Although the Hawaiian Islands are small and remote, their location in the North Pacific Subtropical Gyre results in high amounts of marine debris found on beaches and in surrounding waters. Marine debris travels significant distance from the edges of the Pacific Rim before reaching the coasts of Hawaii. Thankfully, numerous organizations on the Hawaiian Islands bring people together to clean beaches and reefs; however, their mission can only succeed if combined with prevention based on outreach education, laws, and best business practices. Ultimately, fundamental research on the dynamics and impacts of marine debris is necessary to ensure that measures are adequate and efficient.

Sustainable Coastlines Hawaii (SCH) started nearly seven years ago and has been very successful in organizing and utilizing beach cleanups, educational programs, social media messaging and more to inspire better consumer behaviors and continued coastal stewardship. SCH has gathered an impressive data collection since February 2011 that can be used by the scientific community to assess the impact of marine debris in Hawaii. SCH has executed a total of 90 beach clean ups on six different Hawaiian Islands and the Papahanaumokuakea Marine National Monument aka the Northwestern Hawaiian Islands have a total tonnage of marine debris and recycled ~90,000 lbs of marine debris. Since 2017, SCH has also played an important role in terms of citizen science, where volunteers participate in data collection during educational activities. Here, we present the results of two studies on the Island of O’ahu in Hawaii: 1) plastic accumulation at James Campbell National Wildlife Refuge (JCNWR) over a 13-week period and, 2) abundance of plastic pre-production pellets at Kailua beach over a period of 28 weeks.

EXPERIMENTAL DESIGN

For both studies, quadrats were ca. 60 x 60 x 10 cm depth and the content was sifted through a 5 mm mesh. For the plastic accumulation study at JCNWR, pre-determined quadrats were marked and sampled every week at the high, middle and low tide levels between October 24th, 2017 and January 16th, 2018 (Figure 2). All plastic pieces were kept, cleaned, counted, sorted by color and weighed (Figure 3).

The abundance study at Kailua Beach was conducted between April 22nd, 2017 and January 27th, 2018 and only the pre-production plastic pellets were kept, counted and sorted by color (Figure 4).

RESULTS & DISCUSSION

For both studies, all quadrats showed the ubiquitous presence of plastics. The total amount of pieces reported for the plastic accumulation study varied between 94 and 695 pieces (Figure 5), which is equivalent to 43 g to 203 g for the lowest and highest sampling day, respectively. At JCNWR, the plastic pieces sampled at the middle tide level was most of the time in higher numbers compared to the low and high tide levels. The total amount of plastic pre-production pellets varied between 10 and 695 for the 28-week survey period (Figure 7). This repeated occurrence in pellets at Kailua beach located on the eastern side of O’ahu is highly affected by wind events, which brings plastic from the open ocean. This is similar to a study by Karlsson et al., 2018, where they reported millions of pellets released from plastic production sites with drift patterns that tend to follow wind.

The most frequent colors encountered in both studies were white followed by either black or blue and grey (Figure 6). This result suggests that white is a color highly consumed and also frequently discarded. The bleaching and discoloration of plastics can also lead to the whitening of plastic during its aging. In addition, single-used plastic used in the food industry is often white and is a perpetual issue in plastic waste management. Given that high amount of white plastics wash up on the coast we can assume that there are more white pieces in the ocean and that can potentially harm marine wildlife. Indeed, a study investigating the color and size distribution of microplastics in the North Pacific Ocean hypothesized that planktonic organisms will most commonly mistake white and lightly-colored plastic fragments for prey (Shaw and Day, 1994).

The days with the highest number of plastic pieces at JCNWR matched the wind direction and speed that is translated here as onshore wind (positive values; Figure 5). This shows that meteorological conditions highly influenced the occurrence of plastics on the North Eastern beaches of Hawaii. High onshore wind episodes at JCNWR created a higher abundance of plastics due to the transportation of plastic presumably coming from the North Pacific Garbage Patch.

CONCLUSIONS

The overall results from the 41 different surveys at JCNWR and Kailua beach show the presence of plastic across time, indicating a constant input from non-local sources. We also reported similar trends at JCNWR where higher amounts of plastic matched onshore wind events, suggesting an input of plastic coming from the North Pacific Garbage Patch.

Through beach cleanups, plastic accumulation study and plastic abundance surveys, SCH has engaged local and international volunteers to help gather scientific data on marine debris. The two studies were possible due to the help of 110 volunteers from 17 countries helping in collecting the plastic. This shows the power in using citizen data for scientific purposes and the documentation of long-term trends of marine debris accumulation. This valuable information can be utilized to understand the nature of marine debris and plastic and eventually help in informing policies and laws and inspire changes in consumer behaviors.

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REFERENCES


Figure 1: Map and pictures of James Campbell National Wildlife Refuge on the northern Most tip of O’ahu, Hawaii.