AUSMAP

AUSTRALIAN MICROPLASTIC ASSESSMENT PROJECT

Review of Microplastics across GBR Catchments – 2022

Australian Microplastic Assessment Project

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 & 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 form part of community clean-up activities at coastal sites around the GBR over the duration of the ReefClean project, 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), which involves replicate sediment sampling along the most recent high tide of each shoreline. These samples are then sieved for microplastics across the GBR catchments and verified by the AUSMAP Scientific Officer.

2022 Microplastic Overview

Microplastics (1-5mm size class) or 'microlitter' are reported as microplastics per metre squared (mp/m^2) as the standard metric. Data on typology (resin pellets, hard plastic fragments, foam, fibre, film, or rubber), colour and size are also collated. 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 which are then translated into colour-coded points on a national map that represent specific load ranges. The AUSMAP microplastic load colour key is as follows:

Microplastic levels (/m^2)	Grading	Status
0-10	Very Low	GOOD
11-50	Low	WATCH AND ACT
51-250	Moderate	WATCH AND ACT
251-1000	High	HOTSPOT
1001- 10,000	Very High	HOTSPOT
>10 000	Extreme	HOTSPOT

The number of mp/m^2 can be applied to determine if the site is considered a pollution hotspot. Levels above 250 mp/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.

In 2022, ReefClean and the Tangaroa Blue Foundation team conducted 34 AUSMAP surveys across six Natural Resource Management (NRM) areas within the GBR monitoring region **(Figure 1).** Where practical, additional surveys were conducted in each NRM area throughout the year. The 34 surveys were conducted at 18 different sites and included:

- 33 surveys at 17 ReefClean monitoring sites (note, one previous ReefClean site, Walker Bay, was not surveyed in 2022 and Half Tide Beach was sampled only once in March 2022), and
- One additional survey was conducted at Heron Island.

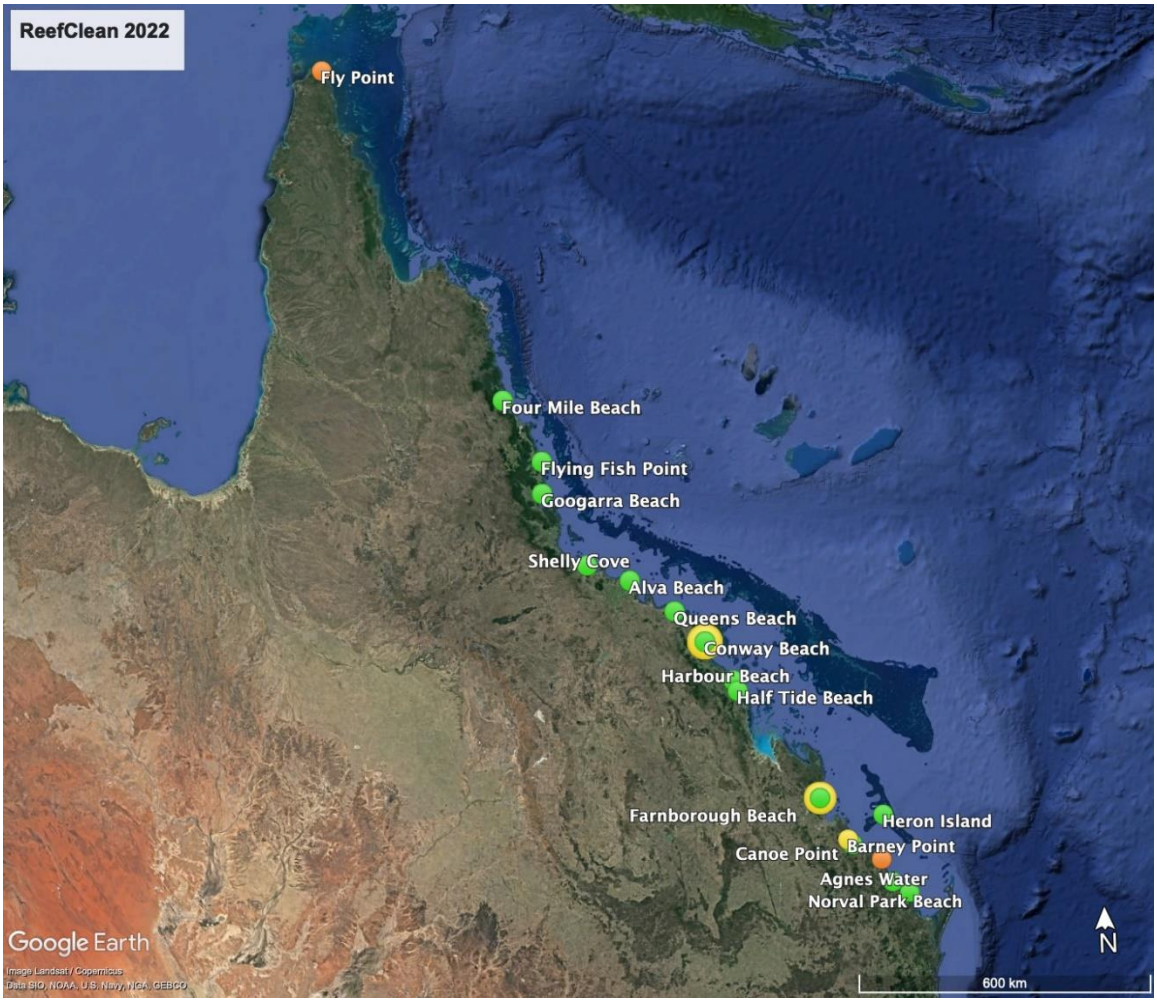


Figure.1. *Summary of ReefClean sample locations and Microplastic loads. (Green = Very Low; Yellow = Low; Orange = Moderate).*

Out of the 34 surveys, 20 surveys yielded microplastics. ReefClean samples in 2022 exhibited variation from **Very Low** to **Moderate** microplastic loads varying from 0 to 136 mp/m^2, with the highest levels recorded in September at Fly Point in the Cape York region (**Table 1**). The values at Fly Point are a drastic reduction from the 2021 September sample at this site which found 1,191 mp/m^2. This observation may indicate a variation in microplastic loads associated with annual environmental oscillations such as the occurrence of cyclones and other weather patterns.

Surf Beach in the Burnett Mary region was also shown to have **Moderate** microplastic loads with 86 mp/m^2. This site has been observed to have increasing microplastic loads over the four sampling years from '**Very Low**' to '**Moderate,**' indicating a potential developing hotspot in this locality that needs further monitoring. Further robust and consistent monitoring should be conducted within both the Cape York and Burnett Mary regions to determine potential sources and causes of microplastic accumulation.

All other sites investigated in the 2022 ReefClean sampling events resulted in '**Very Low**' or '**Low**' microplastic loads between 0 and 11 mp/m^2. The continuation of sampling across all sites is vital in understanding microplastic hotspot developments across the ecologically significant GBR Region.

Table 1. *Summary of ReefClean microplastic sampling activities in 2022 and regional averages measured in mp/m².*
(Green = Very Low; Yellow = Low; Orange = Moderate).

Region & Regional Average	Site & Microplastic Level		Region & Regional Average	Site & Microplastic Level	
Cape York: **4 surveys** **2 sites** **NRM average all surveys = 34 mp/m²** **Adjusted average from surveys where plastic was found was 136 mp/m²**	Fly Point (Mar)	0	**Mackay Whitsunday:** **5 surveys** **3 sites** **NRM average all surveys = 4.2 mp/m²** **Adjusted average from surveys where plastic was found was 5.3 mp/m²**	Conway Beach (Mar)	11
	Fly Point (Sept)	136		Conway Beach (Sept)	2
	Quintell Beach (Mar)	0		Harbour Beach (Mar)	1
	Quintell Beach (Sept)	0		Harbour Beach (Sept)	7
	Walker Bay (Mar)	NA		Half Tide Beach (Mar)	0
	Walker Bay (Sept)	NA		Half Tide Beach (Sept)	NA
Wet Tropics: **6 surveys** **3 sites** **NRM average all surveys = 0.83 mp/m²** **Adjusted average from surveys where plastic was found = 1.7 mp/m²**	Four Mile Beach (Mar)	2	**Fitzroy:** **6 surveys** **3 sites** **NRM average all surveys = 10 mp/m²** **Adjusted average from surveys where plastic was found = 19 mp/m²** ***Additional site Heron Island**	Farnborough Beach (Mar)	23
	Four Mile Beach (Sept)	0		Farnborough Beach (Dec)	0
	Flying Fish Point (Mar)	0		Barney Point (Mar)	24
	Flying Fish Point (Sept)	1		Barney Point (Sept)	0
	Googarra Beach (Mar)	0		Canoe Point (Mar)	11
	Googarra Beach (Sept)	2		Canoe Point (Sept)	0
				Heron Island (Dec)	0
Burdekin: **6 surveys** **3 sites** **NRM average all surveys = 2.3 mp/m²** **Adjusted average from surveys where plastic was found = 4.6 mp/m²**	Shelly Cove (Mar)	2	**Burnett Mary:** **6 surveys** **3 sites** **NRM average all surveys = 14.3 mp/m²** **Adjusted average from surveys where microplastic was found = 86 mp/m²**	Surf Beach (Mar)	86
	Shelly Cove (Sept)	0		Surf Beach (Sept)`	0
	Alva Beach (Mar)	7		Norval Park Beach (Mar)	0
	Alva Beach (Sept)	0		Norval Park Beach (Dec)	0
	Queens Beach (Mar)	5		Nielson Beach (Mar)	0
	Queens Beach (Sept)	0		Nielson Beach (Dec)	0

The Cape York region had the highest average microplastic load in 2022 with an average of 34 mp/m^2. Whilst this result is within the **'Low'** category on the AUSMAP grading scale, Fly Point demonstrated a '**Moderate**' level of 136 mp/m^2 in September. This differed from all other surveys in this region which recorded 0 microplastics **(Table 1)**. A similar trend was observed in 2021, when a high September result at Fly Point also affected Cape York's regional average, resulting in a rating of '**High**' microplastic loads.

The lowest microplastic average was observed in the Wet Tropics region at 1.7 mp/m^2 in 2022 **(Table 1)**. This observation is consistent with previous years of minimal microplastic loads within the Wet Tropics region, although 2022 had particularly low averages in comparison to previous annual trends.

The Mackay Whitsundays region demonstrated a decrease in average microplastic loads from 77 mp/m^2 in 2021 to 3.5 mp/m^2 in 2022. This average was specifically influenced by microplastic levels at Half Tide Beach in 2021 (86 mp/m^2).

The Burnett Mary region exhibited a consistent average of '**Low**' microplastic values with 17 mp/m^2 in 2021 and 14 mp/m^2 2022. The primary influence on these averages was higher than normal results at the Surf Beach site which recorded results of 68 mp/m^2 86 mp/m^2 respectively.

Overall, all regions recorded an average decrease in microplastic presence from the 2021 sampling year. The trends observed across all focal regions, however, are influenced by changes at one site rather than broad regional changes.

Regional Breakdown

Region 1- Cape York

The Cape York Region was sampled on four occasions across two sites during 2022 **(Figure 2**), which represents a decline in sampling efforts in comparison to the six samples undertaken at five sites in 2021 **(Table 2)**. Both Fly Point and Quintell Beach are standard sampling sites and have been well documented throughout ReefClean surveys.

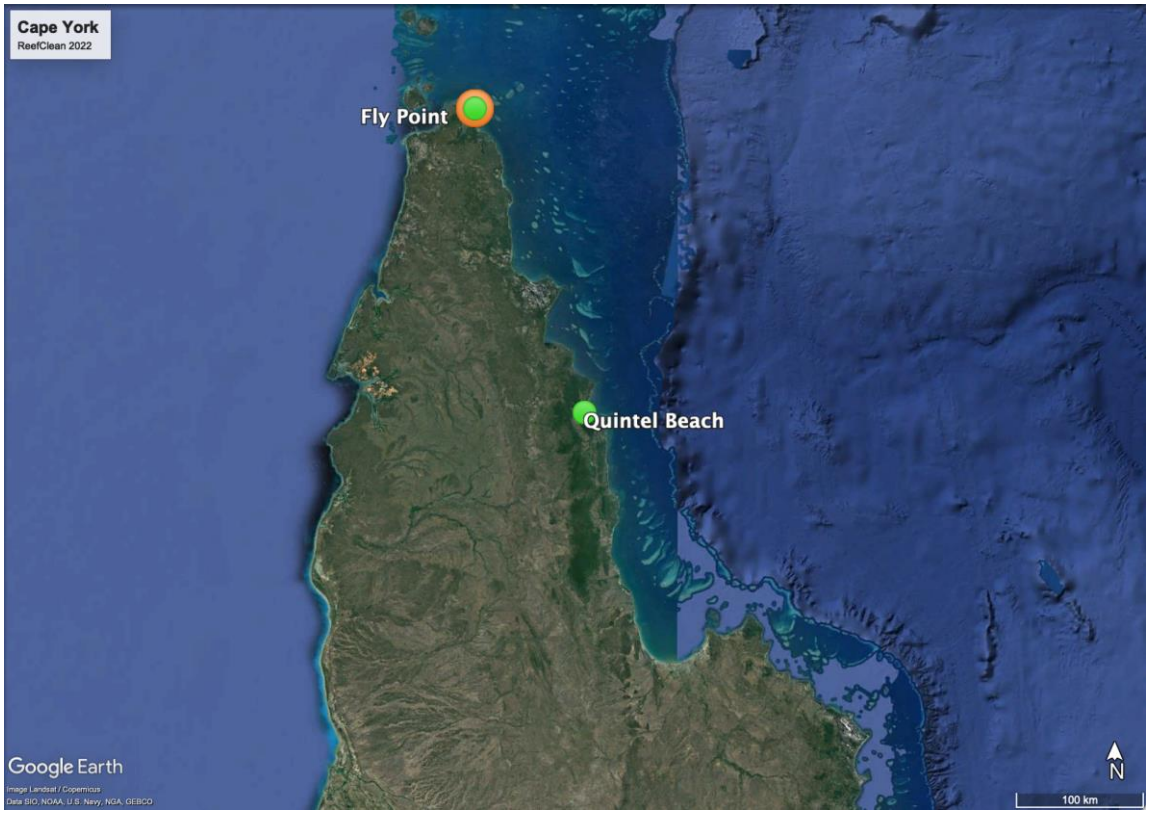


Figure 2. *Cape York sample locations and microplastic loads (2022) (Green = Very Low, Orange = Moderate)*

Table 2. *Summary of previous ReefClean microplastic sampling activities in the Cape York Region from 2019, 2020, 2021. All samples are included from each sample year. Where no repeat sample was collected, cells have been omitted. Microplastics measured in mp/m²*
(Green = Very Low; Yellow = Low; Orange = Moderate; Red = High; Black = Very High).

Site & Microplastic Level (2019)		Site & Microplastic Level (2020)		Site & Microplastic Level (2021)		Site & Microplastic Level (2022)	
Quintell Beach	0	Quintell Beach	1	Quintell Beach (Mar)	12	Quintell Beach (Mar)	0
				Quintell Beach (Sept)	17	Quintell Beach (Sept)	0
		Fly Point	44	Fly Point (Mar)	7	Fly Point (Mar)	0
				Fly Point (Sept)	1191	Fly Point (Sept)	136
Walker Bay	7			Walker Bay	34		
Friday Island	5			Running Creek	3		
Goods Island	21			Chili Beach	26		
Rocky Islet Reef	0						
North Shore Cooktown	23						
Thursday Island	4						

Four surveys have been undertaken at Quintell Beach since 2019, which provides valuable insight into microplastic loads at this site **(Table 2).** The results have varied from zero (2019, 2022) to 17 mp/m² (2021), with an AUSMAP graded range of '**Very Low**' to '**Low**' microplastic loads. These results do not require immediate concern but repeat sampling should continue to monitor for changes.

As previously stated in the 2022 Microplastic Overview, Fly Point exhibited the highest microplastic loads this year in September with 136 particles per/m² **(Table 1)**. This result classifies Fly Point as having '**Moderate**' levels of microplastics according to AUSMAP's grading scale. This sample was dominated by hard fragments (72.8%) and fibres (22.8%) **(Figure 3)**. These were typically found to be white (58.1%) or blue (25%) and were often greater than 5mm (40.4%), or between 3-4 mm in length (19.9%) **(Figure 4, Figure 5).**

It is worth noting that whilst this is comparably higher than any other loads found in 2022, it represents a considerable reduction from levels in September of 2021 where a result of 1191 mp/m² was obtained at Fly Point. This finding marked the first occasion of any ReefClean site exceeding the threshold of **'Very High'** microplastic loads and warranted considerable concern. This was more than ten times the 2020 findings of 44 mp/m², which established a new record high for the Cape York region in its respective year. The most recent sample enables the 2021 finding to be placed in the context of ReefClean's four-year dataset, implying that 2021's result may have been an outlier.

Such findings indicate how spatial and temporal variation can influence microplastic loads at a given site, with the 2021 value potentially attributed to seasonal weather conditions on the South-East coast. It is crucial to observe however, that both results from 2021 and 2022 exceeded that of 2020 and therefore suggest a general increase in microplastics at this site that should continue to be monitored.

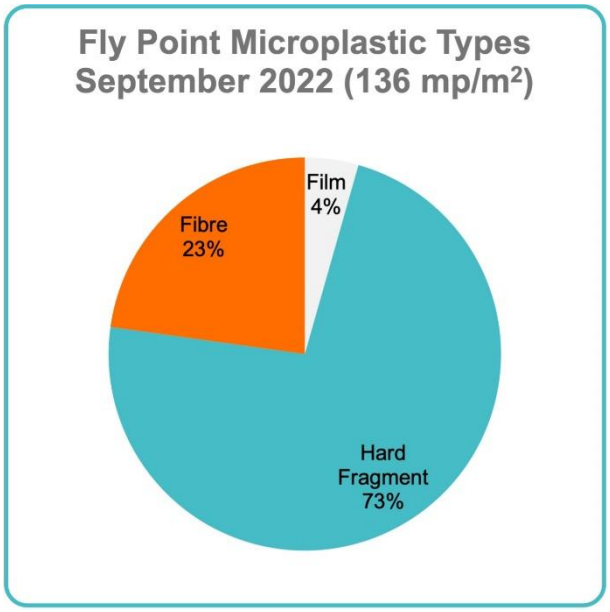


Figure 3. *Microplastic Types at Fly Point (Sept. 2022).*

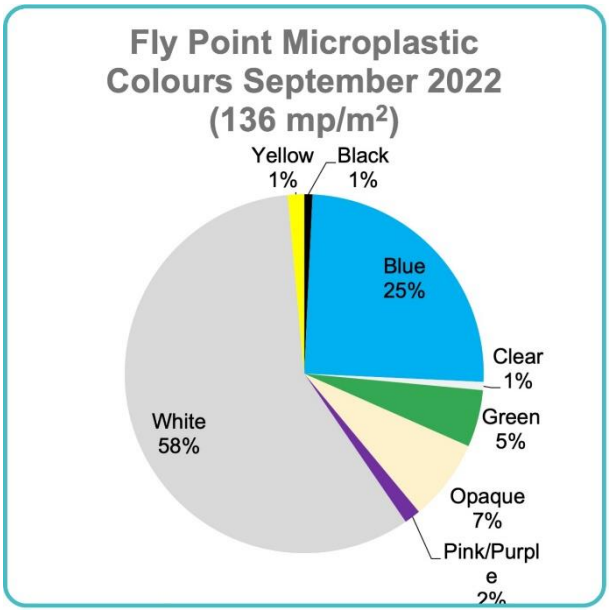


Figure 4. *Microplastic Colours at Fly Point (Sept. 2022).*

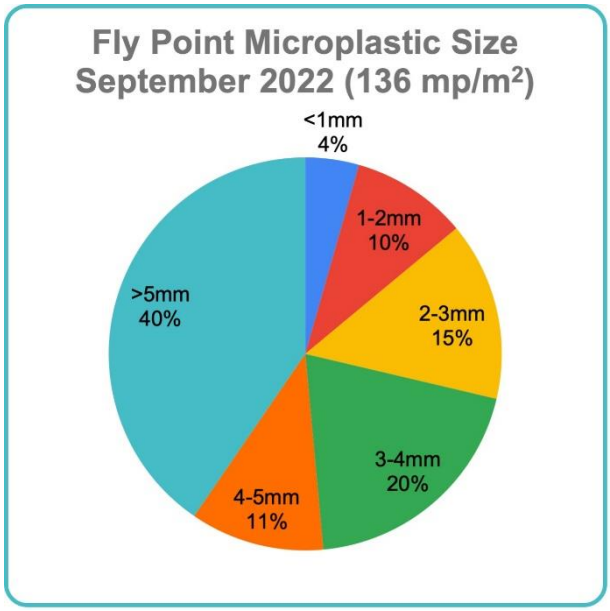


Figure 5. *Microplastic Sizes at Fly Point (Sept. 2022).*

Region 2 - Wet Tropics

Figure 6. *Wet Tropics sample locations and microplastic loads (**Green** = Very Low)*

Six surveys were undertaken at three locations in the Wet Tropics, with samples being collected biannually in March and September of 2022 **(Figure 6)**. All sites reported '**Very Low**' loads of microplastic debris, ranging from 0 to 2 mp/m2 at both Four Mile Beach (March) and Googarra Beach (September) (**Table 2)**. These findings are consistent with prior results which have typically observed '**Very Low**' to **'Low'** concentrations in this region, with the notable exception of Lucinda in 2020 which yielded a '**Moderate'** load of 81 mp/m^2 **(Table 3)**.

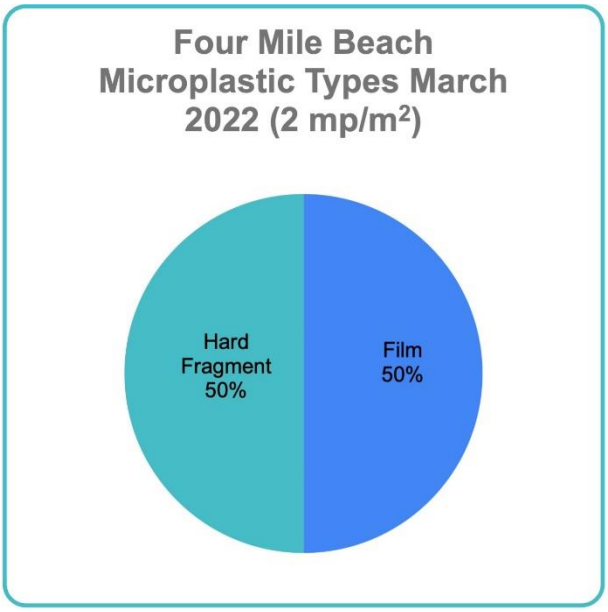
In light of 2022's trends, it can be concluded that this result from Lucinda was atypical and should be investigated further to determine whether it was the consequence of seasonal variation or potentially a microplastic hotspot. The geographic distance between sites sampled this year and Lucinda is noteworthy, as they are unlikely to be subject to the same conditions and therefore would be expected to display some variation.

Table 3. *Summary of previous ReefClean microplastic sampling activities in the Wet Tropics Region from 2019, 2020, 2021. All samples are included from each sample year. Where no repeat sample was collected, cells have been omitted. Microplastics measured in mp/m² (Green = Very Low; Yellow = Low; Orange = Moderate).*

Site & Microplastic Level (2019)		Site & Microplastic Level (2020)		Site and Microplastic Level (2021)		Site and Microplastic Level (2022)	
		Four Mile Beach (Feb)	0	Four Mile Beach (Mar)	3	Four Mile Beach (Mar)	2
		Four Mile Beach (Sept)	1	Four Mile Beach (Sept)	5	Four Mile Beach (Sept)	0
				Flying Fish Point (Sept)	5	Flying Fish Point (Mar)	0
						Flying Fish Point (Sept)	1
				Googarra Beach (Mar)	15	Googarra Beach (Mar)	0
				Googarra Beach (Sept)	0	Googarra Beach (Sept)	2
Michaelmas Cay	0	Lucinda (Feb)	81	Coconuts (Sept)	32		
Holloways Beach	8	Lucinda (Sept)	7	Hull Heads (Sept)	0		
Cairns Esplanade	0	Hinchinbrook Island	1				
Kurrimine Beach	0						

During 2021, Flying Fish Point and Googarra Beach were included in ReefClean monitoring. An average of 1.3 mp/m² in September 2022 appeared to be in line with last year's September sample at Flying Fish Point which was additionally classified as '**Very Low**' with 5 mp/m² **(Table 3)**. Whilst it is difficult to determine long-standing trends, these findings suggest that there is minimal seasonal fluctuation at the site, though further sampling should strengthen this conclusion. In contrast, Googarra Beach experienced some variation in prior samples from 2021, which yielded results of 15 mp/m² in March and 0 mp/m2 in September **(Table 3)**. It is hard to conclude trends based on two years of sampling data, however it is likely that this small difference between 2021 and 2022 is within normal variation.

Prior to 2022, biannual samples were taken at Four Mile Beach in 2020 and 2021, with results of 0, 1, 3 and 5 mp/m² respectively **(Table 3)**. Due to its longer sample history within the ReefClean project, the analysis below will focus on trends in microplastic debris at Four Mile Beach **(Table 3)**. AUSMAP's evaluation revealed that the 2022 sample was composed of film and a hard fragment which were clear and opaque in colour (**Figure 7, Figure 8**). Both plastics were 2-3 mm in size (**Figure 9**). Loads at Four Mile Beach have been consistently '**Very Low**' and subject to minimal temporal variability. Given the proximity of Four Mile Beach to Port Douglas' urban centre, it is promising to observe low microplastic debris.



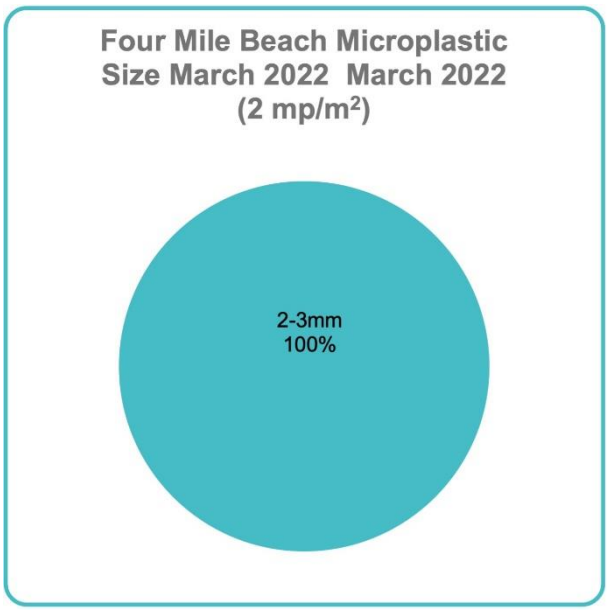


Figure 7. *Microplastic Types at Four Mile Beach (March 2022).* **Figure 9.** *Microplastic Sizes at Four Mile Beach (March 2022).*

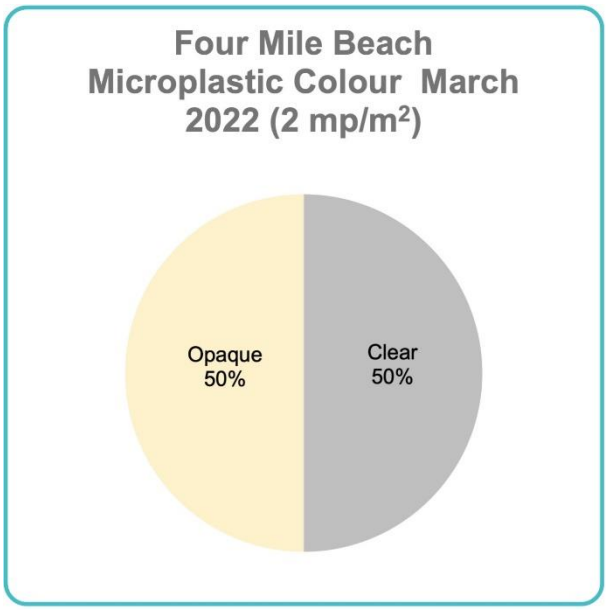


Figure 8. *Microplastic Colours at Four Mile Beach (March 2022).*

Region 3 - Burdekin

Figure 10. *Burdekin sample locations and microplastic loads (**Green** = Very Low)*

Six surveys were conducted at three separate locations during March and September of 2022, including Shelly Cove, Alva Beach, and Queens Beach **(Figure 10)**. All sites recorded results below 10 mp/m^2, categorising them as having '**Very Low**' concentrations. These ranged from a minimum of 0 mp/m^2 at Shelly Cove (September), Alva Beach (September) and Queens beach (September) to 7 mp/m^2 at Alva Beach (March) **(Table 1)**. Each of these locations were surveyed in 2021, providing an ideal reference point to observe preliminary trends at each site **(Table 4)**.

Table 4. *Summary of previous ReefClean microplastic sampling activities in the Burdekin Region from 2019, 2020, 2021. All samples are included from each sample year. Where no repeat sample was collected, cells have been omitted. Microplastics measured in mp/m² (Green = Very Low; Yellow = Low; Orange = Moderate).*

Site and Microplastic Level (2019)		Site and Microplastic Level (2020)		Site and Microplastic Level (2021)		Site and Microplastic Level (2022)	
Shelly Cove	11	Shelly Cove	0	Shelly Cove (Mar)	1	Shelly Cove (Mar)	2
				Shelly Cove (Sept)	0	Shelly Cove (Sept)	0
		Alva Beach	0	Alva Beach (Mar)	111	Alva Beach (Mar)	7
				Alva Beach (Sept)	4	Alva Beach (Sept)	0
		Queens Beach	0	Queens Beach (Mar)	14	Queens Beach (Mar)	5
				Queens Beach (Sept)	4	Queens Beach (Sept)	0
Alma Bay	27	Alma Bay	209				
Orpheus Island	20	Nelly Bay	5	Bowen Water Park Beach	3		
		Geoffrey Bay	0				

Shelly Cove's March sample was composed entirely of blue hard fragments between 1-2 mm in size, which appeared to be shavings from a larger plastic item. Shavings typically originate from land-based sources and travel into waterways due to their small size and mass, though it is possible that they could have come from off-shore, for example, boats with plastic sidings bumping into plastic pylons or those with plastic collars often create shavings due to friction. The highest load ever recorded at Shelly Cove was 4 mp/m² in 2020 **(Table 4)**, indicating that concentrations have marginally decreased throughout the three-year dataset. In this case, consistently low variability between seasons and over time provides a valuable baseline for future samples to be measured against.

Conversely, Queens Beach has reported some oscillation in microplastic concentrations since it was first surveyed in 2021. The survey conducted in March of 2021 yielded a result of 14 mp/m² which remains the highest value found at this specific site. This finding of **'Low'** concentrations differs from the 2022 and September 2021 results of 0 to '**Very Low**' loads, and this change could be considered within normal variation patterns. Further surveys should be conducted to develop this understanding.

Alva Beach's March sample demonstrated the highest volume of microplastic debris in the Burdekin region in both 2021 and 2022 **(Table 4)**, which warrants further analysis - albeit that the loads in 2022 were '**Very Low**.' This contrasts with the September sample which recorded zero microplastics in 2022 **(Table 4).** The March sample was composed predominantly of hard fragments (~60%), film, fibres, and foam (~15% each) **(Figure 11)**. Many of these were blue and typically fell within smaller sizing parameters (<1 mm, 2-3mm), likely due to extensive weathering from environmental exposure **(Figure 12, Figure 13)**.

In 2021, Alva Beach's leading volume exceeded the threshold for **'Moderate'** microplastic loads with greater than 100 mp/m^2. The disparity between the 2021 and the 2022 total highlights how microplastic pollution can fluctuate over time, and therefore the significance of regular ongoing sampling to place these results in a broader context.

It is worth noting that all September samples within the Burdekin region demonstrated zero microplastic presence compared to March of 2022, which may suggest a seasonal influence. Higher than average rainfall and wind, for example, are known to alter the depositional patterns of coastal sites which can impact the volume of plastic debris accumulating on shorelines. Further sampling should continue seasonally at these sites and throughout the Burdekin region to comprehend this relationship.

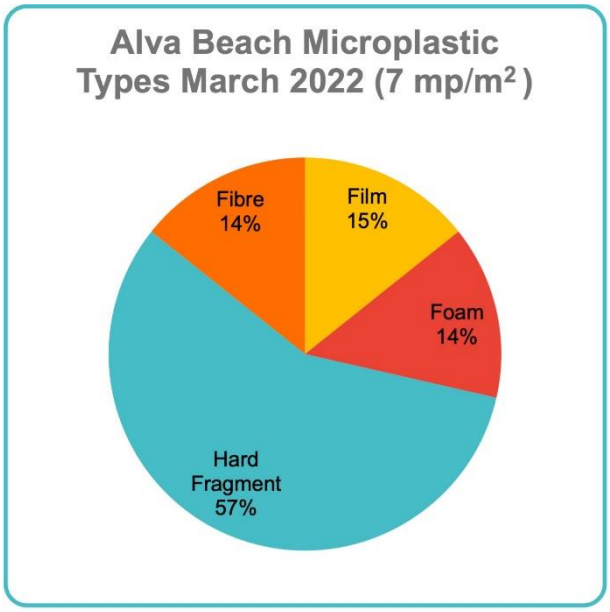


Figure 11. *Microplastic Types at Alva Beach (March 2022).*

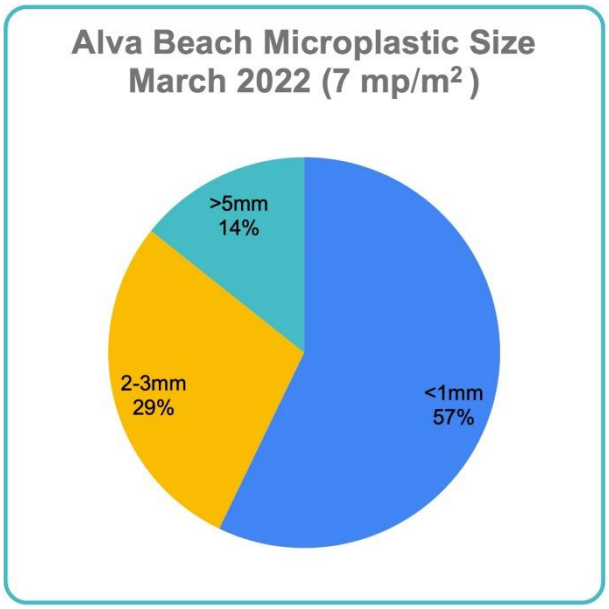


Figure 12. *Microplastic Sizes at Alva Beach (March 2022).*

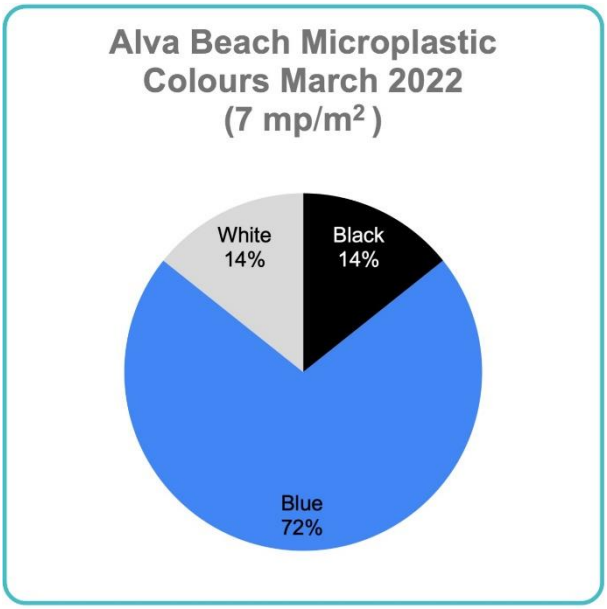


Figure 13. *Microplastic Colours at Alva Beach (March 2022).*

Region 4 - Mackay Whitsunday

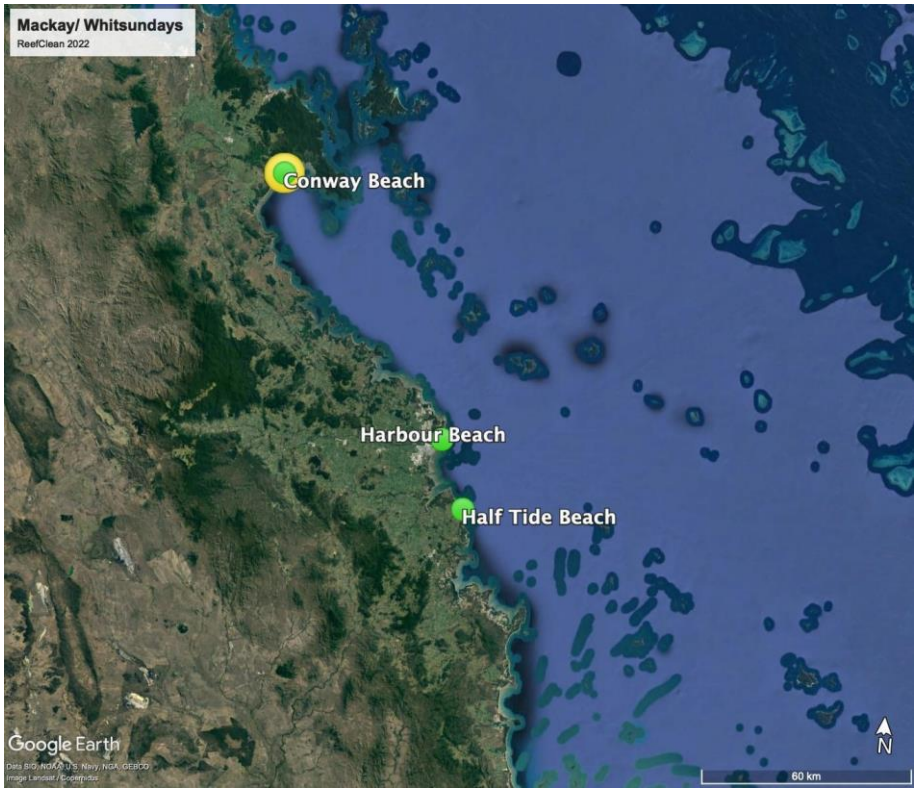


Figure 14. *Mackay Whitsunday sample locations and microplastic loads (Green = Very Low, Yellow = Low)*

The Mackay Whitsunday region saw 3 sites sampled biannually, except for Half Tide Beach which was not sampled in September **(Figure 14; Table 5)**. This is comparable to the volume of surveys completed in 2021, with Conway Beach, Harbour Beach and Half Tide Beach all being assessed in prior years **(Table 5)**. The highest microplastic load in 2022 was observed at Conway Beach, with 11 mp/m^2 found in March signifying a **'Low'** load according to AUSMAP's grading scale **(Table 1)**. Surveys conducted at the same site in September 2022 indicate a '**Very Low**' microplastic load with 2 mp/m^2. Similarly low results have been reported at this site by ReefClean surveys conducted in 2021 and 2020.

Table 5. *Summary of previous ReefClean microplastic sampling activities in the Mackay Whitsunday Region from 2019, 2020, 2021. All samples are included from each sample year. Where no repeat sample was collected, cells have been omitted. Microplastics measured in mp/m²*
(Green = Very Low; Yellow = Low; Orange = Moderate; Red = High).

Site & Microplastic Level (2019)		Site & Microplastic Level (2020)		Site & Microplastic Level (2021)		Site & Microplastic Level (2022)	
		Conway Beach	3	Conway Beach (Mar)	1	Conway Beach (Mar)	11
				Conway Beach (Sept)	2	Conway Beach (Sept)	2
				Conway Beach (Dec)	14		
		Harbour Beach	8	Harbour Beach (Mar)	1	Harbour Beach (Mar)	1
				Harbour Beach (Sept)	11	Harbour Beach (Sept)	7
		Half Tide Beach	1	Half Tide Beach (Mar)	140	Half Tide Beach (Mar)	0
				Half Tide Beach (Sept)	311		
Cannonvale	7						

Half Tide Beach had zero microplastics in March 2022, and there was no sample obtained in September. These figures indicate a significant reduction in microplastic loads as data obtained from 2021 revealed '**Moderate**' to '**High**' microplastic loads of 140 and 311 mp/m² in March and September, respectively **(Table 5)**. These results influenced a high regional average of 77 mp/m² in 2021, which has since decreased to 4.2 mp/m² in 2022. Both 2020 and 2022 shared '**Very Low**' loads **(Table 5)**, which suggests that the dramatic increases in 2021 were the result of seasonal variation and may have coincided with abnormal weather conditions.

Harbour Beach samples obtained in March and September 2022 showed '**Very Low**' microplastic loads of 1 particle/m² and 7 mp/m² **(Table 1)**. These results are consistent across previous sampling years which displayed '**Very Low**' to '**Low**' microplastic loads. In comparison to the other sampling sites, Harbour Beach had the most diversity in the types of microplastic found with deposits of hard fragments (71.4%), film (14.3%) and pellets (14.3%). Whilst the dominance of hard fragments is typical of ReefClean samples, the presence of pellets implies an industrial land-based source. Pellets or nurdles, are a primary microplastic which can be derived from virgin or recycled plastic to mould them into a wide variety of products. Nationally, there is concern regarding the storage and transportation of these microplastics which are poorly regulated and enter waterways via nearby stormwater networks. Further sampling and tracking of these particles up-catchment should be conducted to provide insight into the local source.

Additional analysis on this year's March sample from Conway Beach indicated that it was entirely composed of hard fragments **(Figure 15)**. This finding was replicated in the September result, which reflected the same plastic type for both identified microplastics.

Microplastic colours were shown to vary with a combination of blue (64%), white (18%) and green 18%) particles found **(Figure 16)**. The greatest variation, however, was found in microplastic size with all size ranges being represented **(Figure 17)**. Whilst this was the highest sample found in the Mackay Whitsunday region in 2022, it is important to note that these findings are still low and therefore do not warrant substantial concern. Ongoing sampling should rely on them as a baseline to measure future results to assess any emerging litter issues.

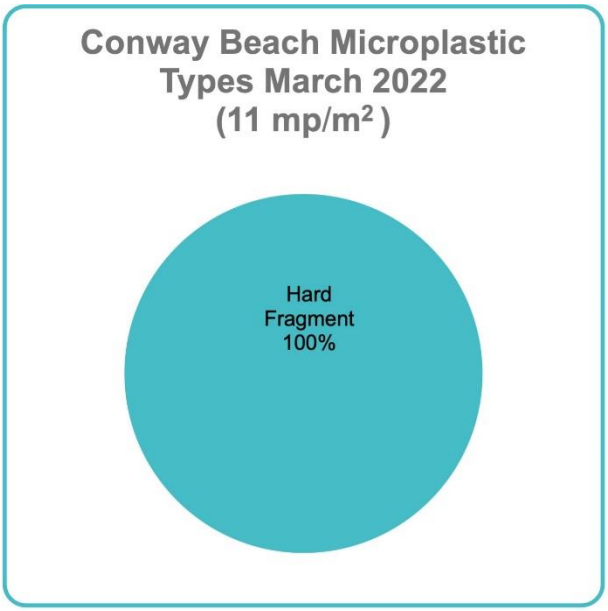


Figure 15. *Microplastic Types at Conway Beach (March 2022).*

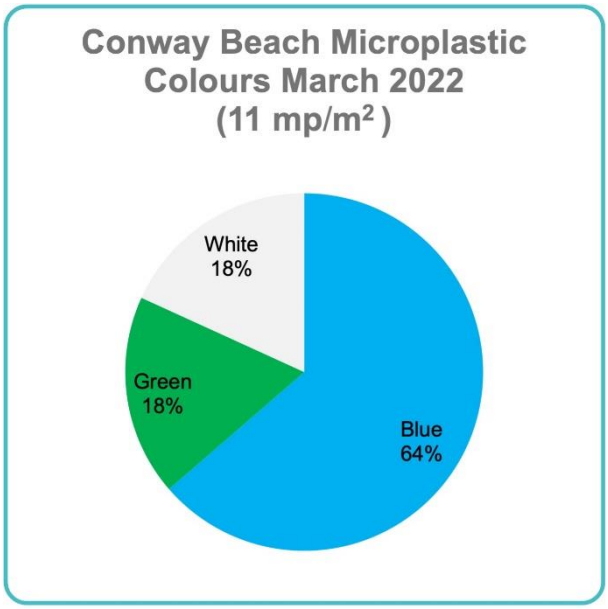


Figure 16. *Microplastic Colours at Conway Beach (March 2022).*

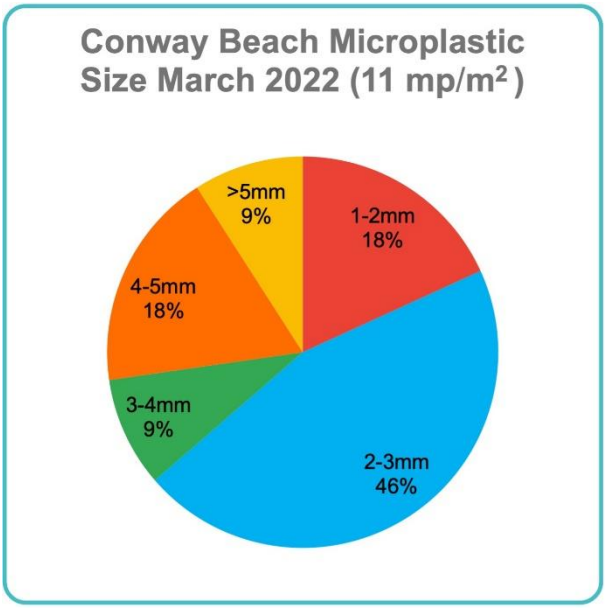


Figure 17. *Microplastic Sizes at Conway Beach (March 2022).*

Region 5 - Fitzroy

Figure 18. *Fitzroy sample locations and microplastic loads (Green = Very Low, Yellow = Low)*

The Fitzroy region was surveyed seven times across four different locations in 2022, which included ReefClean monitoring sites (Barney Point, Farnborough Beach, and Canoe Point) **(Figure 18)**, as well as an opportunistic survey conducted on Heron Island. Together, these samples comprise the largest region-specific survey effort in 2022. Microplastic loads within this region ranged from '**Very Low**' to '**Low**,' with the highest load recorded in March 2022 at Barney Point with 24 mp/m^2 **(Table 6)**.

Table 6. *Summary of previous ReefClean microplastic sampling activities in the Fitzroy Region from 2019, 2020, 2021. All samples are included from each sample year. Where no repeat sample was collected, cells have been omitted. Microplastics measured in mp/m² (Green = Very Low; Yellow = Low).*

Site & Microplastic Level (2019)		Site & Microplastic Level (2020)		Site & Microplastic Level (2021)		Site & Microplastic Level (2022)	
Canoe Point	16	Canoe Point	0	Canoe Point (Mar)	0	Canoe Point (Mar)	11
				Canoe Point (Sept)	2	Canoe Point (Sept)	0
		Farnborough Beach	23	Farnborough Beach (Mar)	5	Farnborough Beach (Mar)	23
						Farnborough Beach (Dec)	0
				Barney Point (Mar)	1	Barney Point (Mar)	24
				Barney Point (Mar)	4	Barney Point (Sept)	0
						Heron Island (Dec)	0

Farnborough Beach has been a recurring survey site and has displayed fluctuating trends since it was initially surveyed in 2020. The results from that year graded this site as having '**Low**' loads, with a result of 23 mp/m² **(Table 6)**. Findings from March 2021 revealed a '**Very Low**' load at the same site, with 5 mp/m² **(Table 6**). Both values are similar to the 2022 findings, which ranged from 23 mp/m² in March to only 2 mp/m² in December. The difference in load size could be a result of seasonal changes, which may influence microplastic distribution in the region.

Heron Island was an opportunistic sampling site and is not a typical location for ReefClean analysis. This survey documented 0 microplastics per m², which is a promising value, though further sampling should be undertaken to confirm this positive trend. Given its general isolation from mainland Australia and reduced urban density, lower microplastic loads are to be expected. Marine debris research conducted on Heron Island has previously shown low loads, however, it is influenced by tourism in the area.[1]

Further analysis was undertaken on the March sample from Barney Point which had the highest load of 24 mp/m². The types of microplastics found at Barney Point were predominantly composed of hard fragments (~54%), followed by film (~33%), foam, fibre and other (~4% each) **(Figure 19)**. The foam uncovered at this location was fresh, indicating that it was newly introduced into this environment, perhaps from a land-based source. The proximity of Gladstone CBD to this site suggests this as a potential source for the foam. Foam is composed of light materials and is therefore transported easily via wind and water. The colours of the microplastics were typically blue or white, and varied in size **(Figure 20, Figure 21)**.

[1] Wilson, S.P. and Verlis, K.M (2017). The ugly face of tourism: marine debris pollution linked to visitation in the southern Great Barrier Reef, Australia. *Marine Pollution Bulletin* 117, 239-246

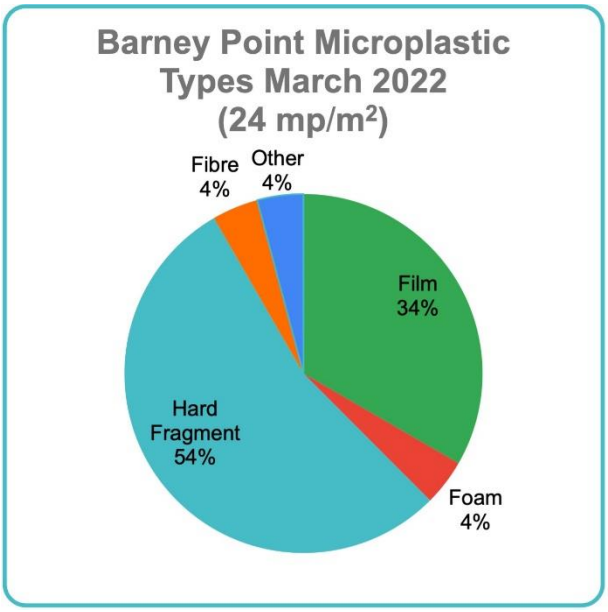


Figure 19. *Microplastic Types at Barney Point (March 2022).*

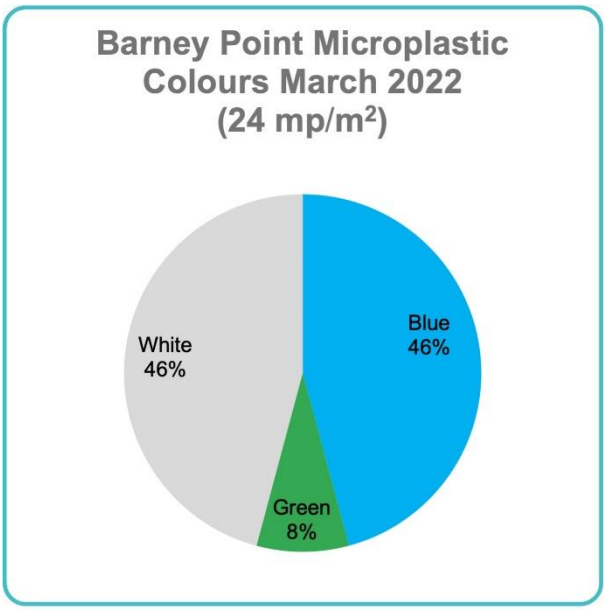


Figure 20. *Microplastic Colours at Barney Point (March 2022).*

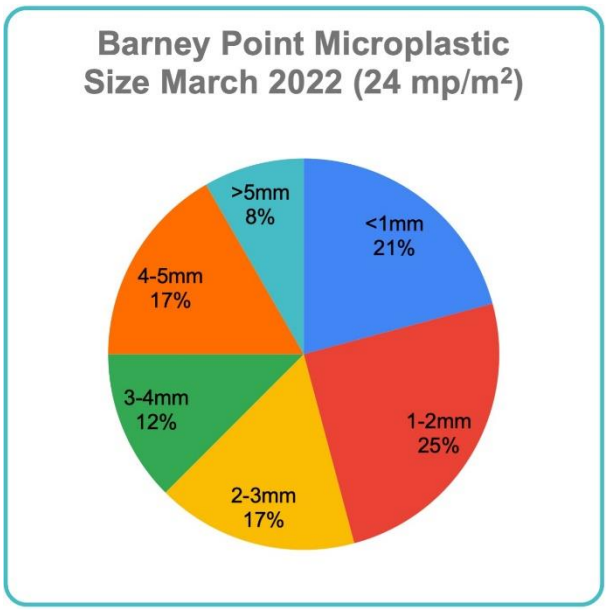


Figure 21. *Microplastic sizes at Barney Point (March 2022).*

Region 6 - Burnett Mary

Figure 22. *Burnett Mary sample locations and microplastic loads (**Green** = Very Low, **Orange** = Moderate)*

Within the Burnett Mary Region a collective six surveys were conducted at three sites including, Surf Beach, Norval Park Beach, and Neilson Beach **(Figure.22)**. These sites have previously been analysed under the ReefClean initiative. The highest recorded microplastic sample in the Burnett Mary Region to date was observed in March 2022 at Surf Beach, with 86 mp/m^2 recording a 'Moderate' level using AUSMAP's grading scale **(Table.1)**. This exceeded the highest previous result of 68 mp/m^2 in September 2021, which was unusual following a '**Very Low**' result of zero microplastics found in March 2021 **(Table.2).**

Table 7. *Summary of previous ReefClean microplastic sampling activities in the Burnett Mary Region from 2019, 2020, 2021. All samples are included from each sample year. Where no repeat sample was collected, cells have been omitted. Microplastics measured in mp/m² (Green = Very Low; Yellow = Low; Orange = Moderate).*

Site & Microplastic Level (2019)		Site & Microplastic Level (2020)		Site & Microplastic Level (2021)		Site & Microplastic Level (2022)	
Surf Beach	2	Surf Beach	0	Surf Beach (Mar)	6	Surf Beach (Mar)	86
				Surf Beach (Sept)	68	Surf Beach (Sept)`	0
		Norval Park Beach	0	Norval Park Beach (Mar)	3	Norval Park Beach (Mar)	0
				Norval Park Beach (Sept)	5	Norval Park Beach (Dec)	0
				Neilson Beach (March)	8	Nielson Beach (Mar)	0
				Nielson Beach (Sept)	11	Nielson Beach (Dec)	0
Bargara	1	Bargara	0				
Miara	0						

This represents a concerning trend of increasing microplastic debris at Surf Beach, as in 2020 there were no observable microplastics recorded **(Table 7)**. Individual surveys in September of 2021 and March of 2022 identified a sharp rise in microplastic loads to 68 mp/m² and 86 mp/m² respectively **(Table 7**). Whilst concerning, these results occurred at different times during the year which does not suggest a consistent seasonal pattern.

Norval Park Beach and Neilson Beach both yielded results of 0 mp/m² in all samples throughout 2022 which places these sites in the '**Very Low**' category of microplastic pollution. This marks a promising decrease in microplastic loads from prior samples taken at both sites in 2021, as Norval Park Beach recorded 3 mp/m², and 5 mp/m², while Neilson Beach had 8 mp/m² and 11 mp/m² **(Table 7)**. It's important to consider that this year's samples were undertaken in December rather than the typical sampling periods of March and September, which may have influenced the results. As has been shown, microplastic deposition is strongly linked with seasonal variation and is subject to different weather influences. Further monitoring at these sampling sites is necessary to confirm trends.

Analysis of the March sample from Surf Beach showed that it consisted mainly of hard fragments (~84%) **(Figure. 23)**, which is typical for ReefClean samples at this location. These fragments were found to be mostly blue (~46%) and opaque (~23%) **(Figure. 24)** and were typically 2-3 mm in size (~50%) **(Figure 25)**. were found to be mostly blue (~46%) and opaque (~23%) **(Figure. 24)** and were mostly 2-3 mm in size (~50%) **(Figure 25)**.

However, unlike previous samples which have consisted of hard fragments and fibres only, 16% of the 2022 sample consisted of pellets which indicates a potential new pollutant source, most likely in the form of an industrial land-based source. The pellets in this sample were mainly blue and green and therefore will be

easier to track to a specific source. Based on their condition, there were minimal signs of wear, suggesting that they had spent a short time in the environment, and therefore originated from the local area. Source tracking and source reduction are viable steps to be undertaken to address the issue of pollution and intervene at primary pollution sites. Furthermore, negligence in storage and transport methods from plastic processing facilities is another potential cause for the introduction of pellets into this region and warrants further investigation.

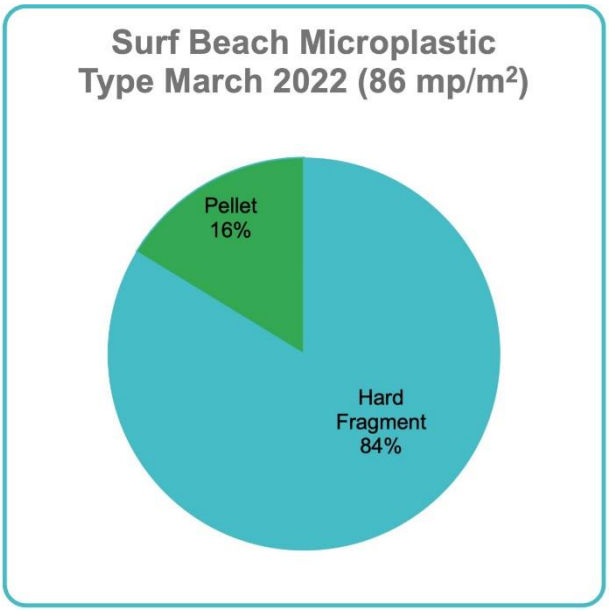


Figure 23. *Microplastic Types at Surf Beach (March 2022).*

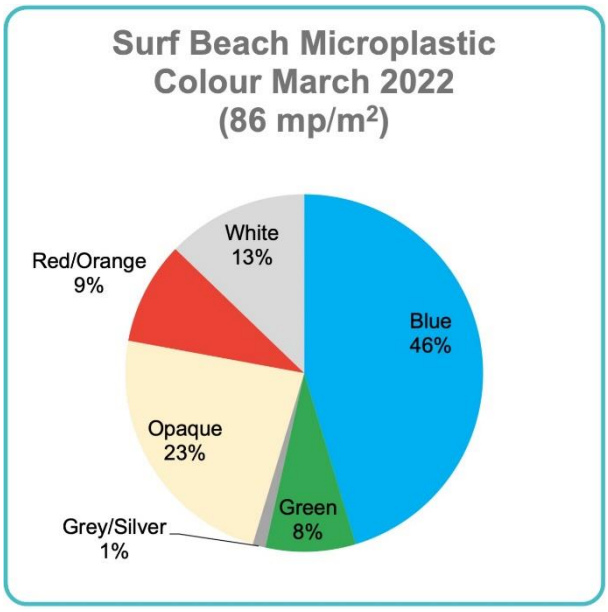


Figure 24. *Microplastic Colours at Surf Beach (March 2022).*

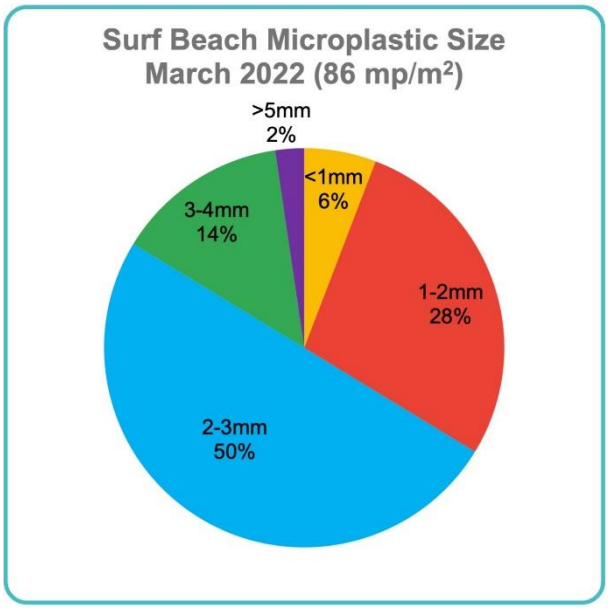


Figure 25. *Microplastic Size at Surf Beach (March 2022).*

Potential Sources of Microplastics

ReefClean sampling during 2022 identified hard plastic fragments as the dominant microplastic type, which typically presented as blue, white, or opaque. This has been a consistent trend since the first ReefClean sampling in 2019, indicating that hard plastic fragments are a sustained pollutant entering the GBR. Hard plastics are defined as *secondary microplastics* which can enter the environment from land and sea-based sources as larger pieces of plastic. Due to environmental processes such as ultraviolet photodegradation, aeolian action and wave force, these larger pieces break down into smaller fragments over time and persist in the marine environments.

Understanding of the exact sources of hard plastics entering the GBR are limited, due to the volume and diversity of microplastics found. To an extent, identifying the characteristics of a plastic, pertaining to its colour, shape, and relative age, can help to draw tentative connections to potential sources. The remote beach of Fly Point in Cape York reflects this, having been dominated by hard plastics in this year's sample (~73%) (**Figure 3**). AUSMAP's analysis identified that many of these showed visual signs of weathering which were confirmed using a microscope. It was also noted that many of these particles were prone to further fragmentation upon handling, which is consistent with the assumption that they had been in the marine environment for extended periods. Very often, this is indicative of a distant origin point from which the plastic particles have been dispersed by ocean and wind currents to their destination. With currents from both the east and the west influencing the Torres Strait area, the microplastics could have originated from several offshore sources.

On the contrary, styrofoam balls are more likely to come from a source in closer proximity to where they are deposited. Their lightweight nature makes them easily transportable by wind and water from land-based sources like packaging materials. Samples in 2022 indicated the presence of foam at a range of sites, including Alva Beach (Burdekin region) and Barney Point (Fitzroy region) **(Figure 10, Figure 18)**. Analysis of both these samples indicated that foam, which comprised 15% and 4% of total microplastics in each respective sample, had recently entered the marine environment. This was determined based on the degree of discoloration, physical weathering and the presence of algal growth that is typically indicative of exposure to the marine environment.

The presence of primary microplastics such as nurdles continued to be a feature of the 2022 ReefClean samples. These can be made of virgin or recycled plastics which have been known to enter the marine environment via stormwater drains after spillage during storage and transportation. The notoriously poor regulation of this industry up-catchment has manifested itself as a pollutant of aquatic ecosystems where nurdles and resin pellets are now found in high concentrations. The greatest loads of nurdles in 2022 were found at Harbour Beach (Mackay Whitsunday) which was composed of approximately14% nurdles, and Surf Beach (Burnett Mary) was 18% nurdles **(Figure 23)**. In the case of Surf Beach, nurdles were observed to be mostly blue and uniform in size (2-3mm), which implies that they have a single source. Identifying these specific features can help to inform future source tracing and source reduction efforts in local catchment areas, with the goal of reducing their presence in the GBR. Identifying microplastic conduits into the GBR catchment is imperative to understanding how to stop these pollutants at the source.

As was illustrated by each regional summary, microplastic loads are influenced by local weather and anthropogenic land use and are therefore subject to temporal and spatial variation. ReefClean monitoring has allowed trends to be observed across sites and NRM regions, though ultimately further sampling is crucial to identify further trends. Doing so enables relevant councils, communities, and government agencies to intervene appropriately in addressing the sources of litter in their local area to produce the best environmental outcomes for the GBR.

Interim Conclusions

The fourth year of the ReefClean microplastic sampling project continued to build upon the foundations established in 2019 and presents a more complete picture of microplastic loads and trends for the regions adjacent to the GBR. Determining region-wide trends is difficult when considering that individual results can skew regional averages.

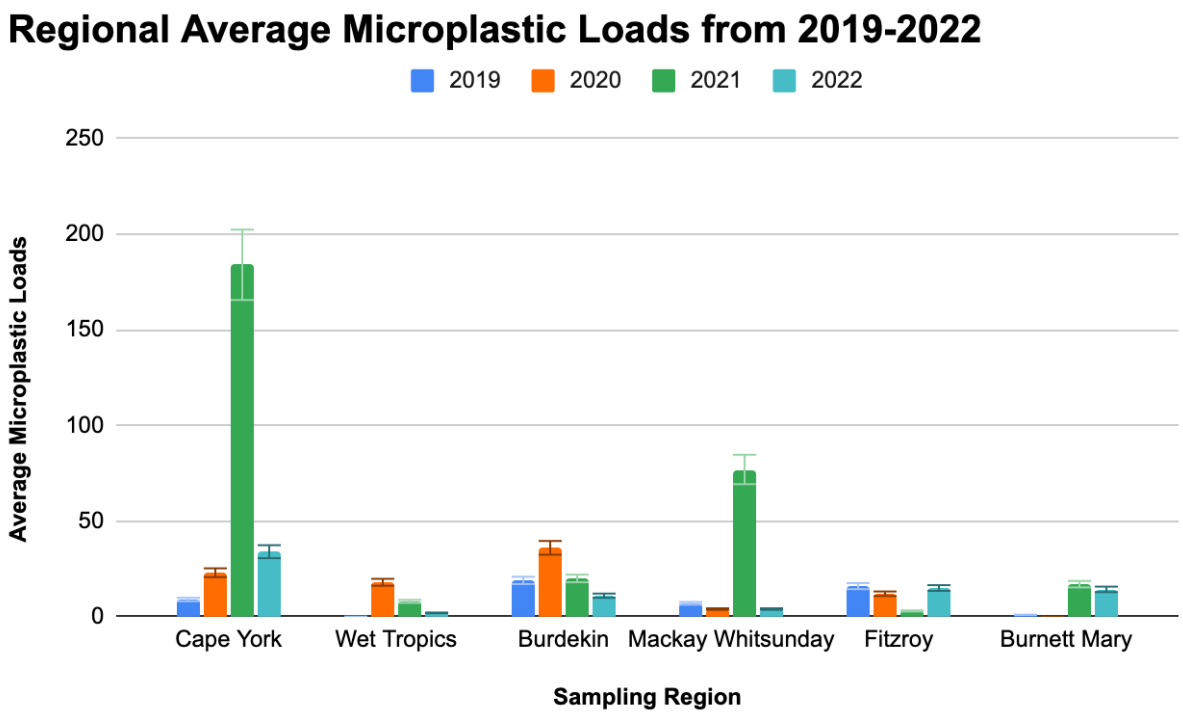


Figure 26. *Regional Average Microplastic Loads from ReefClean samples between 2019-2022. Averages include opportunistic samples and are influenced by the volume of surveys taken in each region. Error bars reflect variance during each sampling year. Microplastics measured in mp/m^2.*

Figure 26 demonstrates general regional trends, whilst considering regional variance. Three major trends can be observed from this graph, including:

- A substantial spike in 2021 in the Cape York and Mackay Whitsunday regions (primarily driven by vast increases at individual sites);
- A downward trend over time in the Wet Tropic region since 2019; and
- An upward trend in the Burnett Mary region since 2019.

Future monitoring should consider these regional trends to capture the full picture of microplastic pollution in the GBR.

Site averages typically decreased from those found in 2021. The largest difference in microplastic presence was detected at Fly Point which recorded 1191 particles per m^2 in September of 2021, and 136 particles per m^2 in September of 2022. Additional site-specific decreases were observed between 2021 and 2022 samples at Quintell Beach (17 mp/m^2 in September 2021, 0 mp/m^2 in September 2022), Alva Beach (111 mp/m^2 March 2021, 7 mp/m^2 in March 2022) and Half Tide Beach (140 and 311 mp/m^2 in 2021, 0 mp/m^2 in March 2022). Further sampling should seek to affirm whether these trends continue in future years despite a promising reduction in microplastic loads.

Season appeared to be the most influential factor on microplastic loads in 2022, with higher values typically being found in March. Evidence of this can be found in five of the six sample regions, apart from Cape York due to its substantially large load at Fly Point in September (136 mp/m^2), which because of its geographical location, is likely to be exposed to different currents and weather patterns. Key examples include Alva Beach (7 mp/m^2 in March; 0 mp/m^2 in September), Conway Beach (11 mp/m^2 in March; 2 mp/m^2 in September), Farnborough Beach (23 mp/m^2 in March; 0 mp/m^2 in December), Barney Point (24 mp/m^2 in March; 0 mp/m^2 in September) and Surf Beach (86 mp/m^2 in March; 0 mp/m^2 in September). Microplastic inflow into aquatic systems is influenced by seasonal oscillations, including changes to rainfall and ocean currents which may help to interpret these trends. It is also worth noting that March sampling is undertaken towards to the end of the Tropical Wet Season and may have attributed to the higher microplastic loads due to increased rainfall and runoff from land.

Notably, during both 2021 and 2022, Fly Point (Cape York) and Surf Beach (Burnett Mary) yielded relatively high results - an increase from prior years. This year's dataset helps to contextualise the unseemingly high values first observed at these sites in 2021. Given the continuation of this trend, it is uncertain whether site specific factors including human activity, beach direction, wind and current deposition are the cause. Continuing regular sampling at these sites is crucial to identify if these '**Moderate**' to '**Extremely High' loads** are ongoing, and what level of intervention is required.

Substantial increases of spatio-temporal microplastic sampling efforts within the GBR region are recommended to further build upon the last four years of data. This should occur through maintaining the sites previously sampled, focusing on those locations susceptible to high microplastic loads including Fly Point and Surf Beach, along with establishing new sample locations identified through spatial data gap analysis.

ReefClean Partnering Agencies and Organisations

Thank you to all ReefClean partnering agencies, organisations, and volunteers for all their support and efforts in conducting AUSMAP surveys during 2022.

- Tangaroa Blue Foundation
- Capricornia Catchments
- Reef Check Australia
- Whitsunday Catchment Landcare

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