Community assessment of plastic on Goode Beach and its wildlife.

Funded by Community Stewardship Grants 2018 - Small — CSGS18556

Frenchman's Bay Association May 2020

Background

Plastic in the marine environment harms wildlife and degrades the amenity of the coastline. High concentrations of plastic debris have been recorded along the south coast of Western Australia [e.g. 53 pieces in an area of 0.25 m^2]. Seabirds ingest plastics. Approximately 25% and 33% of Flesh-footed Shearwaters washed up on the south coast have been found to ingest plastic fragments (Pers Com H. Paterson).

Detailed information is required to understand annual cycles of plastics to improve management strategies for marine coastlines. Community-based surveys have been used to monitor the distribution of microplastics (<1cm) on beaches. Not only are these groups invested in their beaches, but they can also survey large areas producing valuable datasets.

The Project

The Frenchman Bay Association (FBA) and the Albany Campus of the University of Western Australia (UWA) have joined together in a Citizen Science project to monitor annual changes in the abundance and attributes of plastics on Goode Beach. The size and colour of the beach plastic debris can be compared with plastics found in sea birds that are periodically washed up on this beach. In October 2017 an estimated 80 Flesh-footed Shearwaters were washed up on Goode Beach (Pers Com H. Paterson). Almost all of these birds had plastic in their gizzard. The highest number of fragments in one bird was recorded as more than 40 pieces.

The knowledge gained from this project will enable the FBA members to have ongoing stewardship of the beach through targeted management strategies. These activities will contribute to a broader understanding of the negative impacts of this insidious product and subsequently improve the amenity of the area and create a better habitat for the local wildlife.

Workshops complemented the six bi-monthly surveys with activities and presentations aimed at enhancing knowledge of ways to reduce the use and reliance of plastics and limit their negative impacts on the environment.

There were five activity components of the project:

1. Bi-monthly CSIRO transect surveys at three locations [south, middle, north} on Goode Beach.

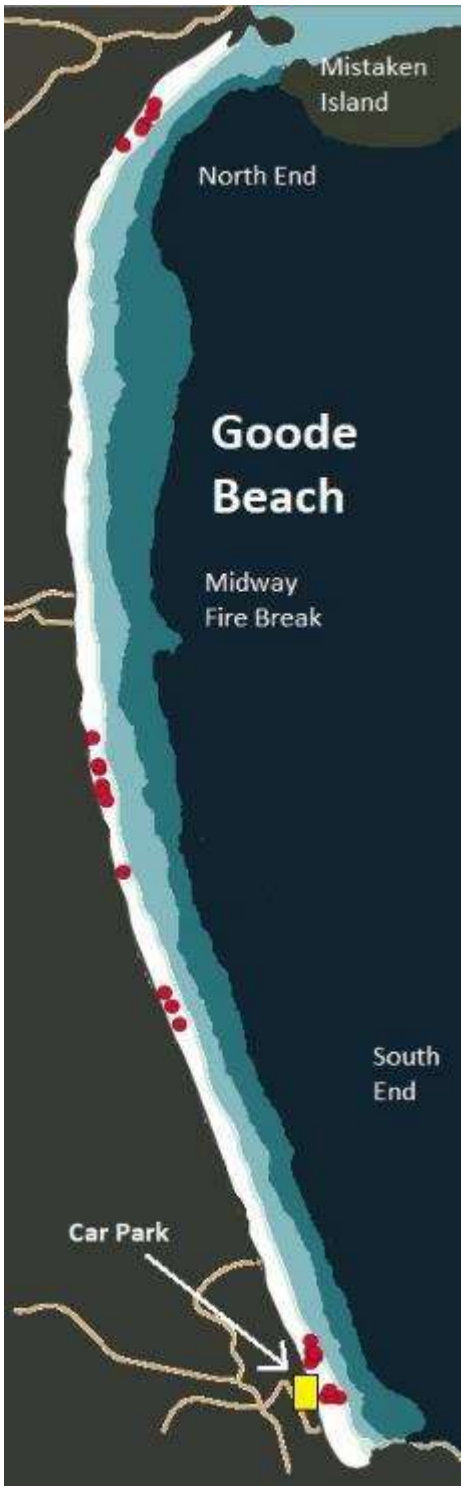
2. Bi-monthly beach clean-up followed by Tangaroa Blue method of debris recording.

3. Bi-monthly lunchtime workshop presentations on topics about plastic debris in marine environments.

4. Daily beach clean-ups between bimonthly events.

5. Bi-monthly laboratory sessions to sort weigh and record further debris collected using Tangaroa Blue Method.

Results



The weekend events were well attended with all jobs more than adequately filled (Table 1). The volunteers gathered in the Goode Beach car park at 10 am for each survey/workshop/beach clean event (Figure 1 Map). After signing in, everyone deposited their daily beach-clean collections into boxes. (Details below). After a short welcome, volunteers dispersed to complete their allocated tasks. One small group drove to the northern end of the beach to undertake the CSIRO transects at that location. Some members of this group would walk back collecting debris for the Tangaroa Blue beach clean. Another group walked to the middle of the beach to conduct the CSIRO Transect. Others commenced walking from the southern end of the beach to collect debris for the Tangaroa Blue exercise. The remaining volunteers did the CSIRO transects at the south end. On completion, all volunteers gathered at the car park at the southern end. Debris collected from the beach was placed on a blue tarp to be sorted and counted for the Tangaroa Blue exercise. Datasheets from the CSIRO transects, and Tangaroa Blue work was collated at a later date. Volunteers then had a small but well-deserved lunch while attending workshop presentations on various topics including types of plastic, global ocean circulation, alternatives to plastic and a presentation from a local indigenous elder.

The locations of all CSIRO transects are indicated in Figure 1 by the red dots.

The daily collections made by volunteers during the periods between each bi-monthly event were placed in designated boxes, one for each week of the collection period. The samples were processed the Wednesday evenings after each bi-monthly beach clean day. The contents of each collection envelope/bag were weighed and recorded against the collector's name. The materials were then sorted by size using a sieve set, then sorted visually by colour and then counted. These data were recorded, analysed and are presented below.

Table 1 Bi-monthly Surveys, Workshops and Laboratories.

Date Workshop Presentations	Survey and Clean-up Attendance Saturday	Sorting and Weighing Labs. Attendance Wednesday
16/03/2019 Seven Types of plastic	30	10
18/05/2019 Ocean Circulation	23	9
20/07/2019 Menang elder, Lynette Knapp 6 University of Bristol Students	21	8
21/09/2019 Alternatives to plastic	13	8
23/11/2019 Alternatives to Plastic	19	7
18/01/2020 Summary of finds to-date	13	1 (The COVID Crowd)

At the beginning of each bi-monthly survey and workshop, empty collection boxes were set out at the Goode Beach car park [Figure 2]. Each Collection Box was labelled with the date indicating the 8 or 9 weeks between surveys. Volunteers placed their bags/envelopes of rubbish collected from the beach into the appropriate box. The individual collections were labelled with the collectors' names, date of collection, part of the beach where the collection was made and the wind direction at the time. By the time the group had assembled at the beach, these boxes were full.

Figure 2 Boxes containing rubbish collected between bi-monthly survey/workshop days.

The day began with a short welcome and volunteers were allocated the following tasks [Figure 3]: three groups to do the CSIRO transects at the south, middle and northern sections of the beach and the others to do a beach clean using the Tangaroa method. A volunteer remained to sort the boxes of individuals' collections from daily beach clean-ups.



Figure 3. A short welcome and the equipment set out for people to collect to complete their task.

On the first occasion that we met, the whole group was introduced to and trained to used CSIRO transects to survey the abundance of plastic debris on a beach. Volunteers were shown how to extend a measuring tape from the shoreline to the edge of the dunes. Then the area along the length of the tape was divided into ten, and any plastic found 1m either side of the tape was collected (Figure 4 and 5).



Figure 4. Learning how to do the CSIRO transect and then putting the method into practice.


Figure 5. Volunteers undertaking the CSIRO transect at the northern end of the beach.

When the volunteers arrived back at the car park, they had either, three small envelopes with plastic from a CSIRO transect or orange bags from Keep Australia Beautiful Campaign with plastic collected for the Tangaroa Blue method. The envelopes were collected, and the orange bags emptied onto a blue tarp and sorted according to Tangaroa Blues data sheets (Figure 6 and 7).

Figure 6. Volunteers sorting the debris and considering the loot.

Figure 7 Major find on the first expedition

There was often discussion as volunteers perused the wide range of plastic objects, bits and pieces recovered from the beach (Figure 8). Amongst the many household items found was clothing, a paintbrush caked in paint, a small jewellery box and a toilet seat. The discussions often moved to how household products used in our daily tasks could be replaced to reduce the amount of plastic in our lives.

During a lunchtime workshop presentation about global ocean circulation, the expectation that our shores are likely to become even more heavily polluted in the next thirty years was put forward for discussion.

Figure 8. Discussing the find before lunch. A Presentation; ‘Why plastic comes to our shores.’

In July, Menang Elder Lynnette Knapp spoke to the local volunteers and a group of Masters students from Bristol (UK) about the cultural significance of the marine environment in the local area and the wider region (Figure 9).

Figure 9. Presentation by Menang Elder, Lynnette Knapp

Alternatives to plastics used in the home were featured at two of the bi-monthly workshops (Figure 10). These included a demonstration on how to make wax wraps and advice on where to find products on the market that could reduce the consumption of plastic products. One example of this was a chewable tablet that is an alternative to toothpaste, which some FBA members had the opportunity to sample. Volunteers exchanged ideas about other products that they use routinely in their homes as alternatives to plastic. After beach clean-ups and before lunch, soap shavings from a small tin were used to wash hands instead of soap from plastic containers.

Figure 10. Making wax wraps as an alternative to plastic wrap.

CSIRO Transects

CSIRO transects were conducted at the ends and middle of the beach. Two transects were conducted in each location (Figure 1). A total of 162 items were collected from the transects. An estimated abundance of 30 items for every 100 m was obtained. Although there appear to be some differences between months and locations, there were no statistically significant differences spatially or at different times (Figure 11)

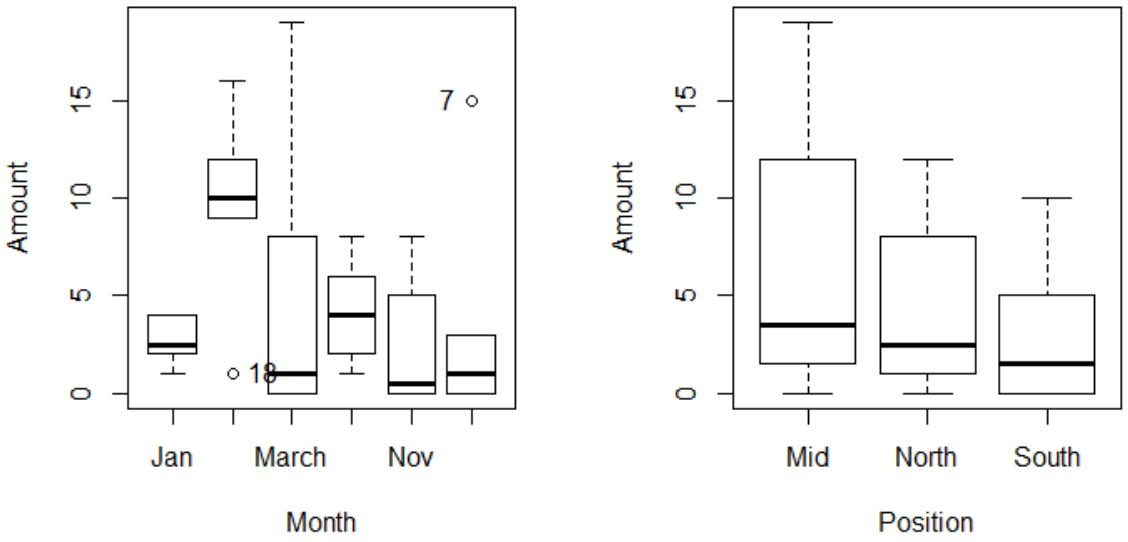


Figure 11 Box plots of debris gathered during the Tangaroa Blue beach cleans and displayed for each month and location on the beach. For each box, the bold black line represents the mean number of plastic items for that month or location. The top and bottom of each box represent the top 25 or bottom 25 % of samples. The error bars represent data points outside the box. There are no significant differences between months or location.

The bi-monthly Tangaroa Blue Collections

Volunteers collected a total of 2573 pieces [including a toilet seat], averaging 14.3 items per 100 m. During this part of the project, a lot of debris, including many large pieces of wood, were removed from the small dunes at the back of the beach. The rope in the photo below was included in the report but was too large to remove (Figure 12). Many small fragments of plastic were found, particularly in July 2019

Figure 12. A large pile of marine rope.

The Tangaroa Blue datasheet captured most debris types found on the beach. The most abundant debris recovered were plastic fragments that are presented in a separate graph (Figure 13).

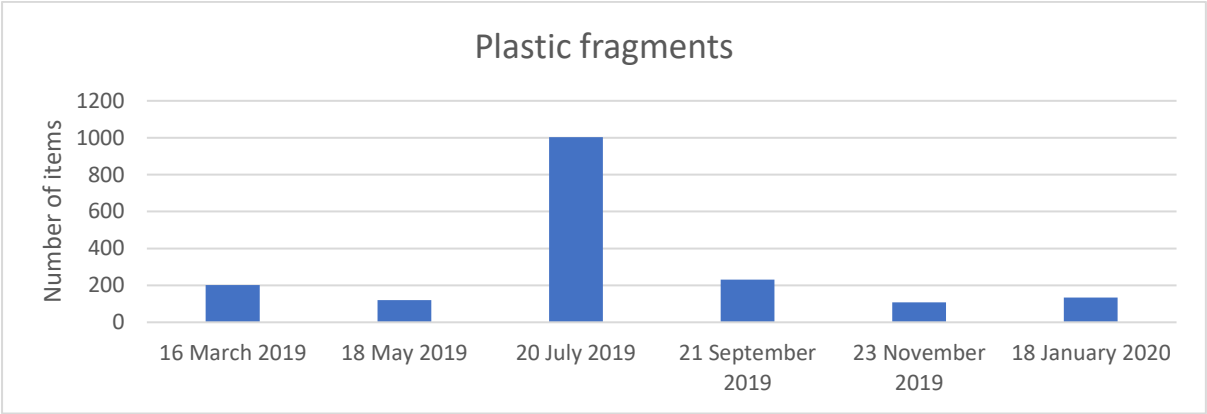


Figure 13. Plastic fragments recovered from Goode Beach, 2019/20.

The third most abundant item was fishing gear (Figure 14). And then a mix of other items including wood and metal.

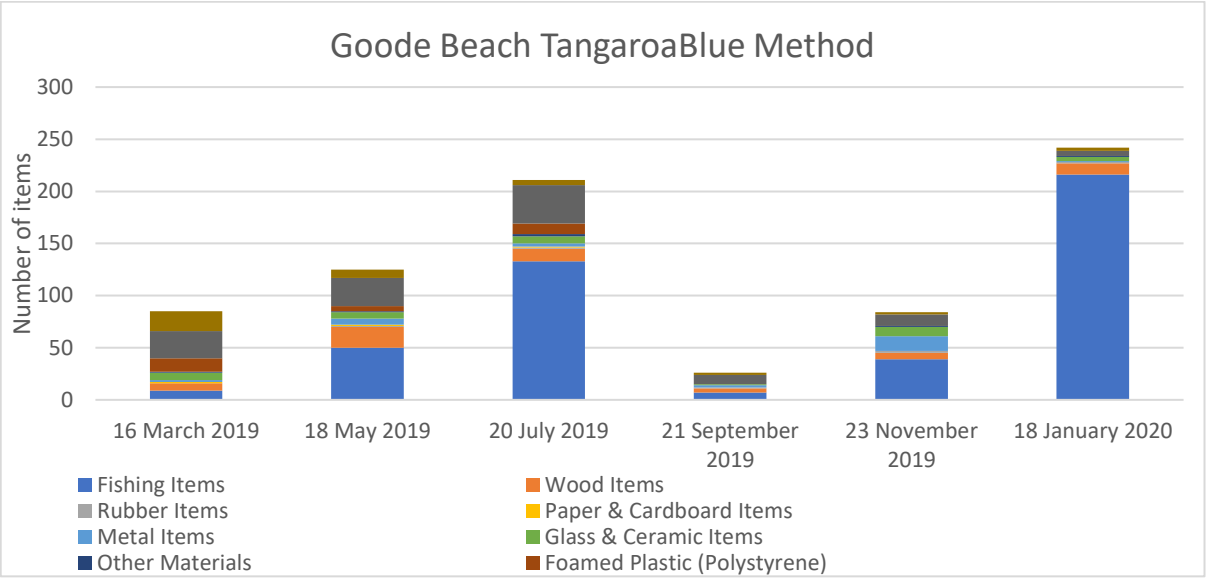


Figure 14 All items collected apart from plastic debris during six Tangaroa Blue style beach cleans in 2019 and early 2020.

The shape of each graph differs depending on the category (Figure 15 and 16). Some of the changes are due to the different seasons. Consumer items, for example, is high in Autumn and decreased during the winter. It is possible that this reflects an accumulation of summer holiday paraphernalia that is measurable at the end of the summer holiday season. It is possible that the holiday season had not been long enough to detect this change in January 2020. There is a large decrease in packing items driven by lids.

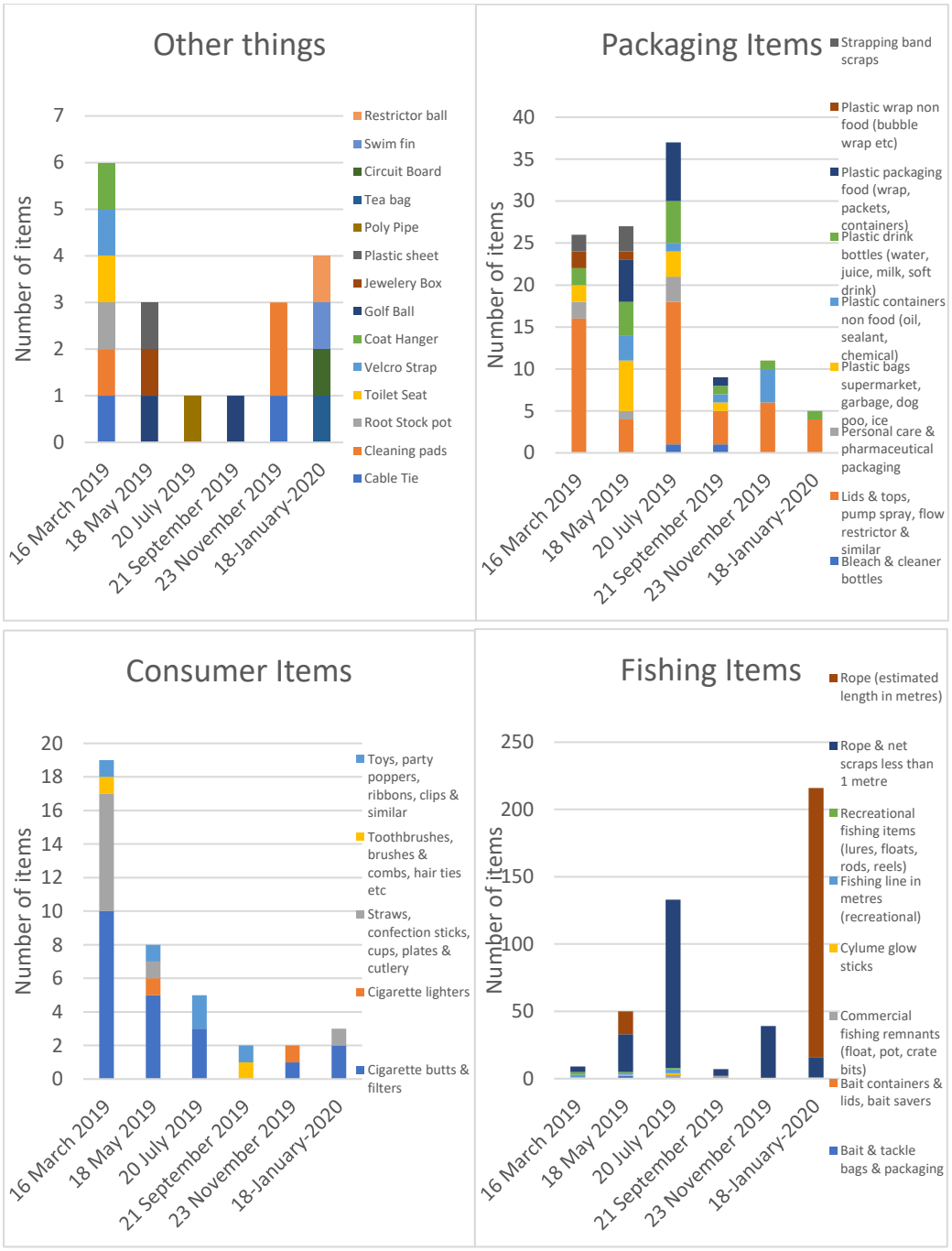


Figure 15 Further breakdown of items for the major categories of beach debris collected as part of a Tangaroa Blue Style beach clean.

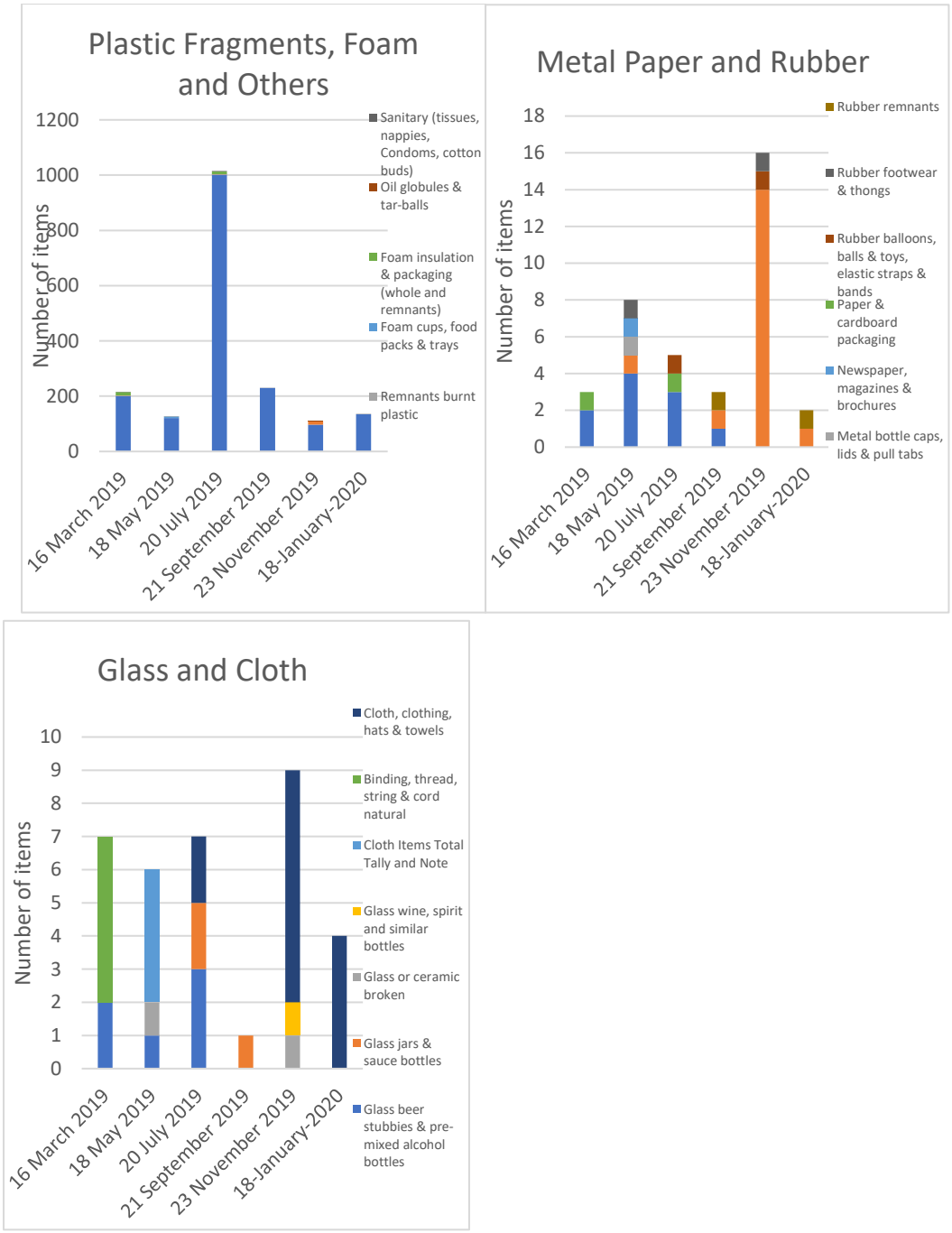


Figure 16 Further breakdown of items for the major categories of beach debris collected as part of a Tangaroa Blue Style beach clean.

Daily Collections

Between the bi-monthly beach clean activities, volunteers collected debris during their recreational walks on the beach (Figure 17). It is known that other community members gathered plastic as part of their regular routines but did not participate in this project, making this an underestimate of the total collected by the community.

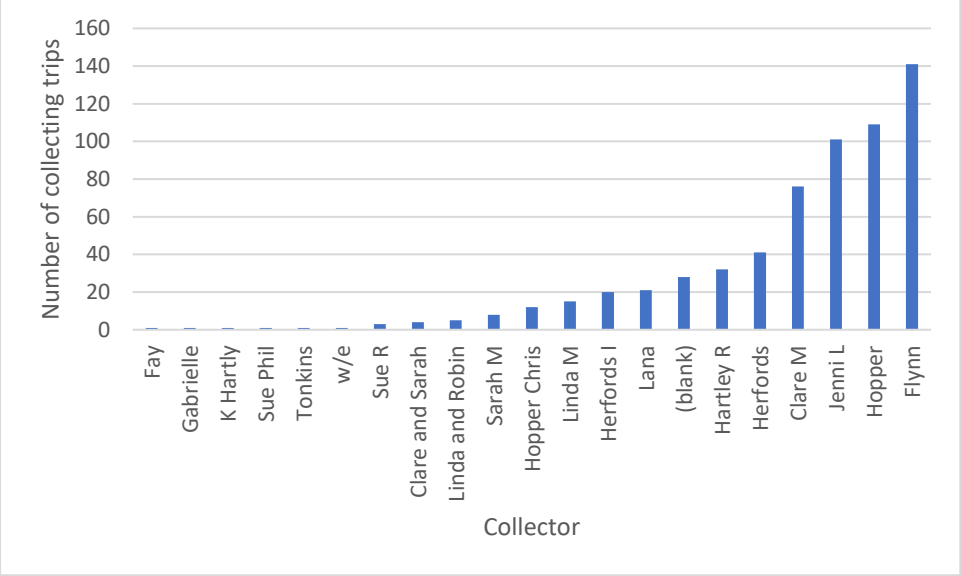


Figure 17. The number of collecting trips per participant.

The total number of trips increased during the first few months as people incorporate collecting debris into their daily routines (Figure 18). The most trips were undertaken during the summer months of January and February, reaching a peak of just over 80 trips per month.

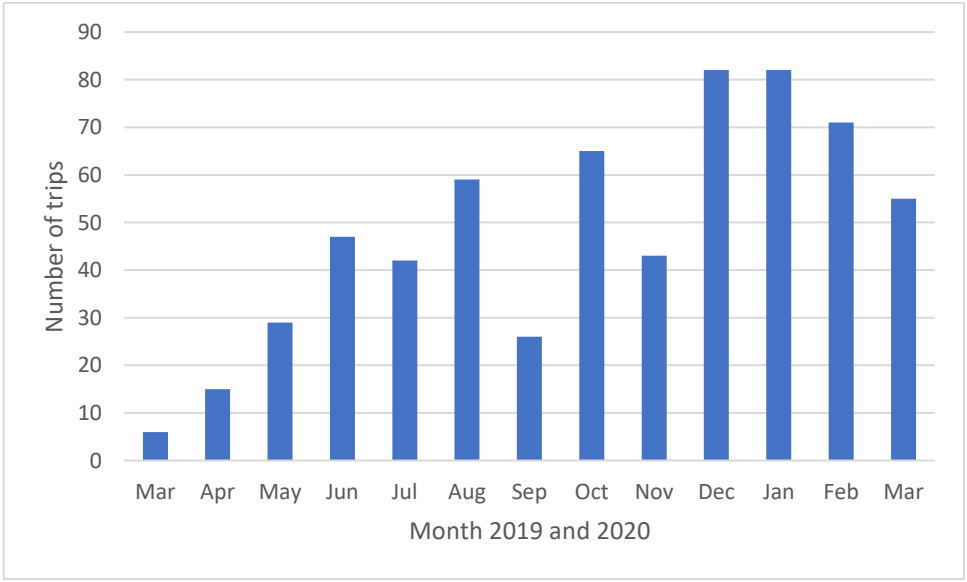


Figure 18 Number of trips per month

The distance travelled by each volunteer differs, so the amount of debris collected is reported here as items per 100 m (Table 2). It is unsurprising that 89% in the variability of the amount of debris collected is explained by the distance travelled. However, some volunteers completed shorter trips but sampled more intensely, or found large individual items yielding some larger samples.

Table 2 Mass and distance travelled by each collector. Total distance covered was 784 km, and 17 kg of debris was collected.

Collector	Total Mass Collected g	Distance km	Mass g per 100 m
(blank)	312.31	21.3	1.47
Clare and Sarah	50.46	1.4	3.50
Clare Mitchell	1188.15	52.0	2.28
Flynn	3508.311	128.7	2.73
Fay	172	1.0	17.20
Gabrielle R	0.94	0.0	
Harley Rob	427.53	15.3	2.80
Herford	1605.22	82.8	1.94
Herford Ian	493.58	37.4	1.32
Hopper	2091.31	137.2	1.52
Hopper Chris	138.62	7.4	1.86
Jenni L	4123.581	245.0	1.68
K Harly	0.94	2.0	0.05
Lana	683.04	9.6	7.12
Linda and Robin	266.13	7.8	3.41
Linda M	455.3	23.4	1.95
Sarah M	155.48	2.4	6.48
Sue Phil	36.6	1.5	2.44
Sue R	1197.28	7.5	15.96
Tonkins	34.26		
w/e	7.2		
		Average	**4.21**

Daily collections of volunteers were analysed on a Wednesday evening following the beach exercise. Two teams weighed the contents of every envelope/bag and then sorted the items by size and colour. The amounts for each category were recorded for analysis. The setup is demonstrated in Figure 19.

Figure 19: L to R Envelopes ordered by date in the collecting box. They were preparing to weigh an individual collection sample and processing the samples by weight, passing them through a sieve stack to sort them by size and the taking each size group and sorting them by colour.

The items were sorted into size groups using s sieve stack (Figure 20). The 6 mm sieve can be seen in the left image of Figure 20. Each item was then sorted by colour.

Figure 20: [Left] Pile of debris between 6 and 12 mm in size. [Right] One size fraction being sorted by colour for counting. Items grouped in piles of ten.

Daily collections continued until the end of March. This was to ensure that we collected for a whole year, but also to recollect in March 2020. The first month of collecting can be considered a training period as volunteers became more aware of the plastic debris. The difference between March 2019 and 2020 (Figure 21) may be in part due to the development of skills over time, in addition to varying amounts of plastic on the beach.

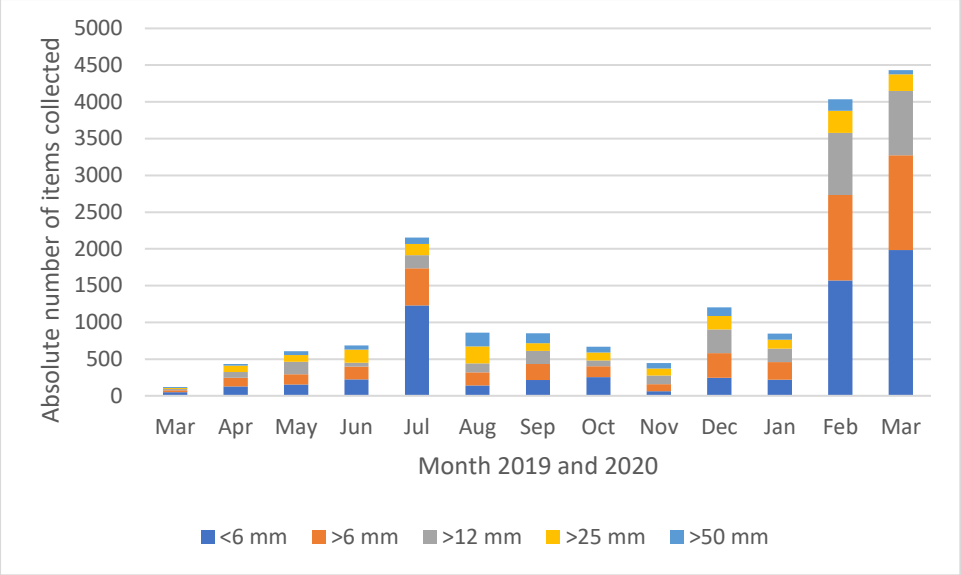


Figure 21: Absolute number of plastic fragments collected over 15-months. Samples dominated by the two fractions smaller than 12 mm.

The absolute number of items varied for each month but is affected by the number of trips as wells as the amount of debris on the beach. It is likely that people's ability to see debris on the beach was influenced by their motives for going to the beach. Someone intending on walking the length of the beach with some constraints on their time is likely to see fewer items than someone who is intensely searching the beach. To account for distance, the amount of plastic has been converted to plastic per 100 m to make the abundances more comparable (Figure 22 and 23).

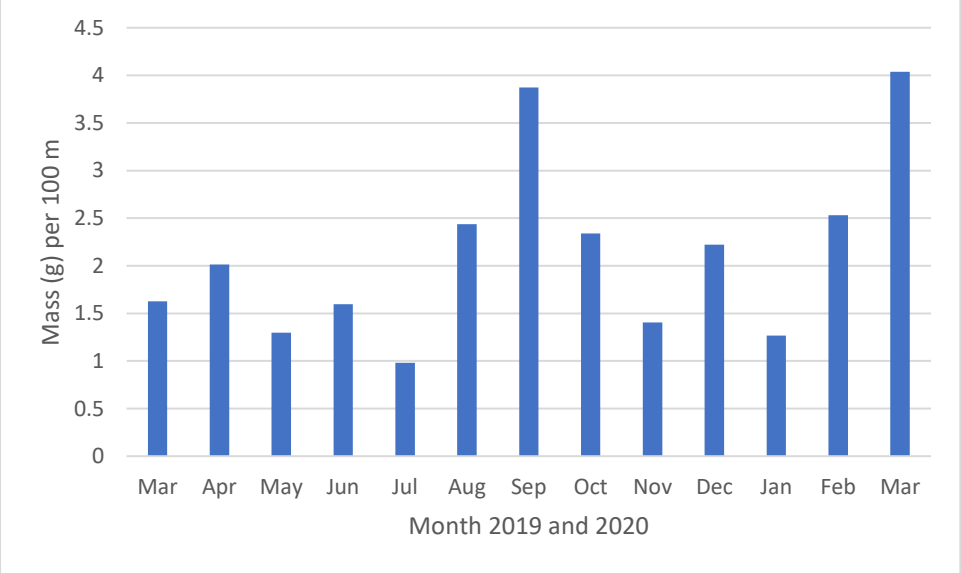


Figure 22 Mass of debris per 100 m of the beach.

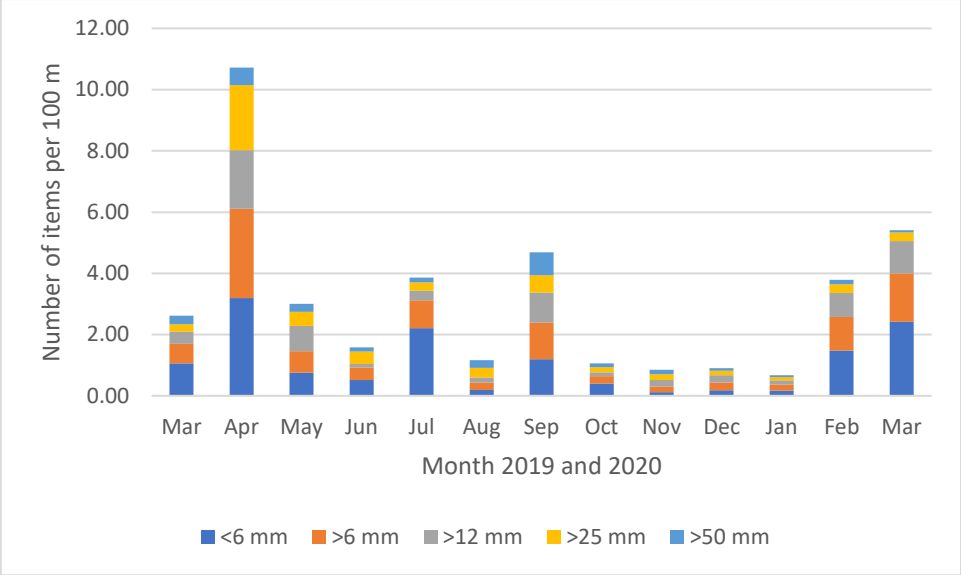


Figure 23: Number of items collected per 100 m of beach each month. The columns are coloured by size.

The size and colour data reveal that blue was the most abundant colour (Figure 24). However, it should be noted that we are more likely to see blue fragments compared to white bits (Lavers et al. 2016). This has been demonstrated in the literature and means we may have underestimated the amount of white of the beach. White fragments of plastic and shell are often confused until they are carefully inspected. The colour profile is very similar to that found in the published literature.

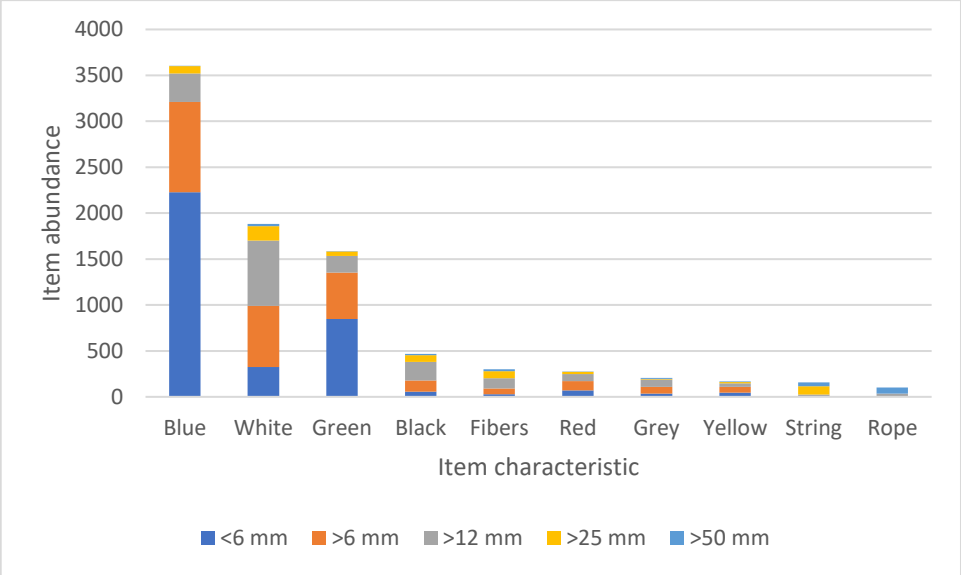


Figure 24 The most abundant items, occurring over 100 times.

Compared to anecdotal data from Mutton Bird Beach, Goode Beach has more wrappers and bottles (Figure 25). This could be because Goode Beach is a more family-friendly beach than Mutton Bird Beach. It may also be the case that Goode Beach is the recipient of debris from family boating activities in King George Sound. This idea is reinforced by the amount of "party" items such as tinsel and balloons.

For the whole period, only nine nurdles were discovered at Goode Beach. These items are challenging to see as they blend into the sand. However, the very low numbers are very different from Mutton Bird Beach, where 1/3rd of the load is comprised of nurdles. Nurdles are most likely to be washed ashore from the open ocean. This suggests that Mutton Bird Beach receives plastic debris from the Southern Ocean and Goode Beach receives "litter" from King George Sound.

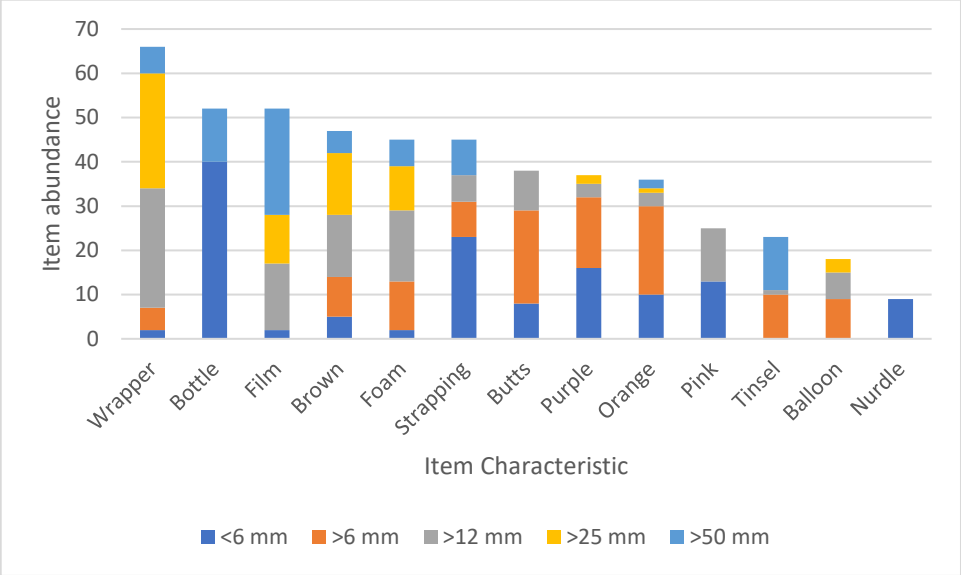


Figure 25: Items occurring between nine and 70 times.

Table 3 Remaining items occurring less than nine times

Lure	Silica Gel	Straw	Foil	Shoelace
Clear	Cyalume Stick	Clothing	Goggles	Tape
Polystyrene	Lid	Cork	Lollipop Stick	Teabag
Band-Aid	Band	Cup	Paint Brush	Tread
Line	Berley cage	Ear Plug	Paper	Velcro
Aluminium	Carton	Elastic Bands	Rubber	

The assortment of items that were found in low numbers represents a wide variety of activities (Table 3). Lures, burley cages and Cyalume sticks represent fishing activities. There are items from packaging, food and drink and a host of other categories.

Discussion

This project seeks to elucidate the annual cycle of plastic abundance and reduce the risk it poses to wildlife on Goode Beach. By developing an understanding of the annual changes in plastic debris on the beach, the local community, through the FBA, will be able to plan future stewardship activities that cause the greatest reduction of plastics. The workshops complemented the surveys and educated the local community towards activities they can undertake to reduce their own use of plastics and limit their impact on the environment.

The FBA and its community have demonstrated that marine debris is an issue on Goode Beach. However, the amount of plastic debris is much smaller than those found elsewhere. The beach is 3 km long, but throughout the project, the volunteers individually walked 784 km and collected 17 kg of waste or 17342 pieces of plastic. A further 2573 pieces were removed during the 6 Tangaroa Blue clean-ups, and 162 pieces were removed using the CSIRO survey method. The project has revealed that there are several significant dates to consider when planning future events. The first is a general clean up at the end of summer to remove items associated with litter from beach users. This will include bottles and wrappers but also other insidious products like balloons. The other significant dates were around the large tidal events associated with the equinoxes in March and September. The findings were that larger numbers of plastic fragments washed ashore in September 2019 and March 2020. These fragments were either washed in by the tides or the tides allowed the fragments to be released from the beach sand where they may have been buried and accumulated and stored over a long period. The positive pressure applied to the plastic due to the density of seawater may have resulted in them floating to the surface of the sand over several tidal cycles. This process should be exploited in years to come by targeting this period for beach clean events on Goode Beach. Concerted efforts to remove plastic from the beach during and after these large tides may yield greater amounts of plastic than at other times.

Plastic debris poses harmful risks to both marine and terrestrial animals. Sea birds, especially Flesh-footed shearwaters, are known to wash up on Goode beach and can be contaminated with plastic pieces. Work by Roman et al. (2019) included an analysis of plastic in Flesh-footed Shearwaters from the region, and they concluded these sea birds consume plastic in the range of 2 – 10 mm. This size class represented 64 % of all plastic found by project volunteers during the year. The continued removal of plastic from beaches will improve the survival rates of the birds.

The community at Goode beach has modified the way they interact with plastic to reduce its consumption in the home. Enhanced knowledge gained from the workshops has been used to change the use of plastic in daily lives. For the six-beach cleaning events, lunch was always delivered in plastic-free containers and detailed conversations were had about the replacement of plastic items with alternatives that could be reused or easily composted. Anecdotally, people are reporting higher use of wax wraps for personal use and giving them away as gifts. The use of Red Cycling also appears to be adopted by the community. The community is interested in removing plastic from the beach, and this activity has become a fundamental part of walking on the beach.

Dr Harriet Paterson was invited to include some of the plastic fragments removed from the beach in a display at the new Museum of Western Australia. About 1 kg of fragments < 12 mm has been provided for a display in their Origin Gallery. The objective of the display is to:

> "Origins explores the relationship between people, space, place and deep time by showcasing the ancient landscapes of Western Australia and the vast skies above. By

> immersing visitors in Western Australian sites and stories, key themes are addressed including, the origin of the solar system, the earliest known life on Earth, the formation of landscapes, the deposit of diverse minerals, and Aboriginal people's deep and enduring connection to Country. The gallery will interrogate these themes from the perspective of complimentary Western scientific and Indigenous knowledge systems to provide a rich understanding of this ancient place."

The plastic items will be part of a timeline of the world. The display starts with presolar stardust grains and finishes with microplastics. Our plastics will be used as a "marker in time" to highlight the short amount of time we have had on the planet and the impact we have had.

The Frenchman's Bay Association has clearly demonstrated its commitment to stewardship of Goode Beach and the surrounding area throughout this project. Their continued involvement is demonstrated by their initiative to become members of the Keep Australia Beautiful Campaign's Adopt-A-Spot program and their enthusiasm to continue to remove rubbish from the beach on daily walks. It is envisaged that the Frenchman's Bay Association will run beach cleaning events in the future as a community-building activity.