WHAT'S IN OUR WATERWAYS? A MICROPLASTIC CITIZEN SCIENCE PROGRAM

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Take 3

Take 3 Ltd is a small, not-for-profit charity established in 2009 on the NSW Central Coast and making a big impact on the issue of plastic marine pollution!

The Take 3 message is simple:
Take 3 pieces of rubbish with you when you leave the beach, waterway or…anywhere and you've made a difference.

Our mission is to significantly reduce global plastic pollution through education and participation. To date we have directly educated over 300,000 students and 200,000 community members, and have a significant social media presence – over 170,000 followers from 129 countries.

Take 3 devolves the responsibility to every person, every day of removing plastic marine pollution and initiates a conversation on reducing our individual plastic footprint. With estimates of 8 to 20 million **new** tonnes of plastic pollution entering our oceans each year (Jambeck et al, 2015) everybody needs to be part of the solution to this global pandemic!

Plastic Marine Pollution

In the ocean, plastic is responsible for the deaths of millions of innocent animals every year. Over 690 marine species are reported to have been impacted by plastic marine pollution, including dolphins, whales, seals, turtles, seabirds and fish (Gall et al, 2015) – few marine animals are immune to this lurking predator. It is estimated over 1 million seabirds and over 100,000 marine mammals/reptiles die each year as a result of eating (ingesting) or becoming caught (entangled) in plastic (UNESCO).

Size Matters!

Plastics can be defined by their size as:
Macroplastic (>25mm)
Mesoplastic (5mm – 25mm)
Microplastic (1 µm* – 5mm)
Nanoplastic (1 nm** – 1µm)
* Micrometer or micron (µm) = 10-6 of a meter (a millionth of a meter).
** Nanometer (nm) = 10−9 of a meter (a billionth of a meter).

The smallest microplastic particle reportedly detected in the oceans at present is 1.6 micrometres in diameter. Zooplankton includes some of the smallest animals in our oceans and are the basis of many oceanic ecosystems – and zooplankton are consuming plastic (Desforges et al, 2015).

In the most well studied of our oceanic gyres, the North Pacific Sub-tropical Gyre, small plastic particles are 40-60 times more abundant than plankton. The smaller the plastic particle, the more available it becomes for consumption by a greater number and variety of marine wildlife, either directly or indirectly – bioaccumulation through the food chain (Carberry et al, 2018).

Microplastics

Microplastics come from a variety of sources, including plastic breakup, clothing, and industrial processes. Two classifications of microplastics currently exist:

1. Primary microplastics are plastic particles purposefully manufactured to be tiny, sometimes microscopic, used in: facial cleansers and cosmetics ('micro-beads'); air blasting technology (to remove rust and paint); in medicine (as vectors for drugs); or in plastic manufacture ('nurdles' or resin pellets as the raw material of plastic).

2. Secondary microplastics are plastic fragments derived from the breaking up of larger plastic. Sources are varied and can include cigarette filters, hard plastic fragments, synthetic fibres/textiles (one load of laundry can contain more than 1,900 plastic microfibers) and waste treatment.

High levels of microplastics have been detected in the environment. According to a recent international report, in many developed countries microplastics are more abundant than the more visible larger pieces of marine litter (Browne, 2011). This will increasingly become the trend in all countries as microplastics are the fate of all larger plastic items (just as nanoplastics are the subsequent fate of microplastics). The entire cycle and movement of microplastics in the environment is not yet known, but research is currently underway to investigate this issue. This is where citizen science comes in!

Citizen Science

While there are strategies and policies in place to reduce the impact of plastic pollution and to improve sustainable practices – including the development of a circular economy and biodegradable plastics – the fact is there is a continuing need to monitor plastics in the environment.

So, we are asking everyone to become citizen scientists! Citizen scientists are members of the general public who collect and analyse data relating to the natural world, typically as part of a collaborative project with professional scientists to help inform management and decision-making.

Four common features of citizen science are:
1. Anyone can participate,
2. Participants use the same protocol/methods so data can be combined and be of high quality,
3. Data can help scientists come to real conclusions, and;
4. A wide community of scientists and volunteers work together and share data to which the public, as well as scientists, have access.

The benefits of citizen science are that data can be collected more broadly – areas can be sampled more often (temporal) and in more areas (spatial) than would normally be possible by scientists alone. The resources normally required for similar large data collection efforts by trained scientists are usually prohibitive.

What's in Our Coastal Waterways/Lagoons?

Coastal waterways are an integral part of the ecology, livelihood and the social/cultural fabric of Sydney and the Central Coast. Coastal lagoons, in particular, are fragile ecosystems and home to a wide variety of plants and animals, specially adapted to a specific mix of freshwater and saltwater conditions.

These coastal lagoons were historically important cultural sites for Aboriginal people, offering seasonal shelter, fish and wetland resources to the Gai-mariagal (Camaraigal) of Sydney and the Darkinjung of the Central Coast. They remain a popular recreational location for coastal dwellers like ourselves!

Microplastics are one modern and insidious threat to these lagoon systems as this pollutant, which is transported through urban waterways, can harm wildlife and impact upon aquatic habitats. Little is currently known about microplastic loads throughout the region and there is a general lack of community awareness/ education on this issue. The first steps in identifying the potential risks of microplastics are to determine how much is out there and where it may be accumulating. Therefore, Take 3 and Macquarie University's Litter Lab are piloting a microplastics assessment programme using citizen scientists to assist in addressing this issue.

This programme is being piloted in the Northern Beaches and Central Coast Local Government Areas, where there are numerous coastal lagoons that are potentially natural sinks for microplastics. Surface sediment will be sampled in selected lagoons with microplastic survey kits to enable sampling for, and analysis of, microplastics. The type, size, colour and amount of microplastic will be quantified. The data gathered via this project will give scientists, government and the community an indication of what is entering our unique coastal lagoon systems.

Methodology

Part 1 – Site Description

Site details to record include:
a. General information
b. Site characteristics
c. Weather
d. Other factors – e.g. recently cleaned, number of bins, pathways/entranceways, etc.
e. Sketch and take site photographs from key points.

Part 2 – Marine Debris Survey

Easy as 1,2,3:
1. Surveys are conducted using a belt transect, laid parallel to the shore and centered on the major strandline. The length and the width of the transect depends on the type and length of the shoreline.

2. Using the Tangaroa Blue marine debris data sheet to record data.

3. Walk up and back along the transect slowly in emu file and collect and record all human generated debris on the beach surface within the transect.

Part 3 – Microplastic Sampling

Digging deeper:
1. Surveys are conducted by placing a 0.5 x 0.5 m quadrat on an obvious strandline (hightide) area outside of marine debris transect, avoiding highly disturbed areas.

2. Then excavate the top 2cm of sediment from the quadrat and sieve through a 5mm and 1mm sieve

3. The 5mm sieve will collect only macro-litter (>5mm) so this should be recorded under the 'other observations' column on the Microplastics Data Sheet.

4. Contents of the 1mm sieve are then transfered to a tray and search for plastics. If item is unknown or difficult to identify as plastic then float in seawater or a hypersaline solution.

5. Resuls are recorded on the Microplastics Data sheet noting:
– colour,
– approximate size class (1 mm ranges),
– type (foam plastic fragment, hard plastic fragment, bead, pellet, fibre, sheet plastic fragment) and
– number of particles.

Part 4 – Recording Results

The macroplastic and microplastic data is housed by Take 3 and is submitted to both the Tangaroa Blue and AUSMAP databases.

Part 5 – Data Analysis & Further Work

A per m^2 value for marine debris and a per cm^3 for the microplastics can be obtained by calculating the total numbers by either the total area or volume sampled.

Results

As this is a pilot programme and is still in process the data pool, by definition, is very limited. However comparative early data indicated that lagoons on Sydney's Northern Beaches had larger microplastic loadings in their samples than lagoons on the Central Coast. Foam and hard plastics were the dominant microplastic types at Dee Why and Curl Curl Lagoons, while fibres were the most common at Manly Lagoon. Industrial pellets also made up around 20% of the microplastics at the two former sites. In the marine debris loads, foam was also prevalent with 46% and 73% at Dee Why and Curl Curl Lagoons, respectively.

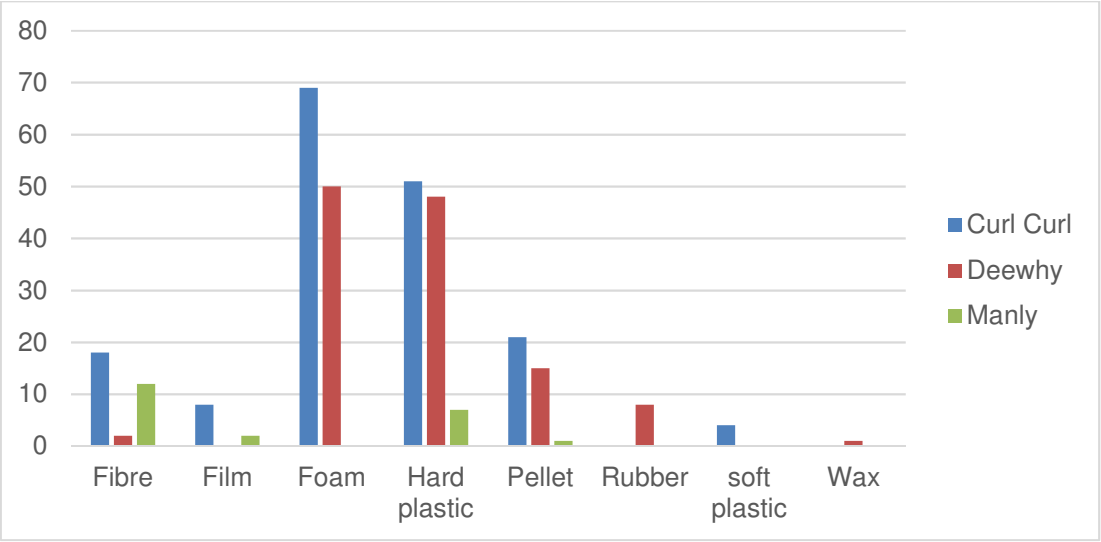

Table 1. Preliminary microplastic results from several Northern Beaches Lagoons.

Both the macro and micro results suggests that foam packaging is an issue in the Northern Beaches lagoon catchments. Recommendations for alternatively packaging is encouraged. The elevated industrial pellets loads also suggests greater management is required to reduce off-site loss with the light industry within these catchments. The proportionally high fibre content at Manly Lagoon, likely linked to recreational activities, implies a need for greater education and awareness of the microplastic issues in the area.

There are many confounding factors with regards to these results. For example, some samples were sorted by eye in the field whereas other samples were sorted in the lab with the aid of microscopes, thus offering potentially greater resolution. Some samples were sorted with assistance from Take 3 and Macquarie University Litter Lab staff, others were sorted without assistance. The number and dispersion of quadrats was also dependent on the number of students involved in the sampling at each lagoon.

Schools

Eight official Take 3/Macquarie University Microplastic School were registered to be involved with this programme – 4 schools from the Central Coast and 4 schools from the Northern Beaches.

Seven additional schools were involved in the Project courtesy of additional funding received form the Central Coast and Northern Beaches Councils.

Specific survey feedback from teachers indicated:

- *Which stage group and curricula did you link the Take 3/Macquarie University Microplastic Program?*
  Stage 4 - Elective Environmental Sustainability; Stage 4 & 5 STEM/Science; Year 6-12 students from the lunchtime conservation group.
- *Was the Take 3/Macquarie University Microplastic Program easy to implement into your programming?*
  Take 3/Macquarie University Microplastics Programme was identified as being very-highly easily implemented into school's programming.

- *Please identify any challenges/benefits of the Take 3/Macquarie University Microplastic Program?*
  Challenges: having too large a group of kids and everyone not being able to 'participate' enough; selecting a suitable date for students of diverse ages to attend!
  Benefits: really hands on, great being outdoors, fantastic to actually see 'microplastics' in real life on our shores rather than just being talked about on a movie or in the classroom; scientific method is great for high school to follow and be strict with; high level of student engagement in a project with huge significance and impacts on the environment and human health;
  students get to do something helpful in the local community and are made aware of the environmental impact of humans even on the almost hidden level.
- *How do you rate student engagement in the Take 3/Macquarie University Microplastic Program?*
  On average, students were identified as being highly engaged (8/10 on a linear scale of engagement).
- *Have you any suggestions to improve delivery of the Take 3/Macquarie University Microplastic program?*
  Easy with a small group, but with larger groups of kids it would be tricky for each child to 'participate' (this leads to distracted, bored behaviours), especially with limited microscopes, tweezers or tubs to search for the microplastics;
  the manual looks fantastic will be a great help and resource to use with students; be great for the kids if there was a way for them to see how/where their results are being used (specifically, not just on the data base e.g. policy making, tertiary studies, local/state council decision making etc); good to link with the Narrabeen Coastal Environment Centre.

Community

To date we have had interest from a number of community groups but as yet no uptake. However to qualify, our focus has been predominantly on high school engagement and determining where the programme fits best within the new curriculum.

AUSMAP

AUSMAP is a new national citizen science program building on this pilot work of Take 3 and Macquarie University: 'What's in Our Waterways? Microplastic Citizen Science Project'. The Take 3/Macquarie University Microplastic Programme will actively feed data into ASMAP in order to extend the reach of the AUSMAP program.

Outcomes

So, 'What's in Our Waterways?' We can confirm that there is indeed microplastics in our waterways and in some waterways there is a lot of it!

The Take 3/Macquarie University Microplastic Programme is ongoing and will continue to collect baseline microplastic data from our waterways and improve delivery/outcomes based on actively sought feedback from those involved.

Key Learnings

Essential key learnings from the pilot work so far include:

- Important to process samples ASAP. Enthusiasm to sort samples from both a teachers and student perspective wanes post fieldwork so it is preferable for the samples to be processed on the day of collection.
- Small group are preferable to large groups in terms of student engagement.
- Difficult to get the results returned post event.
- A low or no result is still a result; in fact it is a better result.

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