AUSMAP

AUSTRALIAN MICROPLASTIC ASSESSMENT PROJECT

Australian Microplastic Assessment Project

Review of Microplastics across GBR Catchments - 2021

Contents

ReefClean is funded by the Australian Government's Reef Trust.

WE ACKNOWLEDGE THE TRADITIONAL CUSTODIANS OF THE LAND AND WATERWAYS ON WHICH WE LIVE, WORK, AND LEARN.

Microplastic Identification in GBR Catchments

The ReefClean project is designed to implement a cost-effective program of targeted and integrated marine debris activities to:

- reduce the volume of debris generated in or entering the Great Barrier Reef (*GBR*) that may impact listed threatened and migratory species, such as dugongs and turtles, as well as vital ecosystems of the GBR, and;
- increase awareness in Reef catchment communities about the issue of marine debris and actions they can undertake to prevent litter from entering Reef waterways.

Microplastic surveys formed part of community clean-up activities at coastal sites around the GBR, to improve awareness of the impacts of microplastics on the environment and contribute to mapping the extent of microplastic accumulation around waterways and beaches.

The AUSMAP sampling methodology was used to collect rigorous and scientifically reliable data on microplastic particles (*1-5 mm*). This method, developed by Dr Scott Wilson, AUSMAP Research Director in conjunction with partners from University of Newcastle and University of Tasmania in early 2018, involves replicate sediment sampling along shorelines and sieving for microplastics by the community across the GBR catchments. Samples collected are then verified by the AUSMAP Scientific Officer.

2021 Microplastic Overview

The relative easing of COVID-19 restrictions enabled AUSMAP and Tangaroa Blue Foundation to expand microplastic sampling as part of the ReefClean program in 2021, with 39 individual samples conducted across 23 sites across the GBR region (Fig. 1). Microplastics (1-5mm size class) or Microlitter is reported as an amount per metre squared (m^2) as the standard metric. Data on typology (*resin pellets, hard plastic fragments, foam, fibre, film or rubber*), colour and size are also determined. These metrics enable a comparison between locations and at sites over time to document changes and effectiveness of any management strategies. AUSMAP rates sites based on identified microplastic loads (*particles per* m^2), which are then translated into colour-coded points on a map that represent specific load ranges. The AUSMAP microplastic load colour key is as follows:

Green	Very Low	<10
Yellow	Low	11-50
Orange	Moderate	51-250
Red	High	251-1,000
Black	Very High	1,000-10,000
Purple	Extreme	>10,000

The number of items per metre squared can be applied to determine if the site is considered a pollution hotspot. Levels above 250 items per m^2 are considered a 'microplastic hotspot', although moderate levels may also warrant further investigation on a '*Watch and Act*' premise. That is, continue to monitor the sites and if levels increase, hotspot grading may be prematurely applied within areas of significance based on the precautionary principle.

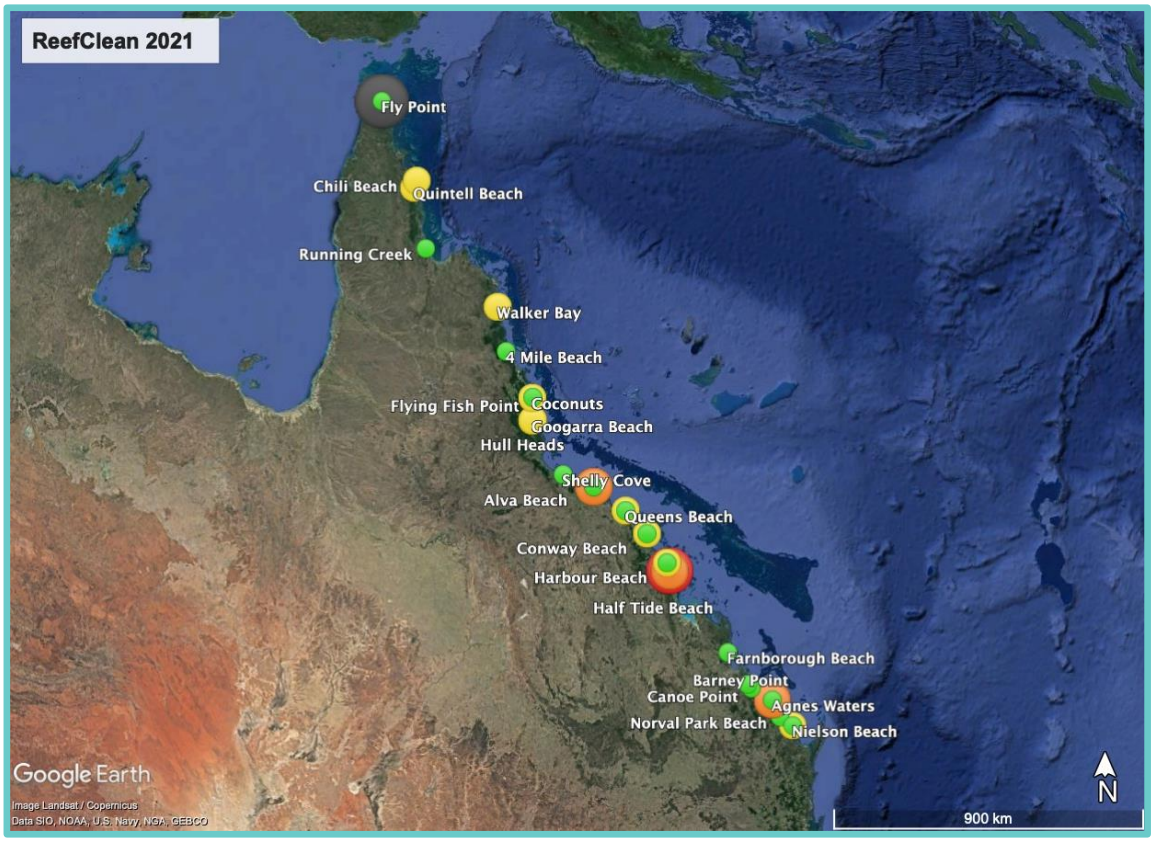

Figure 1. *ReefClean 2021 sample locations and microplastic loads*
*(**Green** = Very Low; **Yellow** = Low; **Orange** = Moderate; **Red** = High; **Black** = Very High; **Purple** = Extreme)*

ReefClean samples in 2021 exhibited considerable variation between sites, from **Very Low** to **Very High** microplastic loads observed ranging from 0 to 1191 particles/m^2 (Tab. 1). The 2021 study has identified a new record-high load of microplastics with **1191 particles per/m^2** found in September at **Fly Point** in the **Cape York** region. This marks the first occasion that any ReefClean study site has reached the threshold denoting **Very High** microplastic loads *(1,000-10,000 particles per m^2)*, drastically exceeding the previous recorded high found at Alma Bay in 2020 *(209 particles per m^2)* (Tab. 2).

This new record-high value represents the greatest microplastic load recorded anywhere in Queensland – however, more robust sampling of remote locations and the more populous SE corner in future will be necessary to confirm this. For some perspective on the scale of these **Very High** microplastic load observations at Fly Point, some of the largest cities in Australia outside the boundaries of the Great Barrier Reef have also recorded microplastic loads in excess of 700,000 particles per m^2 recorded in a wetland in Adelaide, South Australia.

Table 1. *Summary of ReefClean microplastic sampling activities in 2021.*
(Green = Very Low; Yellow = Low; Orange = Moderate; Red = High; Black = Very High; Purple = Extreme).

Sampling Region	Site and Microplastic Level (particles/m²)		Sampling Region	Site and Microplastic Level (particles/m²)	
Cape York	Fly Point (Mar)	7	Mackay Whitsunday	Conway Beach (Mar)	1
	Fly Point (Sept)	1191		Conway Beach (Sept)	2
	Quintell Beach (Mar)	12		Conway Beach (Dec)	14
	Quintell Beach (Sept)	17		Harbour Beach (Mar)	1
	Walker Bay (Nov)	34		Harbour Beach (Sept)	11
	Chili Beach (Aug)	26		Half Tide Beach (Mar)	140
	Running Creek (Jun)	3		Half Tide Beach (Sept)	311
Wet Tropics	Four Mile Beach (Mar)	3	Fitzroy	Farnborough Beach Yeppoon (Sept)	5
	Four Mile Beach (Sept)	5		Barney Point (Mar)	1
	Flying Fish Point (Sept)	5		Barney Point (Sept)	4
	Googarra Beach (Mar)	15		Canoe Point - Tannum Sands (Mar)	0
	Googarra Beach (Sept)	0		Canoe Point – Tannum Sands (Sept)	2
	Coconuts (Sept)	32			
	Hull Heads (Sept)	0			
Burdekin	Shelly Cove (Mar)	1	Burnett Mary	Agnes Water (Mar)	6
	Shelly Cove (Sept)	0		Agnes Water (Sept)	68
	Alva Beach (Mar)	111		Norval Park Beach (Mar)	3
	Alva Beach (Sept)	4		Norval Park Beach (Sept)	5
	Queens Beach (Mar)	14		Nielson Beach (Mar)	8
	Queens Beach (Sept)	4		Nielson Beach (Sept)	11
	Bowen Water Park Beach (Sept)	3			

Table 2. *Summary of previous ReefClean microplastic sampling activities from 2019 and 2020. (Green = Very Low; Yellow = Low; Orange = Moderate; Red = High; Black = Very High; Purple = Extreme).*

Sampling Region	Site and Microplastic Level (2019) (items/m²)		Site and Microplastic Level (2020) (items/m²)	
Cape York	Quintell Beach	0	Quintell Beach	1
	Friday Island	5	Fly Point	44
	Goods Island	21		
	Thursday Island	4		
	Rocky Islet Reef	0		
	North Shore Cooktown	23		
	Walker Bay	7		
Wet Tropics	Michaelmas Cay	0	Four Mile Beach (Feb)	0
	Holloways Beach	8	Four Mile Beach (Sept)	1
	Cairns Esplanade	0	Hinchinbrook Island	1
	Kurrimine Beach	0	Lucinda (Feb)	81
			Lucinda (Sept)	7
Burdekin	Cape Pallarenda	11	Cape Pallarenda	0
	Orpheus Island	20	Geoffrey Bay	0
	Alma Bay	27	Alma Bay	209
			Nelly Bay	5
			Alva Beach	0
			Queens Beach	0
Mackay Whitsunday	Cannonvale	7	Conway Beach	3
			Harbour Beach	8
			Half Tide Beach	1
Fitzroy	Tannum Sands	16	Yeppoon	23
			Tannum Sands	0
Burnett Mary	Agnes Water	2	Agnes Water	0
	Miara	0	Yandaran	0
	Bargara	1	Bargara	0

As a consequence of the higher microplastic loads found within Fly Point, the **Cape York** region has been identified as exhibiting the **greatest average microplastic load** in 2021 (*184 particles per m²*) (Fig. 2). Excluding this notable sample, Cape York would have an average microplastic load of 16.5 particles per m² – more in line with previous years averages (see individual region analysis below for further details).

The Mackay Whitsunday region also experienced a higher average microplastic load (*68.6 particles per m²*), shadowing region averages of prior years. In contrast to this, the **Fitzroy** region had the **lowest average microplastic load** in 2021 (*2.4 particles per m²*), with an observable downward trend from 2020 and 2019 readings. These trends however, are influenced by changes at one site rather than broad regional changes.

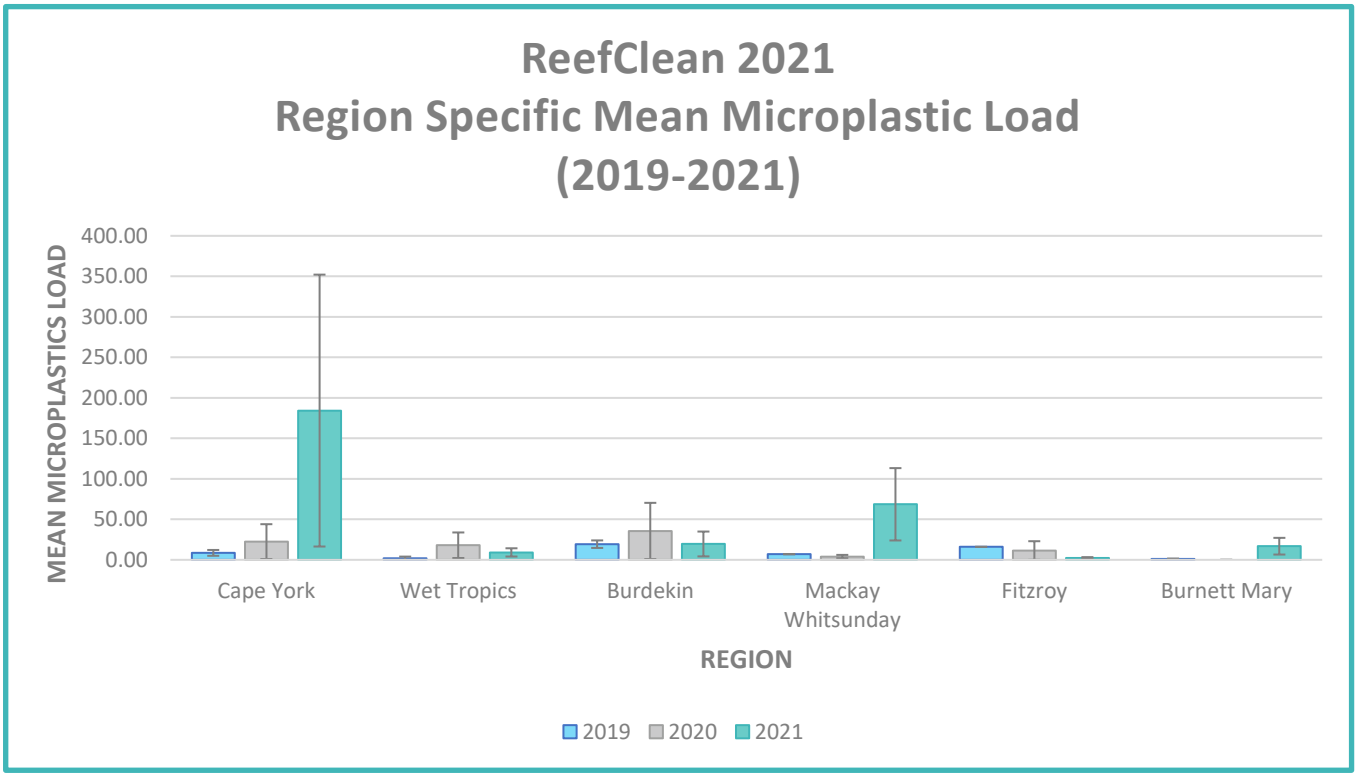

Figure 2. *Mean ReefClean microplastic loads per region (2019-2021)*

Region 1 – Cape York

The Cape York region was sampled seven times across five locations during 2021 – more than doubling the sampling efforts from 2020 (Fig. 3). As previously stated in the 2021 Microplastic Overview, Fly Point in September exhibited the greatest microplastic loads of any region in ReefClean history (1191 particles per m^2).

This is the first ever account for the GBR of exceeding the threshold of **Very High** microplastic loads – a very concerning discovery. Interestingly, the March sample of Fly Point was observed to have **Very Low** microplastic loads (Tab. 1). This sample is more in line with data collected previously from this and other sites in the region. The very high microplastic loads from Fly Point in September are likely related to seasonal weather patterns. At this time of the year the winds blow predominantly from the southeast and as the site has a southeast aspect, it is likely that these factors lead to marine debris accumulating along this shore.

The remaining Cape York study sites (*Chili Beach, Quintell Beach, Running Creek, and Walker Bay*) were found to have **Very Low** to **Low** loads of microplastics ranging from 3 to 34 particles per m^2. Despite the low microplastic load observations from these sites, the Cape York region has on average more than eight times more microplastics per m^2 when compared to 2020 due to the colossal amounts found at Fly Point in September.

Figure 3. *Cape York sample locations and microplastic loads (2021).*
*(**Green** = Very Low; **Yellow** = Low; **Black** = Very High).*

With Fly Point in September 2021 having the most significant loads from all sites in this report, the Cape York analysis will focus primarily on this study site. The sample was dominated by hard fragments, constituting 91% of all microplastics found (Fig. 4). These plastics were mostly clear and white in colour (Fig. 5). Fly Point microplastic exhibited a decreasing trend with size, with particles >5mm (longest dimension) being the most prominent at 29% (Fig. 6).

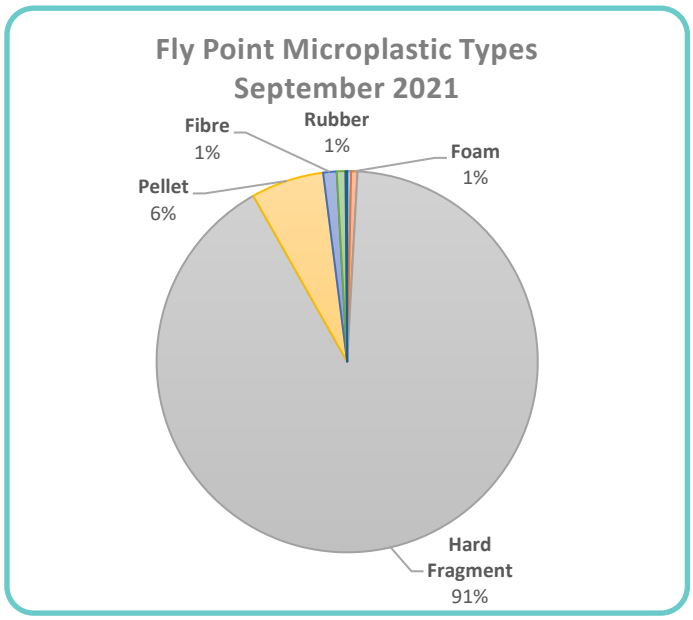

Figure 4. *Microplastic types at Fly Point (Sept. 2021)*

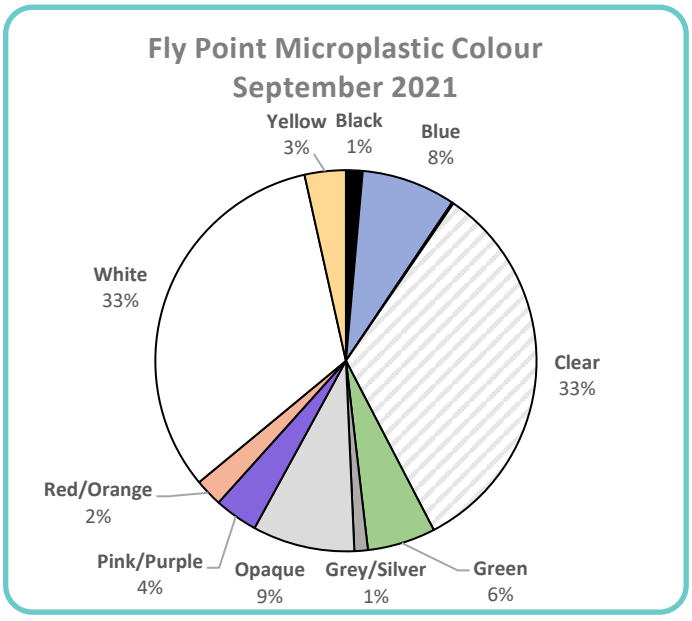

Figure 5. *Microplastic colour at Fly Point (Sept. 2021)*

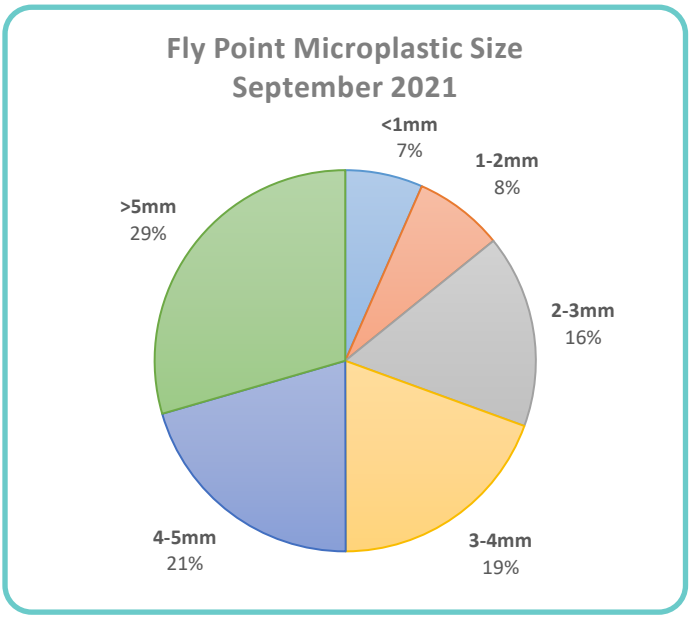

Figure 6. *Microplastic size at Fly Point (Sept. 2021)*

Region 2 – Wet Tropics

The Wet Tropics region was sampled seven times from five distinct locations in 2021 (Fig. 7). Of these sites, two were found to contain Low loads of microplastic debris, with the remaining sites housing **Very Low** loads of microplastics. The majority of these sites were new to ReefClean in 2021, apart from *Four Mile Beach* which was also sampled in 2020.

The greatest loads of microplastic debris were found at *Coconuts Beach* in September, with **32 particles per m²**. This finding is notably lower than the highest loads in the region found at Lucinda in 2020 (*81 particles per m²*). Following this, Googarra Beach in March had the next highest load with **15 particles per m²**. However, a second sample of Googarra Beach in September did not find any microplastics. This load variation may be attributed to temporal changes of environmental factors (*e.g., wind or rain events*).

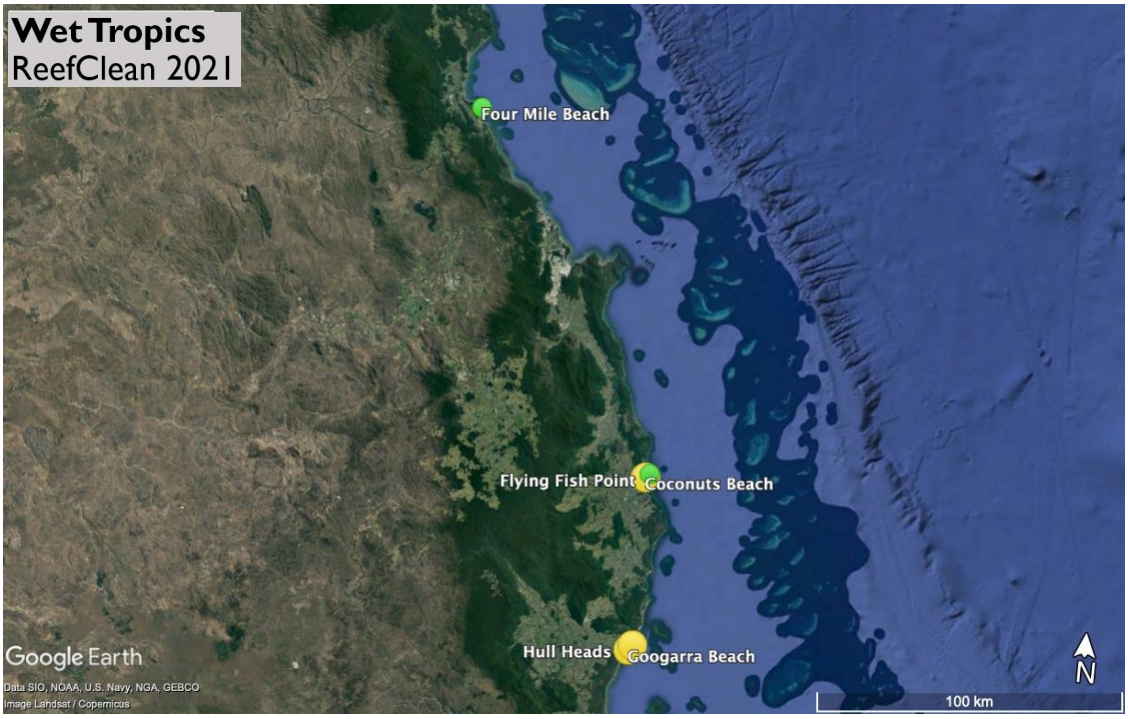

Figure 7. *Wet Tropics sample locations and microplastic loads (**Green** = Very Low, **Yellow** = Low)*

The *Coconuts Beach* sample was found to be primarily composed of hard fragments (**71%**) and industrial pellets (**21%**) (Fig. 8). The particles found were mostly white in colour and >5mm **in size** (Fig. 9; Fig. 10).

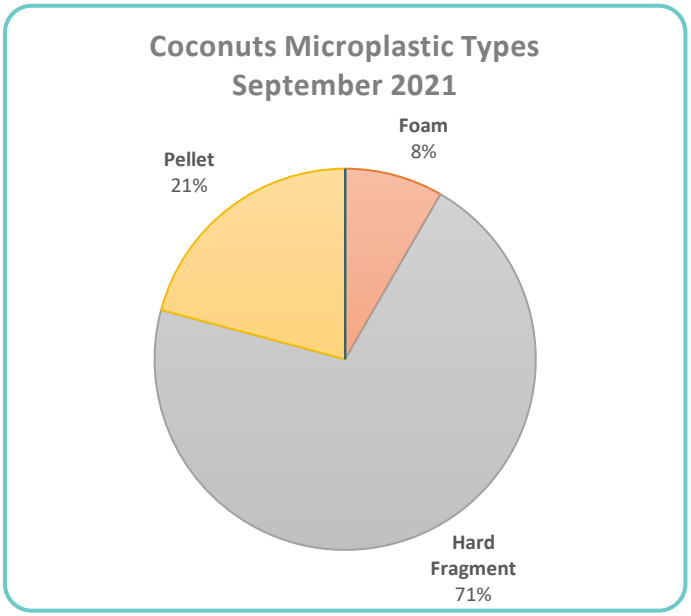

Figure 8. *Microplastic types at Coconuts Beach (Sept. 2021)*

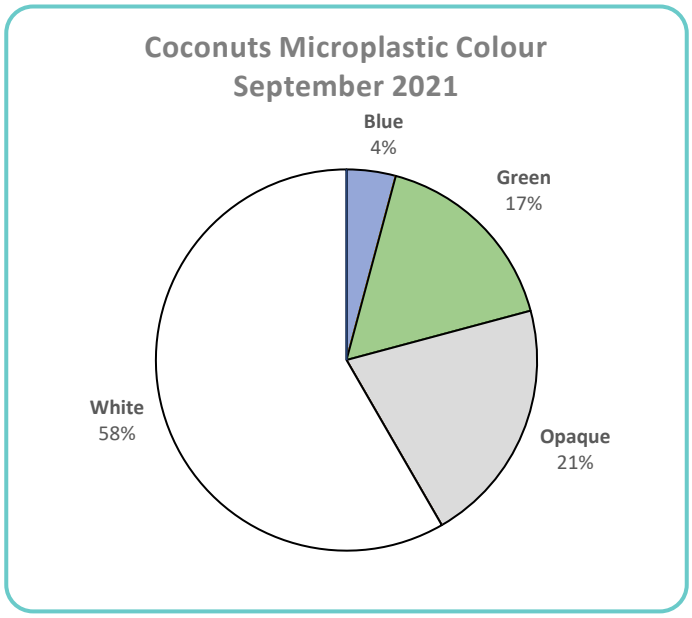

Figure 9. *Microplastic types at Coconuts Beach (Sept. 2021)*

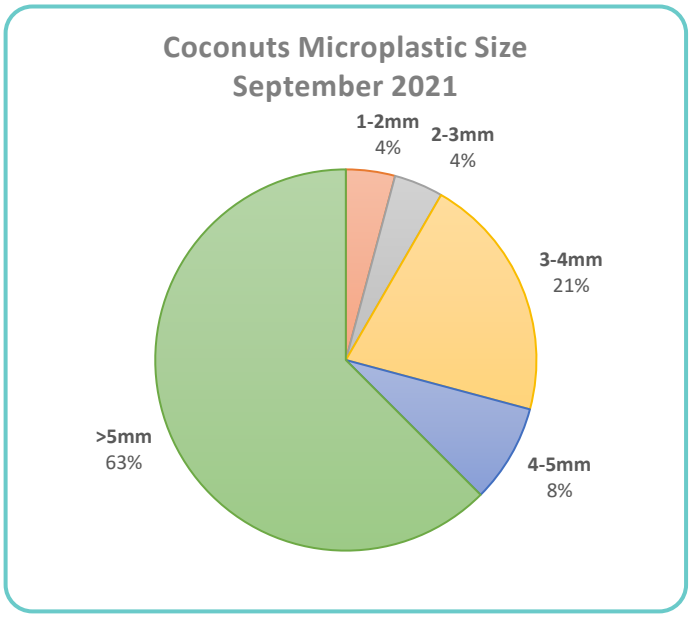

Figure 10. *Microplastic Size at Coconuts Beach (Sept. 2021)*

Region 3 – Burdekin

The Burdekin region was sampled six times over four locations in 2021 – Shelly Cove, Alva Beach, Queens Beach, and Bowen Water Park Beach (Fig. 11). In the prior reporting period (*2020*), the Burdekin had the site with the highest microplastic loads along the GBR at Alma Bay, Magnetic Island (*209 particles per m²*) – a site which was not sampled in 2021 (Tab. 2). In 2021, the highest loads of microplastics were found at **Alva Beach** in March with **111 particles per m²**, indicating **Moderate** microplastic loads. This is interesting considering the 2020 study found no microplastic particles at this site. A second Alva Beach site assessment was conducted in September 2021, which revealed **Very Low** microplastic loads (*4 particles per m²*) resembling these earlier findings.

The remaining sites of Shelly Cove, Bowen Water Park Beach and Queens Beach were all found to have **Very Low** to **Low** loads of microplastic debris (Tab. 1) ranging from 1-14 particles per m².

Figure 11. *Burdekin sample locations and microplastic loads (Green = Very Low, Yellow = Low; Orange = Moderate)*

Analysis of the March 2021 sample taken from Alva Beach reveals that the site was dominated almost entirely by **hard fragments** which contributed to **99%** of the total microplastic loads, with only a single particle of film identified (Fig. 12). Microplastic colours ranged considerably throughout the sample, with white *(40%)* and blue *(19%)* plastics being the most common (Fig. 13). The size of microplastics within this sample were composed mostly of larger fragments *(4-5mm = 32%; >5mm = 31%)* (Fig. 14). More sampling over time will help explain whether these characteristics are linked to seasonal trends.

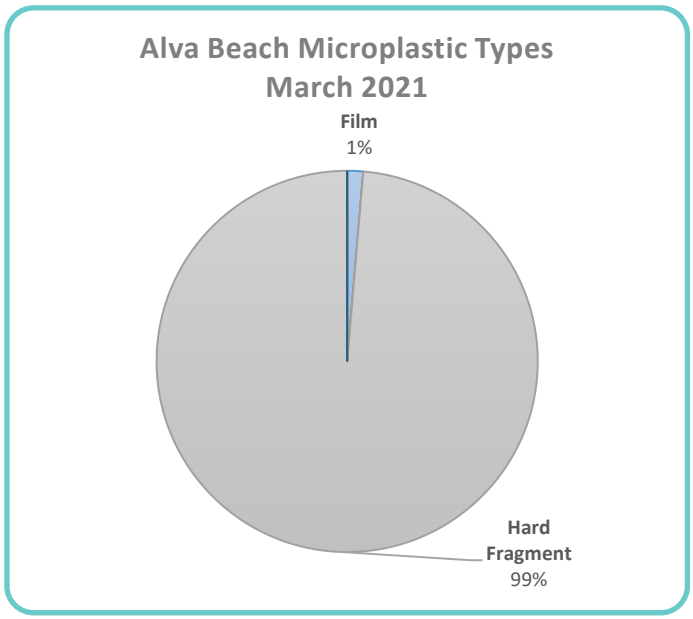

Figure 12. *Microplastic types at Alva Beach, Burdekin (Mar. 2021)*

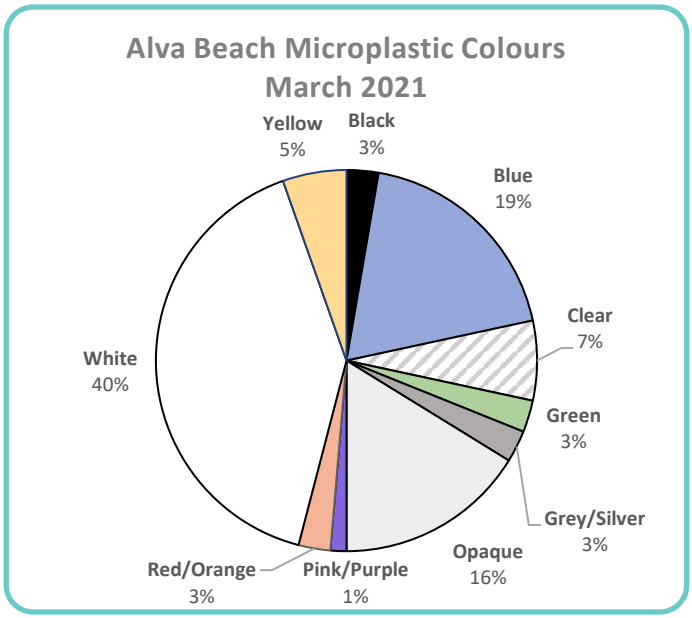

Figure 13. *Microplastic types at Alva Beach (Mar. 2021)*

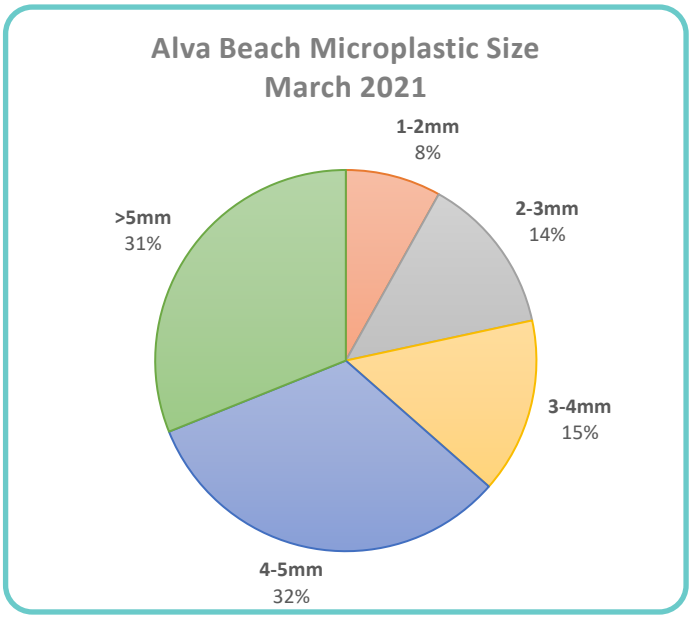

Figure 14. *Microplastic types at Alva Beach (Mar. 2021)*

Region 4 – Mackay Whitsunday

The Mackay Whitsunday region saw three sites sampled a total of seven times in 2021 – these same sites were analysed in prior years *(Conway Beach, Harbour Beach, and Half Tide Beach)* (**Fig. 15**). The highest microplastic loads in the region were observed at **Half Tide Beach**, with 140 particles per m^2 found in March 2021 signifying **Moderate** loads, and 311 particles per m^2 found in September signifying **High** loads. These readings are not only the highest recorded within the Mackay region, but also exceed microplastic load records from all preceding ReefClean studies (**Tab. 2**). With the years prior exhibiting **Very Low** loads across the region, this is a worrying advancement in microplastic inputs for this location. Conway Beach was sampled a total of three times, housing **Very Low** to **Low** microplastic loads throughout *(1-14 particles per m^2)*. Harbour Beach had similarly low microplastic loads ranging between 1 and 11 particles per m^2.

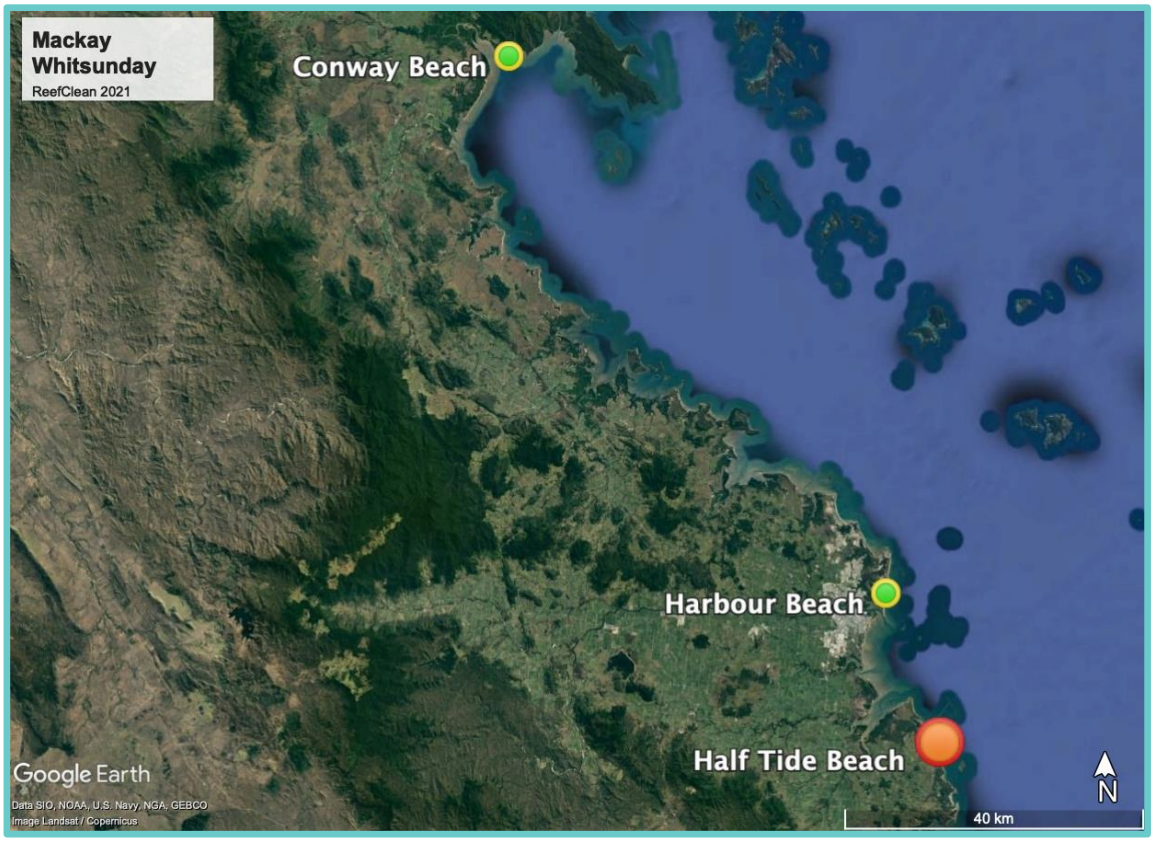

Figure 16. *Mackay Whitsunday sample location and microplastic loads (Green = Very Low; Yellow = Low; Orange = Moderate; Red = High).*

Comparative analysis of the Half Tide Beach samples from March and September 2021 may provide some insight into the seasonal variation of microplastic load composition within the Mackay Whitsunday region. When looking at microplastic types, both samples are similarly composed – primarily of **hard fragments** (*March = 92%; September = 96%*) (Fig. 16; Fig. 17).

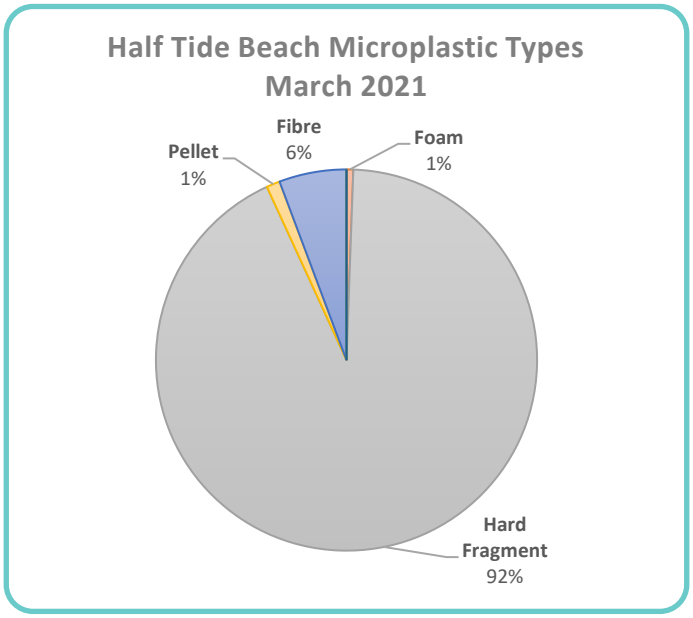

Figure 16. *Microplastic types at Half Tide Beach, Mackay (Mar. 2021).*

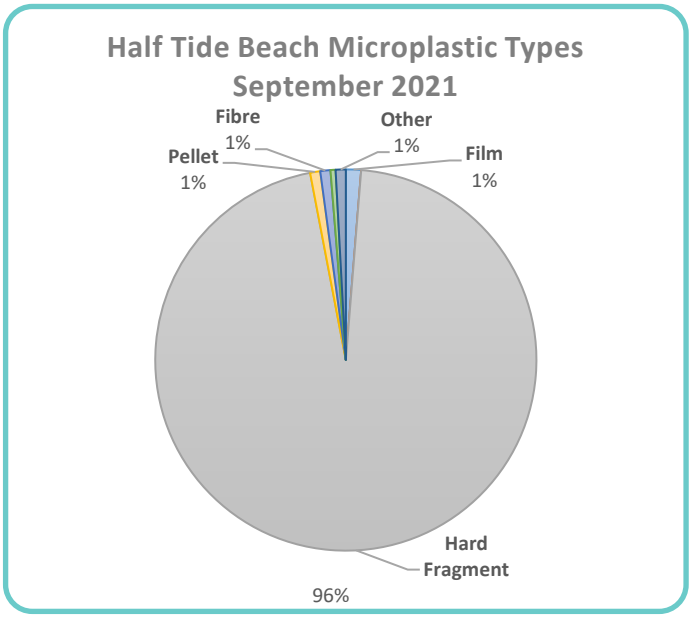

Figure 17. *Microplastic types at Half-Tide Beach, Mackay (Sept. 2021).*

There was also a similarity of the colour of the microplastics found between the samples, with the March sample shown to be made up primarily of opaque (*38%*), white (*30%*) and blue (*17%*) particles (Fig. 18), and the September sample is mostly white (*50%*) and blue (*26%*) particles (Fig. 19).

Sizes of microplastic debris between the two samples were also found to be relatively similar in composition, with both the March and September samples being made up mostly of 1-2mm fragments (*Mar. = 59%; Sept. = 55%*) (Fig. 20; Fig. 21).

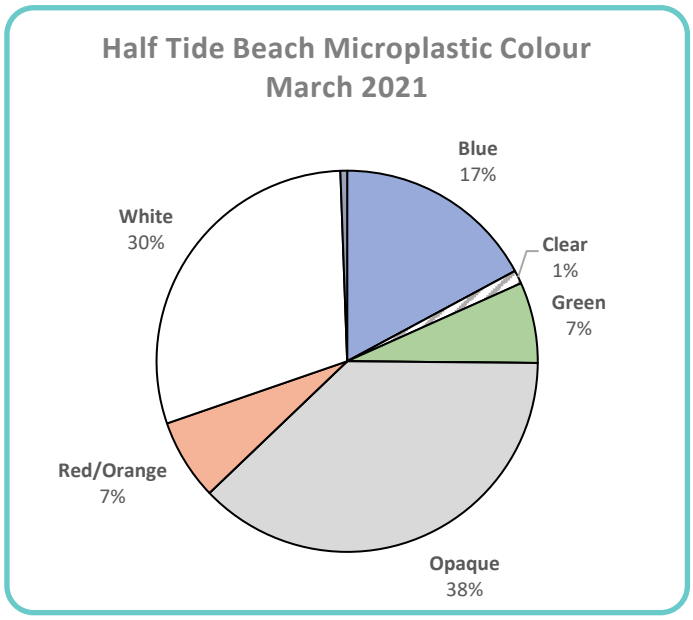

Figure 18. *Microplastic types at Half Tide Beach, Mackay (Mar. 2021)*

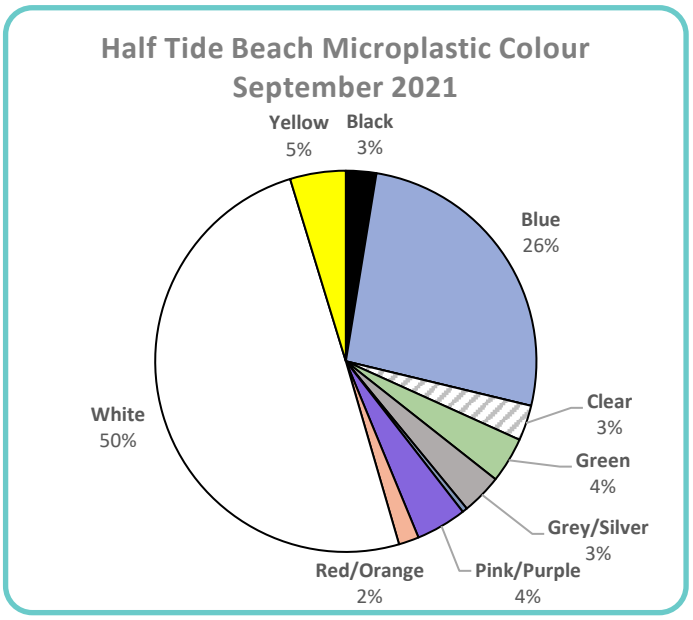

Figure 19. *Microplastic types at Half Tide Beach, Mackay (Sept. 2021)*

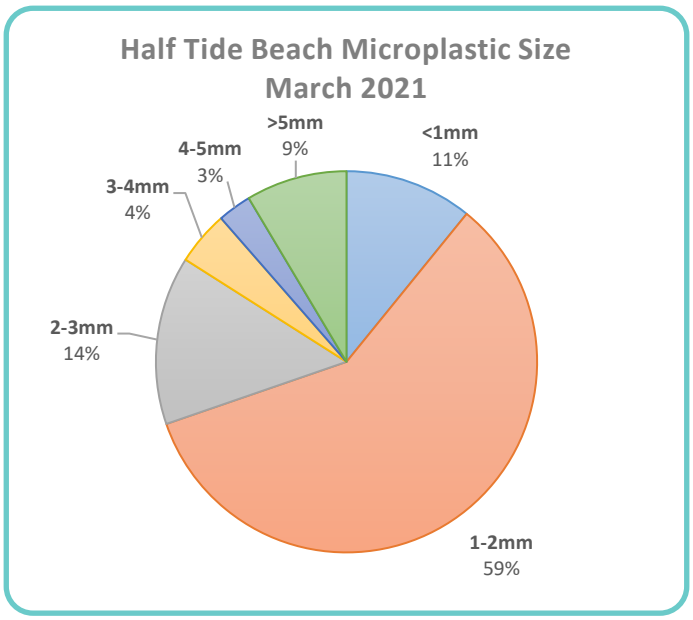

Figure 20. *Microplastic types at Half Tide Beach, Mackay (Mar. 2021)*

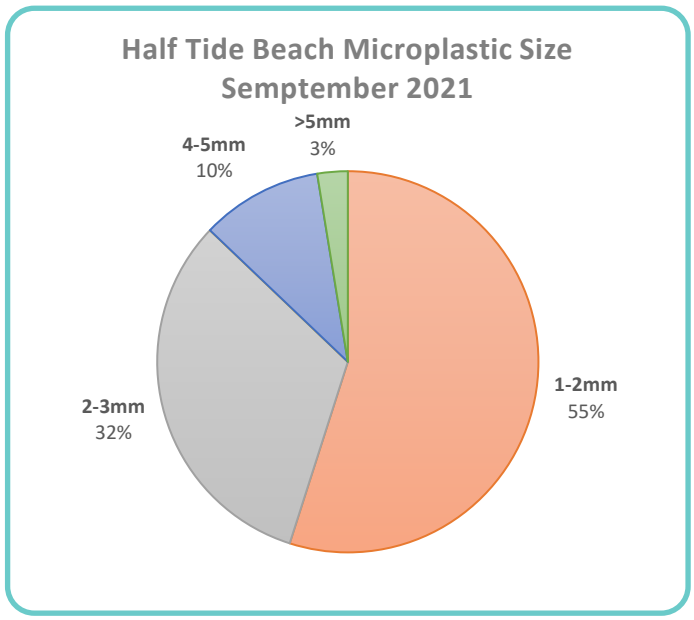

Figure 21. *Microplastic types at Half Tide Beach, Mackay (Sept. 2021)*

These collective analyses suggest that potential sources or pathways have changed at Half Tide Beach between 2020 and 2021. Conversely, the limited sampling in 2020 may not have truly reflected the microplastics loads present in the area. This difference between years highlights the need for further sampling over time to understand the patterns better.

Region 5 – Fitzroy

The Fitzroy region was sampled five times across three locations in 2021 (Fig. 22), with Farnborough Beach and Canoe Point being recurring sites from prior sampling years. Microplastic loads across all sites were found to be **Very Low**, ranging from zero particles per m^2 at Canoe Point in March to five particles per m^2 at Farnborough Beach in September (Tab. 1). These loads are relatively consistent with data from previous years, indicating that the sites in this region are at not major microplastic hotspots. Other locations, where known marine debris accumulates (e.g., Five Rocks/Byfield and Curtis Island) would be worth sampling in the future.

Figure 22. Fitzroy sample location and microplastic loads (Green = Very Low).

Region 6 - Burnett Mary

The Burnett Mary region had three sites sampled in 2021 – Norval Park Beach (*one sample*), Nielson Beach (*2 samples*), and Agnes Water Beach *(2 samples)* (Fig. 23). In all prior years of ReefClean analysis the Burnett Mary exhibited **Very Low** microplastic loads, with no observable microplastic debris reported in 2020 (Tab. 2). However, in September 2021, the sample from Agnes Water recorded **moderate** loads of microplastic debris with 68 particles per m^2 (Tab. 1), representing the highest recorded microplastic loads for the Burnett Mary region to date. Interestingly, analysis of the same beach earlier in March 2021, indicated **Very Low** microplastic loads, more in line with what had been found in prior years at the same beach. The suggests some altered activity or weather pattern has been captured.

Looking at the other sample sites, Norval Park Beach also exhibited **Very Low** microplastic loads (*3-5 particles per m^2*), with Nielson Beach exhibiting **Very Low** to **Low** microplastic loads (*8-11 particles per m^2*). Although minimal, these loads are notably greater than loads found in prior years (Tab. 2).

Figure 23: *Burnett Mary sample locations and microplastic loads (Green = Very Low; Yellow = Low; Orange = Moderate).*

The composition of microplastic debris from the September sample at Agnes Water, revealed the sample was primarily composed of hard fragments (97%) (Fig. 24). These fragments were found to be mostly white (40%) and blue (26%) in colour (Fig. 25) and were mostly 1 to 3 mm in size (Fig. 26). These plastic findings parallel the two most common colours of hard plastic products on the market.

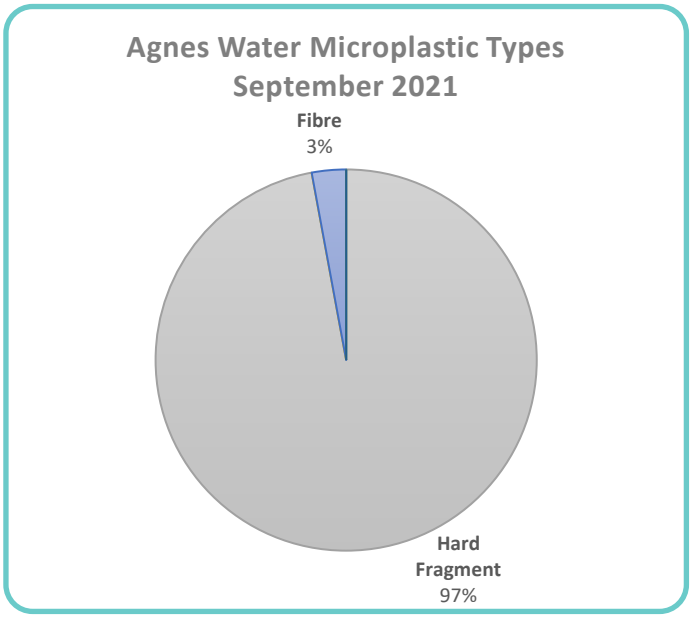

Figure 24. *Microplastic types at Agnes Water (Sept. 2021)*

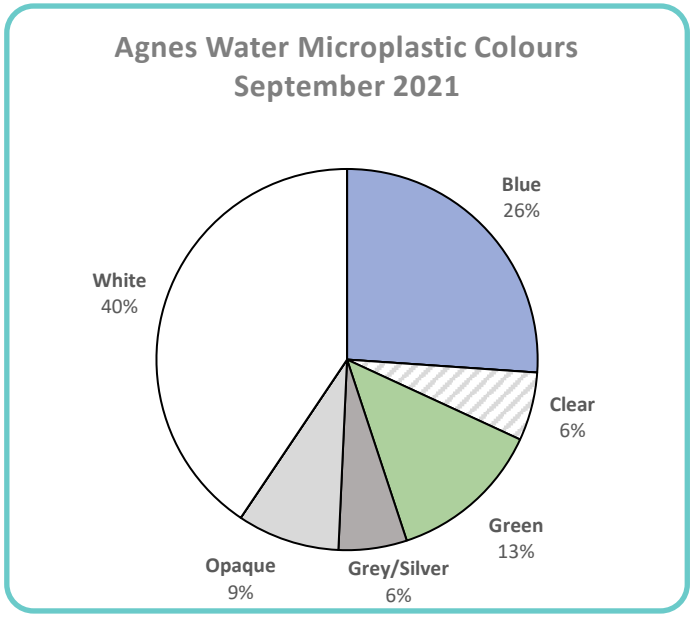

Figure 25. *Microplastic colour at Agnes Water (Sept. 2021)*

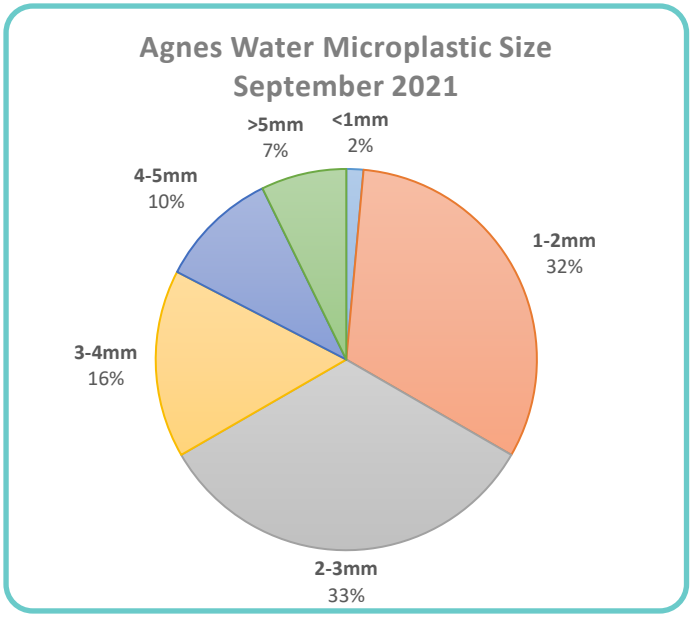

Figure 26. *Microplastic size at Agnes Water (Sept. 2021)*

Potential Sources of Microplastics

ReefClean sampling during 2021 identified hard plastic fragments as the predominant microplastics collected, mostly coloured blue, white or opaque. This is an ongoing trend reported since the first ReefClean sampling in 2019, suggesting that the sources producing this microplastic debris are persistent. Most of the hard fragments identified are considered *secondary microplastics*, meaning they have broken up and fragmented from a larger plastic product through environmental processes such as UV photodegradation and wave action.

Determining the direct point of origin of microplastics is often a difficult and uncertain process. However, physical features such as colour, shape and condition can provide valuable insight into this. For example, many of the hard fragments found within Cape York were extremely weathered and discoloured, suggesting the plastics had spent significant periods of time in the marine environment, likely originating from a disconnected origin point, then transported and deposited into coastal sediments via ocean currents. Through knowledge of the deposition of large plastic items such as beverage and detergent bottles, in this region, with origins related to international shipping or neighbour countries, the source of microplastics is likely to also be offshore.

As with prior years, 2021 saw a notable influx of pre-production resin pellets or '*nurdles*'. Some of these pellets were relatively unaffected by environmental degradation processes, suggesting local inputs from plastic manufacturers or spills during transportation. Primary current functioning within the GBR lagoon flows northward, indicating novel microplastics are entering the marine environment from a southerly location. An unpublished study conducted by Dr Scott Wilson (*AUSMAP Research Director*) found drift cards were able to travel more than 1000km through the current within the GBR lagoon, supporting this theory.

Observable microplastic loads are directly influenced by recent weather patterns and local anthropogenic activities. To get a better understanding of microplastic sources across each studied region, a larger timescale is required to provide a better indication of the microplastic source trends.

Interim Conclusions

The third year of the ReefClean microplastic sampling project continued to build upon the foundations begun in 2019 and continued through 2020, to present a more complete picture of microplastic loads and trends for the regions adjacent to the Great Barrier Reef.

The regions of Cape York, Mackay Whitsunday and Burnett Mary were all found to have considerable increases in average microplastic loads compared to prior years. Fly Point Beach within Cape York exhibited not only the highest microplastic loads for the year, but the highest ever recorded throughout the ReefClean project with **1191 particles per m^2** indicating **Very High** microplastic loads. Half Tide Beach in the Mackay Whitsunday region was also found to have **High** microplastic presence exceeding all sites from previous years with **311 particles per m^2**.

The trends observed this year may be representations of seasonal microplastic loads opposed to longitudinal patterns, which could explain the large temporal load differences from Fly Point (*Mar. = 7; Sept. = 1191*), Alva Beach (*Mar. = 111; Sept. = 4*) and Agnes Waters Surf Club Beach (*Mar. = 6; Sept. = 68*). Increased sampling at these sites in future studies will be able to determine the influence of this. It is, however, clear through physical analysis that observed microplastics are transported and deposited through ocean currents. For the Cape York sites these tend to be dominated by offshore sources, while for the other regions are likely more reflective of regional inputs. There was a trend at most sites where multiple samples were collected for the highest microplastics levels to be in the September period (Alva Beach being the notable exception to this). This reef-wide trend suggests seasonality and prevailing weather to be large drivers of this.

Substantial increases of spatiotemporal microplastic sampling efforts within the GBR region are planned to further build upon the last three years of data. This will be through resampling of already sampled sites, along with establishing new sample locations identified through data gaps. Further AUSMAP training days are planned to allow more data to be gathered along the GBR. A re-engagement of trained volunteers will also occur to encourage more sampling within the targeted areas.

ReefClean Partnering Agencies and Organisations

Thanks to all ReefClean partnering agencies, organisations, and volunteers for all their support and efforts during 2021. We look forward to working with you again in the coming year!

- Kuuku Ya'u Aboriginal Corporation
- Capricornia Catchments
- Discovery Coast Conservatory
- Elijah's World
- Gladstone Homeschoolers
- Lama Lama Land Trust
- Lockhart River State School
- Queensland Parks and Wildlife Service
- ReefClean
- Tangaroa Blue Foundation
- Whitsunday Catchment Landcare
- Yintjingga Aboriginal Corporation