches frequently visited by locals and tourists,
ii) Deposition beaches which are more secluded and difficult to access, and hence, less frequented, and
iii) Underwater sites.

We hypothesized that recreational beaches would have more garbage than the other treatments, and a higher percentage of single use garbage. We sorted collected garbage into over 100 categories based on material composition and purpose from 10 beaches in the south west of Grenada.

Our study was conducted with the intention of bringing awareness to the ongoing problem of littering on beaches. The main objective of our study was to identify the different types of marine debris present on beaches of different levels of anthropogenic activity and to begin to identify sources of the pollution. Our additional objective is to raise awareness to the youth of Grenada on the current problem of marine debris on their island as they are the most impressionable. We anticipate that with this new information, awareness and clean up campaigns can be implemented.

Methods

Our study was conducted on 27 sites (n = 8 recreation; n = 8 deposition; n = 11 underwater) from March 2018 to January 2019. The recreation and deposition beach sites ranged in size from 200 m^2 to 10 000 m^2. [describe underwater sites and sampling methods in one sentence]. We collected data by walking the beach and collecting any anthropogenic debris found. All accessible vegetation was also surveyed and included in the beach sample. To cover the beach in its entirety we walked along the edge nearest the water on the way out and on the vegetation side on the way back. Private property was not surveyed.

When we encountered any inorganic substances they were collected, identified and recorded. We classified items by material and then subcategorised them by function. We used customised data sheets, modified from the Project AWARE data card. Once the sampling was complete we weighted all debris as another quantitative method.

We used generalized linear models (PROC GLMMIX) in SAS 9.4 (SAS Instititue, Inc. 2012) with a negative binomial distribution appropriate for count data to determine whether there were different amounts of garbage among the three different treatments. We compared underwater and deposition sites to recreation sites to determine whether areas with higher recreation would have more debris than deposition and underwater sites.

Results

In total, we collected 17 605 items weighing a combined 670.75 kg. The site with the greatest total of marine items was a recreation site (i.e., Dragon Bay). Overall, we found that plastic was the most abundant material (n = 8 797), while plastic bottle caps were the most abundant single item (n = 713; Table 1). Plastic, cloth, rubber, paper, metal, and mixed material items were significantly more abundant at deposition site when compared to recreation sites ($p < 0.0303$; Figure 1). We also

found significantly more styrofoam at deposition sites when compared to recreation sites (β = 1.6599, SE = 0.6317, p = 0.0148; Figure 1). Further, paper, metal, glass, and mixed material items were significantly less abundant at underwater sites when compared to recreation sites (p < 0.0006; Figure 1).

We found significantly less debris items at underwater sites when compared to recreation sites (β = -0.9812, SE = 0.3514, p = 0.0101), and total weight of garbage collected was significantly less at deposition sites when compared to recreation sites (β = -1.9181, SE = 0.4718, p = 0.0004). The five most commonly found items were metal bottle caps, plastic bags, plastic beverage bottles, cigarette butts, and plastic fishing gear (Table 1). Compared to recreation sites, we found significantly less metal bottle caps (β = -5.4128, SE = 1.2025, p = 0.0001) and plastic bags (β = -1.9804, SE = 0.4383, p = 0.0001) at deposition sites, and less cigarette butts at both deposition and underwater sites (p < 0.0001; Figure 1).

Discussion

We found a significant difference in the material type and total amount found among the three site types in our study. Recreation beaches were more polluted compared to deposition and underwater sites, which is consistent with our hypothesis that the more a site is frequented by a large number of people, the more likely there is to be a greater amount of garbage. Items commonly associated with recreation, such as plastic bags, cigarette butts, and beverage bottles were found more commonly at recreation sites indicating a greater need for education and waste disposal resources on these beaches. Styrofoam items were

Table 1. Top five debris items with the largest count found at the three different sites types, between March 2018 to January 2019, Grenada, W.I.

Item	Deposition	Recreation	Underwater	Total
Metal bottle caps	4	897	99	*1000*
Plastic bags	57	413	396	*866*
Plastic beverage bottles	197	547	233	*713*
Cigarette butts	2	639	4	*645*
Plastic fishing gear	112	151	65	*328*

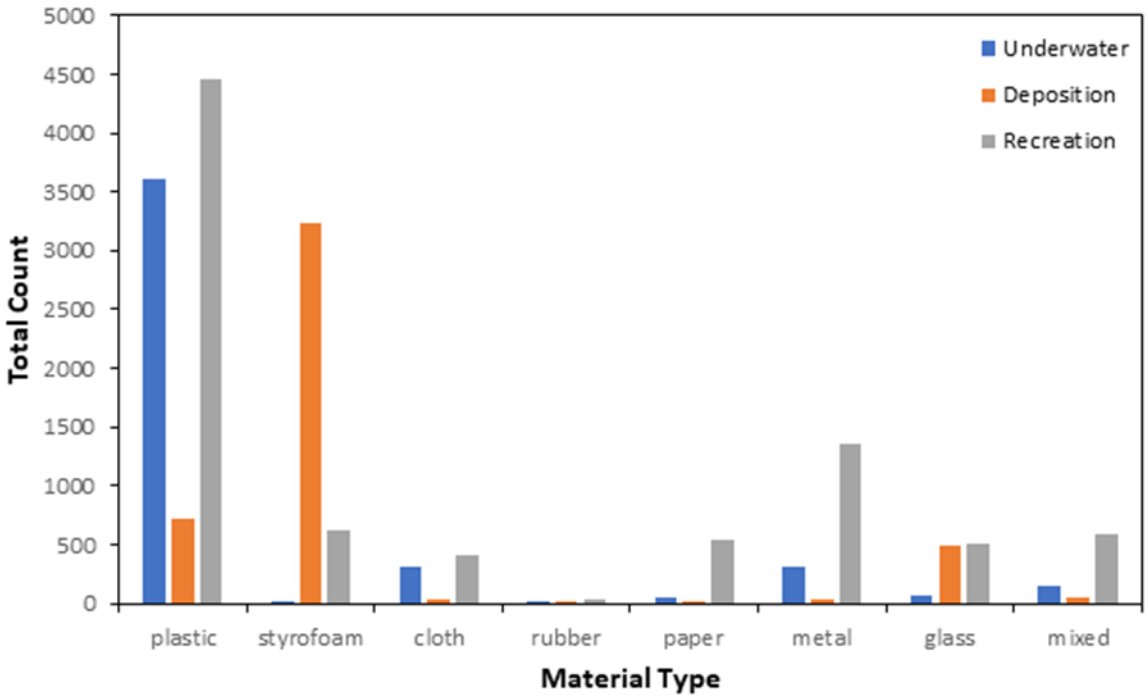

Figure 1. Total count of material type found at underwater, recreation and deposition sites. Sites are classified based on whether the garbage was collected on land or underwater. The land sites were then sub-classified into recreation (sites which are close to human population and frequented by locals and tourists) and deposition (sites which are difficult to access and therefore not used as often).

found significantly more frequently at deposition sites and were often weathered in appearance indicating the items had been deposited from the ocean onto the beach. A ban on unpressed foam floats and buoys would help to reduce the number of styrofoam fragments washing up from items weathered while in the ocean. We also propose that more garbage receptacles be made available for public use, even on the lesser known deposition beaches. We strongly suggest that business establishments such as restaurants and hotels along the sites take responsibility for keeping the areas around them litter-free. A Styrofoam ban has already been implemented in Grenada earlier this year (2019). Grenada is heavily dependent on tourism and marine debris can affect this island negatively, because littered beaches may deter tourism and recreational usage. Although there are fines in place, law enforcement is lacking, and therefore, not as effective as it needs to be to reduce the garbage issue on sites. We are aware that enforcement is difficult and requires time, therefore, we propose directing focus on educating primary school students. If we sensitize the future generation to environmental issues, we can benefit from a less polluted, more sustainable nation. Being responsible about solid waste disposal1 now, will avoid more serious environmental complications. We also propose that more garbage receptacles be made available for public use, even on the lesser known deposition beaches. We strongly suggest that business establishments such as restaurants and hotels along the beaches take responsibility for keeping the areas around them litter-free.

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