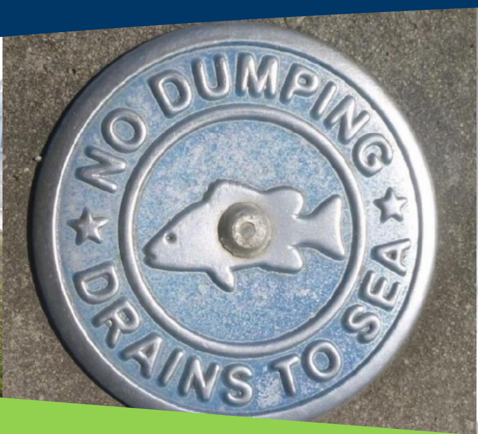

Final report for the stormwater debris assessment of the Goondoon Street & Lord Street Gross Pollutant Trap unit, December 2018

GPC tender OS17304031

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Executive summary

The Biodiversity Offsets Strategy implemented by Gladstone Ports Corporation (GPC) includes the installation of a gross pollutant trap (SPEL Baffle Box) at the corner of Goondoon Street and Lord Street, Gladstone. This report presents the findings of tests of the efficacy of the trap, performed during 2018. Debris was collected from the mesh trap itself, the concrete pit within which the trap was housed, and in a tube net installed over the stormwater outfall pipe below the trap. All debris was dried, sorted and weighed in the research laboratories at CQUniversity's Gladstone Marina Campus.

Shortly after the monitoring program commenced, a mechanical malfunction caused the trap to lift under water pressure (e.g. during a rain event) and allow substantial quantities of stormwater debris to by-pass the trap. This prevented a direct test of trap efficacy in February and March. Debris collected in the tube net across this period comprised a total of 1807 items collectively weighing 119.57 g. Plastic debris was the primary contributor to both the number of items collected (79.63 %) and their combined total weight (77.99 %).

Two subsequent tests of trap efficacy were done, with samples taken in May and August. Overall, it was observed that the trap was capable of retaining up to 80.69 % of the number of items, and up to 85.79 % of the total weight of items, entering the stormwater system. It was noted that the trap performed better in August compared to May, retaining 19.19 % more debris items and 7.18 % more debris weight, which may be related to increased rain events in May allowing greater quantities of debris to by-pass the trap.

Across both sampling periods, hard plastic fragments, fibrous plastics (e.g. cigarette butts), polystyrene and sheet plastic (e.g. food wrappers) comprised the majority of debris sampled in the stormwater system by number and by weight. However, there was clear variation in the retention of different types of debris. Fabric and polystyrene items were captured most effectively during both sampling periods, exceeding 85 % retention. The retention of other debris types, such as metal, wood, paper, and hard plastics, varied between sampling periods. For many debris types, the trap often captured a greater proportion of items by weight compared to individual pieces, suggesting the trap was most effective at capturing the heavier debris items during the sampling periods.

A multivariate comparison of the data revealed that relatively similar compositions of debris items by-passed the trap in the May and August samples (70.83 % similarity), suggesting additional debris interception methods could be designed based on a relatively high degree of predictability of items by-passing the trap.

Finally, a comparison of the debris items sampled in the current study to those sampled at the same outfall location in 2013 showed that despite more items of wood, paper, fabric, rubber, polystyrene, and sheet plastic entering the stormwater system in 2018, fewer of these items were ultimately sampled at the outfall into Auckland Creek due to their interception by the gross pollutant trap.

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Background

Coastal marine environments, such as beaches, mangroves, and salt marshes, are a common collection point for litter and other debris originating from urban centres. Waste items are frequently transported into sewer systems following rainfall events that channel water and debris into gutters or culverts and ultimately into stormwater drainage points (Derriak 2002, Gall & Thompson 2009).

The Biodiversity Offsets Strategy implemented by Gladstone Ports Corporation (GPC) includes initiatives to improve stormwater capture prior to stormwater discharge, thereby enhancing water quality. To meet this objective, installation of a gross pollutant trap (SPEL Baffle Box) at the corner of Goondoon Street and Lord Street, Gladstone, was conducted in June 2017 (Figures 1 and 2). This report summarises the findings of tests to determine the efficacy of this gross pollutant trap between the 19th of March and the 21st of August, 2018.

By placing a collection tube net at the stormwater outfall pipe below the installed gross pollutant trap, comparisons of collected materials between the net and trap were done to indicate the effectiveness of the trap. Collected contents were subsequently divided into multiple categories (e.g. glass, metal, wood, plastics, etc), counted, dried and weighed at CQUniversity's research laboratories at the Gladstone Marina campus.

Figure 1. *Aerial view showing the locations (yellow pins) of the installed gross pollutant trap at the corner of Goondoon Street and Lord Street, Gladstone, and the associated stormwater outfall pipe where the tube net was attached (source: GoogleEarth).*

Figure 2. *The SPEL Baffle Box gross pollutant trap installed at the corner of Goondoon Street and Lord Street, Gladstone (image: CQUniversity).*

Sample collection

A tube net of 1 mm mesh size and measuring 3.6 m long was initially installed over the opening of the stormwater outfall pipe in Auckland Creek on the 6th of February, 2018 (Figure. 3). A mechanical malfunction of the gross pollutant trap shortly after installation of the tube net caused the trap lid to lift under pressure of excessive water flow, where substantial quantities of stormwater debris were observed to by-pass the trap. This malfunction prevented a test of the trap efficacy at this time, although debris captured in the tube net was still collected for analysis of debris items in the drainage system (samples were collected on the 23rd of February and 19th of March, 2018).

Subsequent repairs to the gross pollutant trap included the insertion of a screw on the sliding retaining latch that secures the lid of the trap to ensure the lid would not lift under pressure, as well as the insertion of an aluminium trim to ensure the welded mesh cage would not come loose. These repairs allowed a direct test of trap efficacy by comparing trap contents with tube net contents. Continued observations of the gross pollutant trap during these sampling periods revealed considerable amounts of debris had bypassed the trap and accumulated in the pit below (i.e. still contained within the trap infrastructure but not in the mesh cage). Consequently, all debris in the trap *and* pit were collected for analysis in the laboratory, and compared to items collected in the tube net.

Two independent tests of trap efficacy were done. The first test ran from the 19th of March to the 4th – 8th of May, 2018 (trap and pit samples collected on the 4th of May, with the tube net sample collected on the 8th of May). The second test ran from the 9th of May to the 21st of August, 2018. For each test period, the percentage of total debris items and percentage of total debris weight retained by the trap/pit was calculated as an indicator of trap efficacy. For each debris category (fabrics, hard plastics, etc.), as well as summary debris categories (e.g. total plastics), the percent retention was calculated as the number (or weight) of items collectively sampled in the trap *and* pit, divided by the number (or weight) of items collectively sampled in the entire system of the trap, pit, and tube net.

For the sampling on the 21st of August, it was noted that the float/oil boom of the gross pollutant trap was torn and not functioning properly, allowing its contents to spill out, while the metal trim used to correct the initial trap malfunction was again coming loose. Additionally, a hole approx. 25 cm in diameter was found in the tube net covering the outfall pipe (presumably caused by tidal movement, waves, and winds moving the net over rocks). This may have resulted in some loss of debris from the net, although this was not directly observed.

Figure 3. *The tube net installed over the opening of the outfall pipe spilling into Auckland Creek, Gladstone (image: CQUniversity).*

Results

Initial collections – Tube net contents only due to trap malfunction

In both the February and March samples, plastic debris was the primary contributor to both the number of items collected in the tube net (79.63 % of the total) and their combined total weight (77.99 %).

A total of 910 debris items were sampled in the tube net on the 23rd of February, 2018, weighing 37.5 grams (Table 1). Hard plastic fragments and nurdles (small plastic pellets used to make a wide variety of plastic products) comprised the majority of debris items, collectively representing 62.86 % of the total number of debris items sampled, and 49.65 % of the total weight of debris items. A total of 630.83 grams of organic material (mostly leaf litter) was also sampled in the tube net. A total of 85.6 mm of rainfall was recorded for the Gladstone region by the Australian Bureau of Meteorology during this sampling period.

For the tube net sampling on the 19th of March, 2018, a total of 897 debris items were collected, collectively weighing 82.07 grams (Table 1). Hard plastic nurdles and fibrous cigarette butts comprised the majority of items sampled, accounting for 29.54 % and 22.07 % of the total number items, respectively. By weight, cigarette butts made the greatest contribution of 31.82 grams (38.77 % of the total weight of debris items). The weight of organic material sampled at this time reached 3,492.57 grams. A total of 69.4 mm of rainfall was recorded during this sampling period.

Table 1. *Number and weight of debris categories sampled in the tube net below the gross pollutant trap on the 23rd of February and the 19th of March, 2018. Values in* **bold type** *indicate the greatest contributing category, by count and by weight, for each sampling date. A total of 155.0 mm of rainfall was associated with these sampling periods.*

		Sampling date: 23rd February, 2018 Preceding rainfall: 85.6 mm		Sampling date: 19th March, 2018 Preceding rainfall: 69.4 mm	
Category	Type	Number of items	Weight of items (g)	Number of items	Weight of items (g)
NON-PLASTICS	Glass	15	0.90	31	3.21
	Metal	10	0.05	17	0.77
	Wood	59	5.17	27	2.84
	Paper	88	0.55	97	9.85
	Fabric	4	> 0.01	0	0.00
	Rubber	1	> 0.01	8	2.63
	Masonry	0	0.00	0	0.00
	Other	0	0.00	11	0.35
	SUB-TOTAL	*177*	*6.67*	*191*	*19.65*
PLASTICS	Hard	**572**	**18.62**	**321**	20.21
	Fibrous	46	5.62	230	**32.14**
	Polystyrene	75	4.40	21	0.65
	Sheet	40	2.19	131	8.22
	Rope/Line	0	0.00	3	1.20
	SUB-TOTAL	*733*	*30.83*	*706*	*62.42*
GRAND TOTAL		910	37.50	897	82.07
*Total organics**			*630.83*		*3,492.57*

*predominantly leaf litter

Trap vs Net collection: 19th of March to 4th/8th of May, 2018

A total of 3,644 debris items weighing 793.18 grams were sampled across the trap, pit, and tube net during the May assessment period. This coincided with a recording of 155.0 mm of rainfall for Gladstone over this sampling period.

A total of 1,702 items collectively weighing 415.37 g were sampled in the pollutant trap/pit, representing 46.71 % and 52.37 % of the total number and weight of items collected, respectively. Plastic debris accounted for the majority of items in the trap/pit (83.20 % of the total) as well as the tube net (76.62 % of the total) (Table 2). Major contributors by count and by weight to the accumulated plastic debris were hard plastic fragments and nurdles, fibrous plastic (predominantly cigarette butts), polystyrene foam fragments, and plastic packaging (sheet plastic).

A comparison between debris items sampled in the trap/pit and those that made their way through to the tube net revealed differences that were dependent on the type of debris. The trap was most effective at capturing fabrics (88.57 % retention) and polystyrene (93.21 % retention) (Figure 4). Other debris categories where over 50 % of the items sampled were retained in the trap/pit included wood, rubber, and fibrous plastics (e.g. cigarette butts) (Figure 4).

When examining the weight of debris retained, the data showed that the trap/pit was most effective at retaining polystyrene debris (98.20 % retention) and glass (82.28 % retention) (Figure 5). Other debris categories where the trap/pit retained over 50 % of the total weight of debris included metal, wood, fabric, masonry, and fibrous plastic (Figure 5).

Table 2. *Number and weight of debris categories sampled in the gross pollutant trap, associated collection pit, and outfall tube net below the pollutant trap/pit during the May sampling period, 2018. Values in* ***bold type*** *indicate the greatest contributing category, by count and by weight, for each collection point. A total of 155.0 mm of rainfall was associated with this sampling period.*

		Gross pollutant trap		**Pit sample (bypassed trap)**		**Tube net**	
Category	Type	Number of items	Weight of items (g)	Number of items	Weight of items (g)	Number of items	Weight of items (g)
NON-PLASTICS	Glass	1	1.3	0	0	2	0.28
	Metal	30	55.78	7	27.32	43	33.54
	Wood	17	40	0	0	12	10.91
	Paper	177	20.54	1	0.01	348	33.1
	Fabric	31	0.39	0	0	4	0.13
	Rubber	11	0.88	1	3.55	9	6.44
	Masonry	5	3.74	0	0	13	1.94
	Other	5	0.09	0	0	23	1.77
	SUB-TOTAL	*277*	*122.72*	*9*	*30.88*	*454*	*88.11*
PLASTICS	Hard	102	73.72	12	**27.76**	503	**112.4**
	Fibrous	**625**	**85.72**	12	2.08	**583**	83.88
	Polystyrene	257	3.91	**45**	6.47	22	0.19
	Sheet	324	47.75	7	9.4	346	86.93
	Rope/Line	31	4.77	1	0.19	34	6.3
	SUB-TOTAL	*1339*	*215.87*	*77*	*45.9*	*1488*	*289.7*
GRAND TOTAL		1616	338.59	86	76.78	1942	377.81
*Total organics**			*4,433.30*		*90.36*		*9,101.30*

*predominantly leaf litter

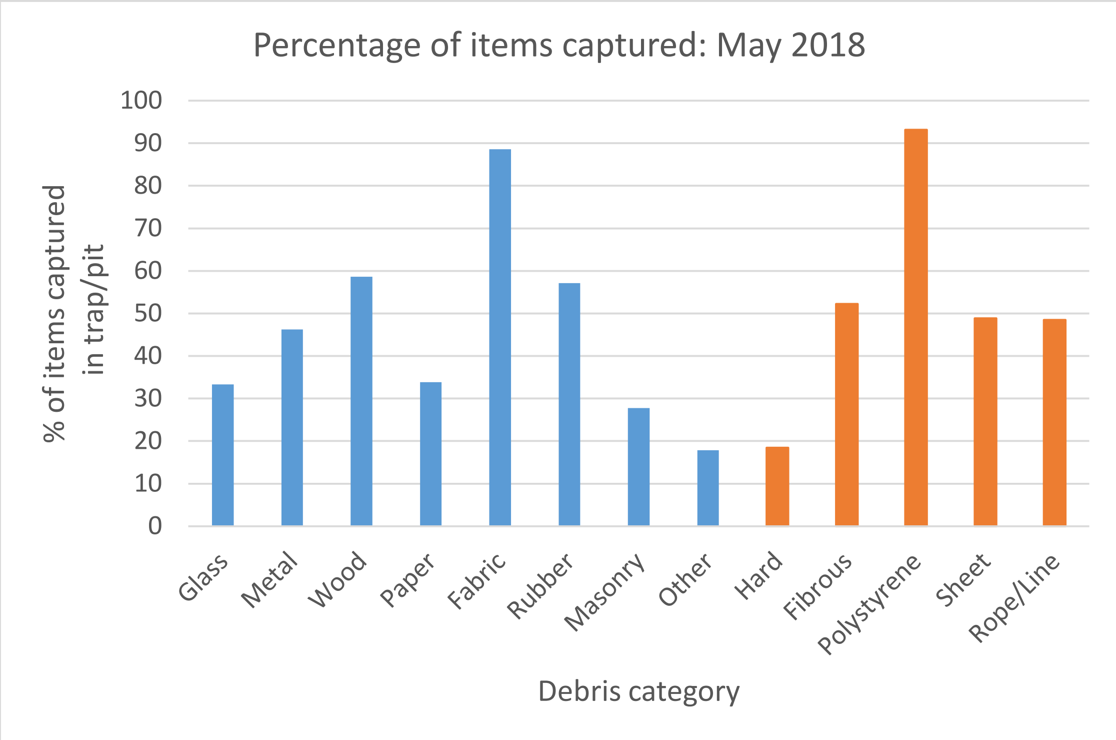

Figure 4. *Percentage of total debris items captured by the gross pollutant trap/pit, sampled across the 4th – 8th of May, 2018. Blue = Non-plastics, Orange = Plastics.*

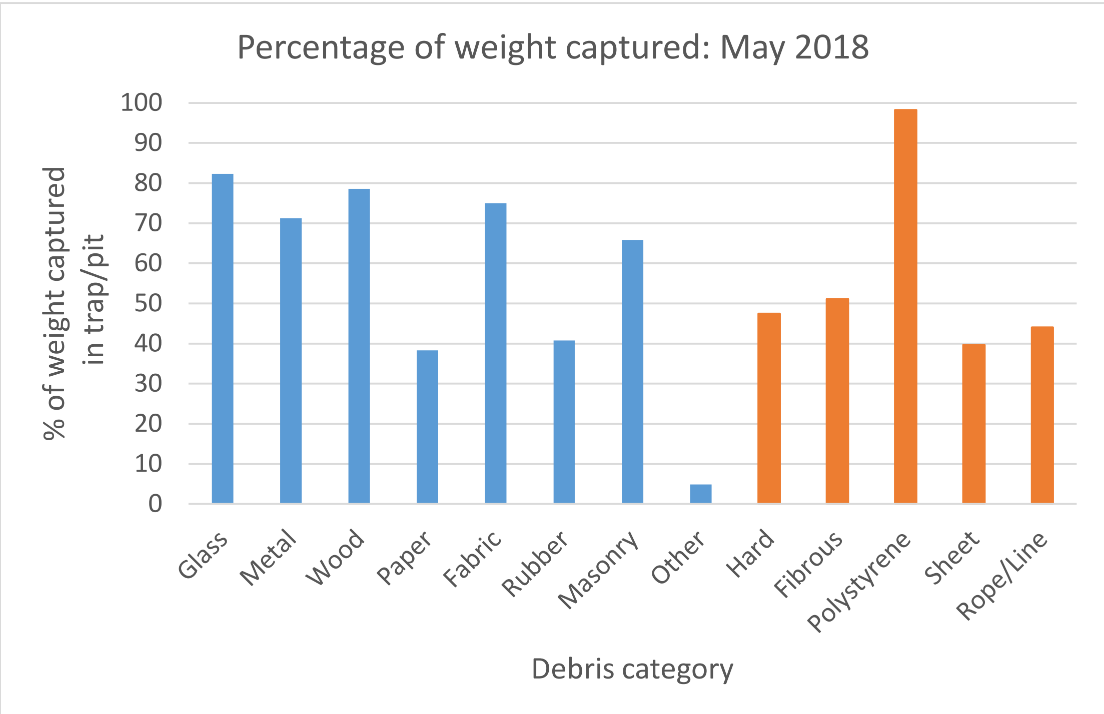

Figure 5. *Percentage of total debris weight captured by the gross pollutant trap/pit sampled across the 4th – 8th of May, 2018. Blue = Non-plastics, Orange = Plastics.*

Trap vs Net collection: 9th of May to 21st of August, 2018

A total of 5,707 debris items weighing 1,365.70 grams were sampled across the trap, pit, and tube net during the August assessment period. This coincided with a recording of 20.0 mm of rainfall for Gladstone over this sampling period.

A total of 4,605 items collectively weighing 1,171.65 g were sampled in the pollutant trap/pit, representing 80.69 % and 85.79 % of the total number and weight of items collected, respectively. As for the May samples, plastic debris accounted for the majority of items in the trap/pit (80.80 %) as well as the tube net (74.41 %) (Table 3). Major contributors by count and by weight to the accumulated debris were again hard plastic fragments and nurdles, fibrous plastic (predominantly cigarette butts), and polystyrene foam fragments. The large amount of nurdles sampled in this period are likely to have been biased due to the tearing of the trap's float/oil boom and subsequent leaking of the internal contents into the stormwater system.

Comparisons between debris items sampled in the trap/pit and those that made their way through to the tube net revealed differences that were again dependent on the type of debris. Identical to the May samples, the trap was most effective at capturing fabrics (98.73 % retention) and polystyrene (95.39 % retention) (Figure 6). All other debris categories except for glass and masonry exhibited over 60 % retention by the trap/pit. For glass and masonry, few pieces entered this particular sewer system during this time (glass: one piece sampled in the tube net; masonry: five pieces sampled in the tube net, one piece sampled in the pit).

When examining the weight of debris retained, the data showed that the trap/pit was again most effective at retaining polystyrene debris (98.70 % retention), but also exhibited over 70 % retention by weight of metal, wood, paper, rubber, hard plastic, fibrous plastic, sheet plastic, and rope/line (Figure 7). Notably, the data suggest the trap retained less than 30 % of the weight of fabric debris items entering the system, in contrast to its ability to trap almost 99 % of all fabric items. Examination of the data showed that one piece of fabric was sampled in the tube net, but this single piece accounted for 72.20 % of the entire weight of fabric sampled.

Table 3. *Number and weight of debris categories sampled in the gross pollutant trap, associated collection pit, and outfall tube net below the pollutant trap/pit during the August sampling period, 2018. Values in* **bold type** *indicate the greatest contributing category, by count and by weight, for each collection point. A total of 20.0 mm of rainfall was associated with this sampling period.*

		Gross pollutant trap		**Pit sample (bypassed trap)**		**Tube net**	
Category	Type	Number of items	Weight of items (g)	Number of items	Weight of items (g)	Number of items	Weight of items (g)
NON-PLASTICS	Glass	0	0	0	0	1	0.50
	Metal	37	86.77	1	21.53	20	19.58
	Wood	23	12.96	0	0	10	2.76
	Paper	718	60.55	3	0.09	235	6.35
	Fabric	78	1.81	0	0	1	4.70
	Rubber	11	128.66	1	52.36	3	8.46
	Masonry	0	0	1	0.32	5	38.81
	Other	5	0.24	6	0.01	7	0.86
	SUB-TOTAL	*872*	*290.99*	*12*	*74.31*	*282*	*82.02*
PLASTICS	Hard	220	**216.64**	**794**	85.91	210	27.69
	Fibrous	**1,111**	162.34	5	0.48	**295**	**42.77**
	Polystyrene	738	8.92	213	**229.22**	46	3.15
	Sheet	577	90.56	15	1.72	257	36.60
	Rope/Line	48	10.56	0	0	12	1.82
	SUB-TOTAL	*2694*	*489.02*	*1027*	*317.33*	*820*	*112.03*
GRAND TOTAL		*3566*	*780.01*	*1039*	*391.64*	*1102*	*194.05*
*Total organics**			*5,258.50*		*471.47*		*4,719.80*

*predominantly leaf litter

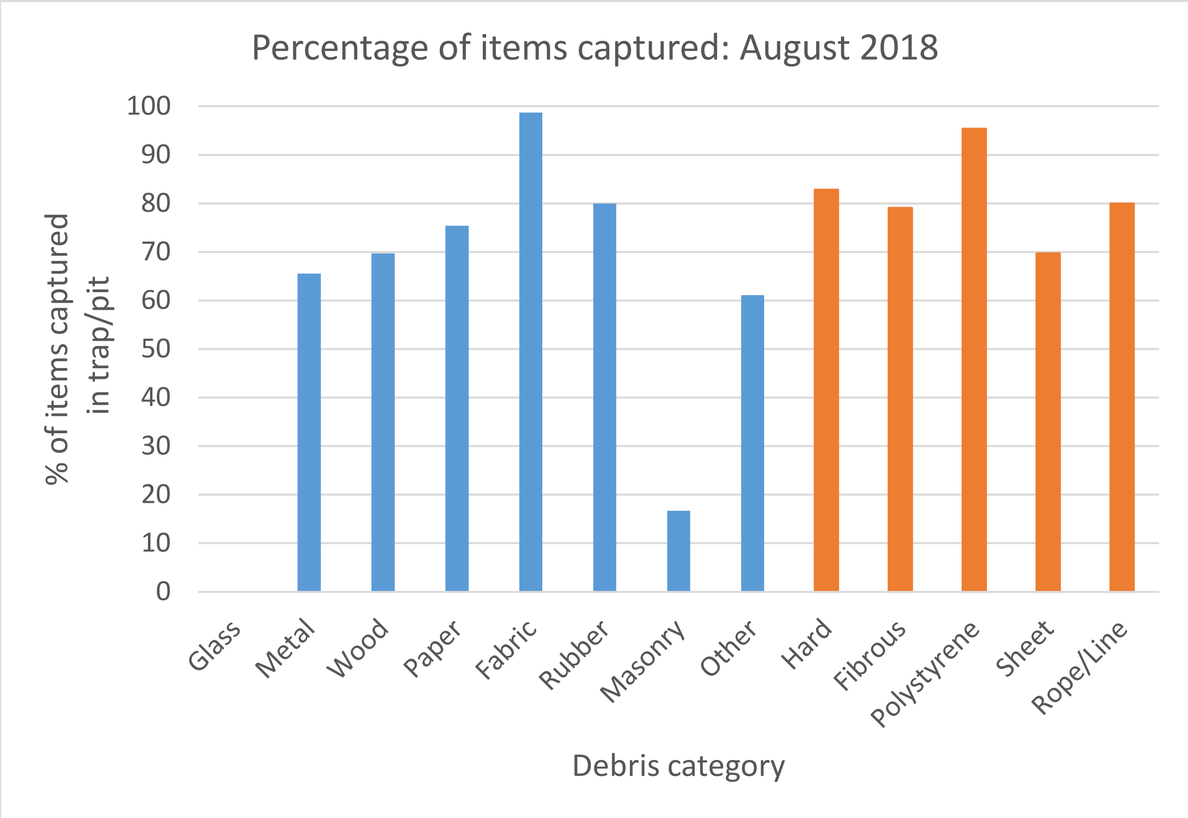

Figure 6. *Percentage of total debris items captured by the gross pollutant trap/pit, sampled on the 21st of August, 2018. Blue = Non-plastics, Orange = Plastics.*

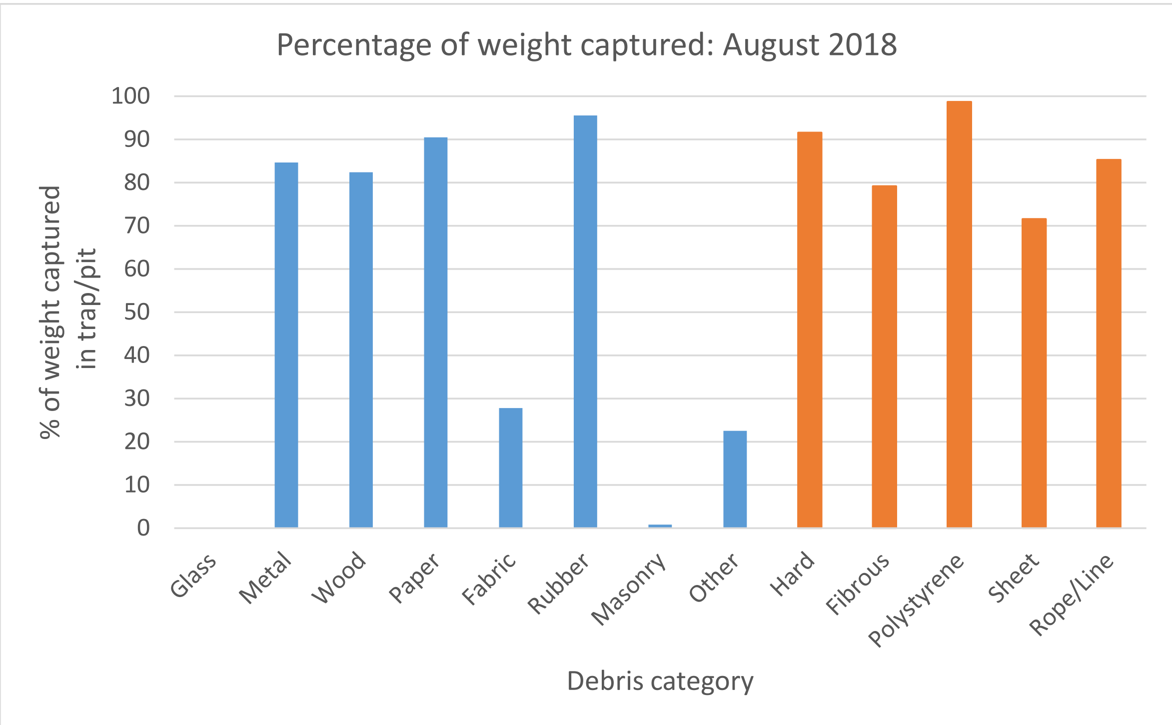

Figure 7. *Percentage of total debris weight captured by the gross pollutant trap/pit, sampled on the 21st of August, 2018. Blue = Non-plastics, Orange = Plastics.*

Comparison of sampling times: May vs August

Comparison of the trap/pit debris capture data between the May and August sampling periods revealed some notable differences. Overall, the trap performed better in August, capturing 19.19 % more debris items and 7.18% more debris weight. It should be noted, however, that this may be attributable to the longer duration of the collection period for the August sampling (104 days vs 50 days for the May sampling).

For 11 of the 13 debris categories sampled, the trap/pit collected more items in August than in May (Figure 8). Over 60 % more hard plastic items, and over 40 % more paper and 'other' debris items, were captured by the trap in August compared to May. Only glass and masonry showed a decline in the percentage of items captured, but this decrease should be interpreted in the context of the small number of these items that entered the system during the August sampling period (one piece of glass, and six pieces of masonry).

Comparison of the weight of debris items captured between sampling times also showed the weight of debris items captured by the trap/pit increased in August for ten of the 13 categories (Figure 9). Glass, fabric and masonry showed a decrease in the weight captured. For glass and masonry, this can again be related to the few items entering the system overall. For fabric, only one of 79 total pieces was not retained by the trap/pit, but this single piece accounted for 72.20 % of the total weight of fabric in the system during August.

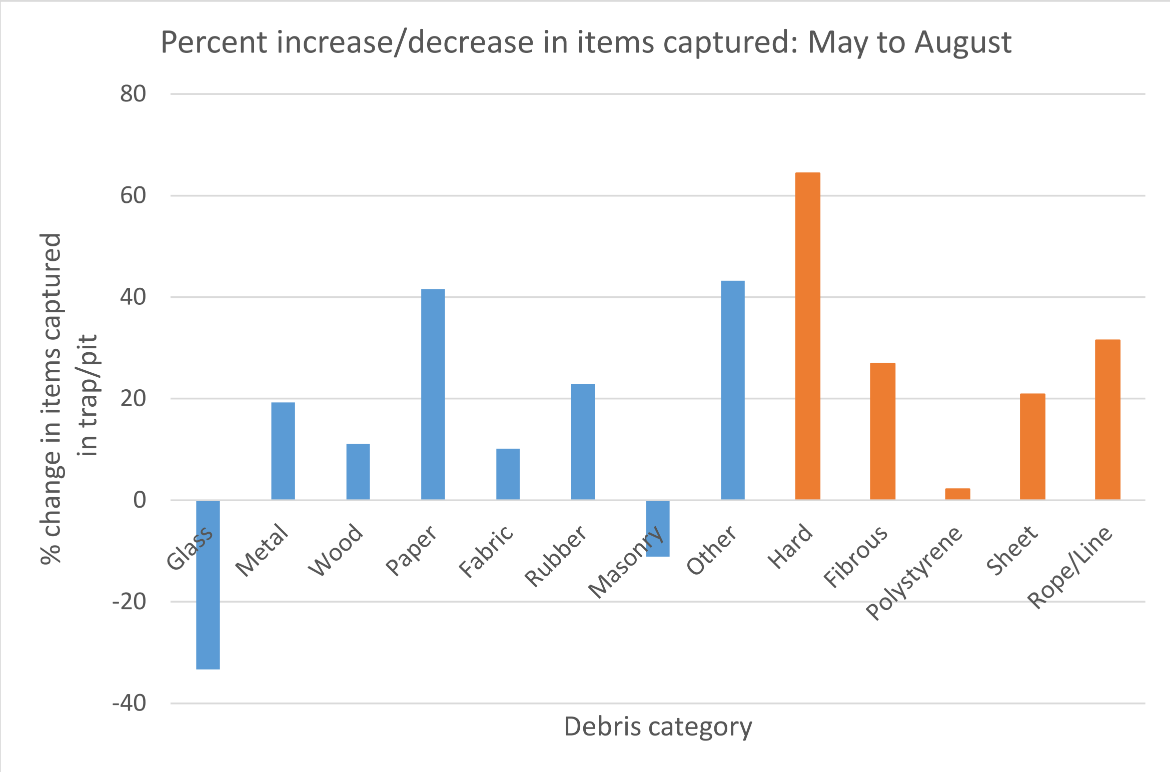

Figure 8. *Percentage change in the capture of debris items by the gross pollutant trap/pit from the May sampling period to the August sampling period. Blue = Non-plastics, Orange = Plastics.*

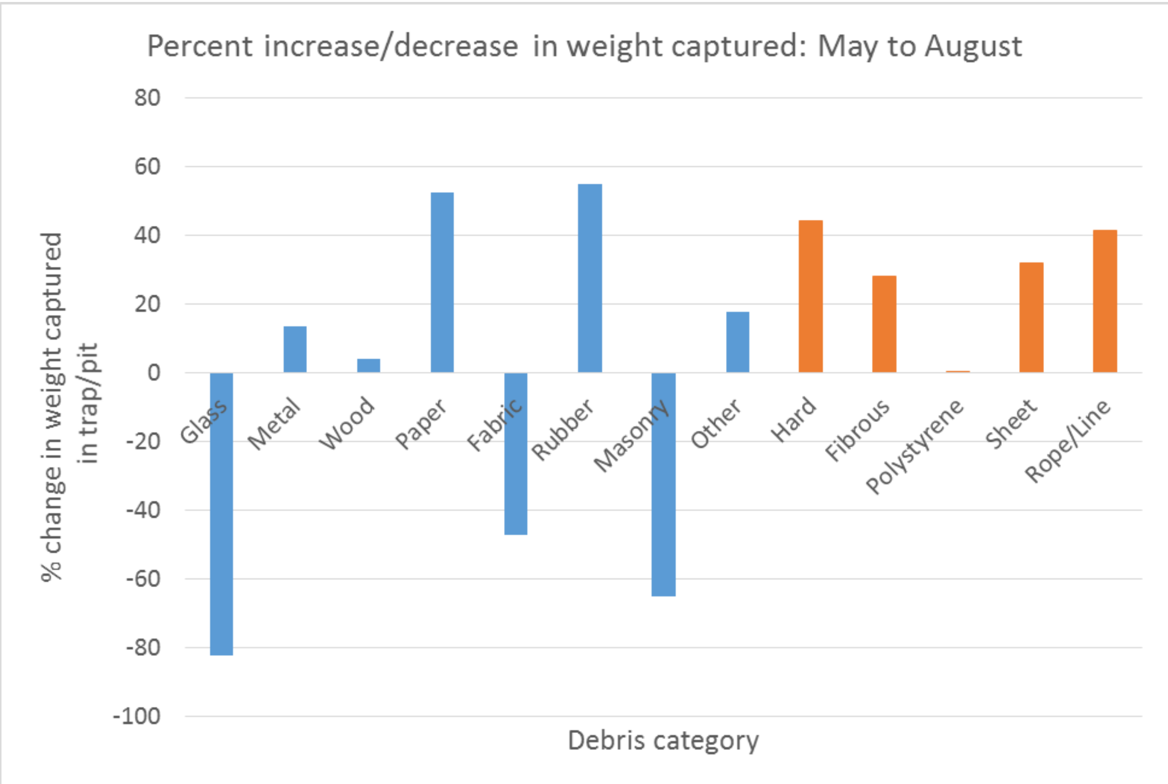

Figure 9. *Percentage change in the capture of debris weight by the gross pollutant trap/pit from the May sampling period to the August sampling period. Blue = Non-plastics, Orange = Plastics.*

Multivariate comparison

Multivariate comparisons of the composition of debris items sampled in the trap/pit and tube net in both May and August were done using the PRIMER 7 statistical package (Primer-e Ltd; Clarke & Gorley 2015).

A SIMPER analysis was done to quantify the percentage dissimilarity of the debris composition between sampling times and collection locations. This analysis showed the greatest dissimilarity in the debris composition was between the August trap/pit vs August tube net samples (61.65 % dissimilarity; Table 4). This is reflected in the graphical representation of the data (Figure 10), which shows these two points as the furthest apart. In comparison, the dissimilarity in debris composition between the May trap/pit vs May tube net was only 26.84 %, which is also reflected by the close proximity of these two data points in Figure 10.

The composition of debris by-passing the trap/pit and accumulating in the tube net was also relatively similar between May and August (29.17 % dissimilarity), suggesting similar items are capable of by-passing the trap/pit over time.

Across all comparisons, hard plastic, polystyrene, and/or fibrous plastic consistently contributed the most to dissimilarities in the debris composition, individually accounting for an average of 25.98 %, 27.78 % and 28.24 % of dissimilarities, respectively.

Table 4. *Result of SIMPER analysis summarising the dissimilarity in the multivariate debris composition sampled in trap/pit and tube net collection points in both May and August 2018. Dissimilarity percentages were calculated from Bray-Curtis distance measures.*

	May Trap/Pit	May Tube Net	Aug Trap/Pit	Aug Tube Net
May Trap/Pit	0.00 %			
May Net	26.84 %	0.00 %		
Aug Trap/Pit	46.19 %	41.62 %	0.00 %	
Aug Net	32.45 %	29.17 %	61.56 %	0.00 %

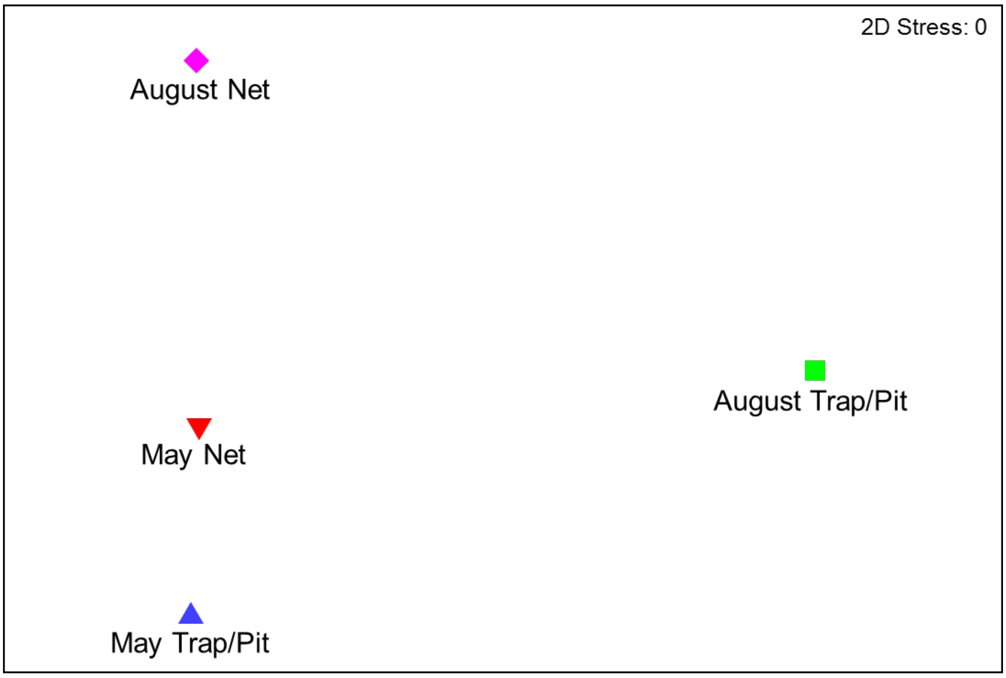

Figure 10. *Non-metric multi-dimensional scaling (nMDS) plot comparing the composition of debris items sampled in the trap/pit and tube net at each sampling time. The stress value of '0' indicates that the multidimensional differences among samples are well preserved in this 2-dimensional plot.*

Comparison to historical data

Comparisons to historical data should always be made with caution, especially when different methodologies are used, and when temporal confounding factors such as differences in potential sources of litter, variation in weather conditions, and changes to population size may influence findings.

For the current study, debris entering Auckland creek at the outfall pipe was previously sampled in January and February of 2013 as part of a broader spatial survey of marine debris in the Gladstone Harbour area (Wilson & Hansler 2014). While the SPEL baffle box had not been installed above the outfall pipe at this time, comparison of the average number of debris items sampled between the 2013 survey and the current study reveals some notable patterns.

While considerable variation exists for the average number of items sampled for each debris category, comparison of the rank abundance of items shows that fewer items of glass, metal, fibrous plastic and 'other' debris were sampled in 2018 (trap, pit, and tube net combined) compared to 2013 (Figure 11: 2013 vs 2018 Total, Table 5). For all other categories of debris, the average number of items sampled in 2018 increased on the 2013 values.

Comparing the rank abundance of the number of debris items captured in the tube net only (i.e. items not retained by the trap/pit in 2018) shows that there were fewer items of glass, metal, wood, paper, fabric, rubber, fibrous plastic, polystyrene, sheet plastic, and 'other' debris in 2018 (Figure 11: 2013 vs 2018 tube net, Table 5).

Table 5. *Average number of items sampled at the Auckland Creek outfall for each debris category in the 2013 survey (Wilson & Hansler 2014) compared to the average number of items sampled at the outfall and in the entire stormwater system during the current 2018 survey.*

Category	Type	**2013 tube net** Number of items	**2018 tube net** Number of items	**2018 total in stormwater system** Number of items
NON-PLASTICS	Glass	64	1.5	2
	Metal	94.5	31.5	69
	Wood	14	11	31
	Paper	585	291.5	741
	Fabric	11	2.5	57
	Rubber	14	6	18
	Masonry	ND	9	12
	Other	28	15	23
PLASTICS	Hard	192.5	356.5	920.5
	Fibrous	1942.5	439	1315.5
	Polystyrene	169	34	660.5
	Sheet	326	301.5	763
	Rope/Line	14.5	23	63

ND = no data recorded for this category

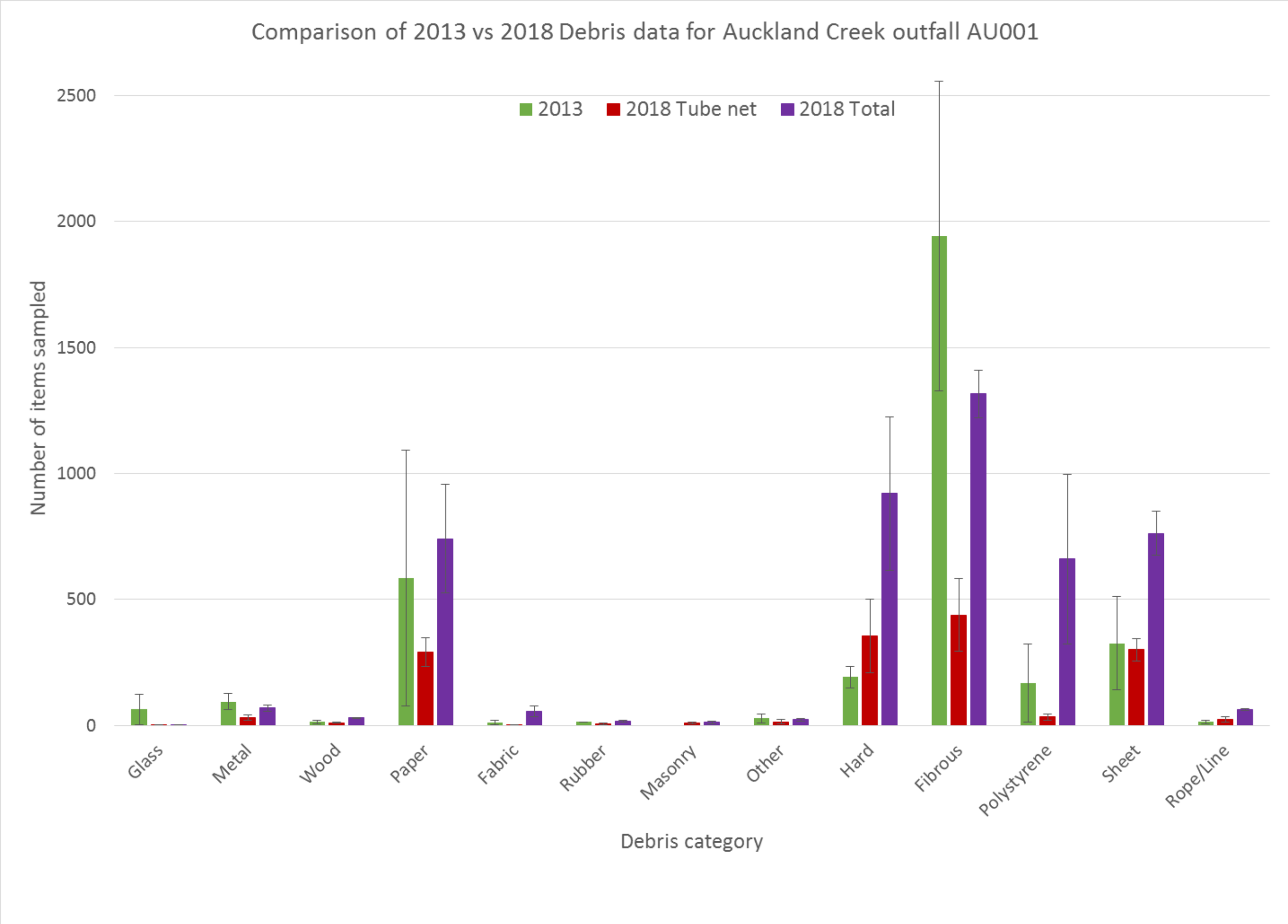

Figure 11. *Comparison of the average number of debris items sampled at the Auckland Creek outfall for each debris category in the 2013 survey (Wilson & Hansler 2014) compared to the average number of items sampled at the outfall and in the entire stormwater system during the current 2018 survey. Note that the masonry category was not sampled in 2013.*

Discussion

The primary objective of the SPEL Baffle Box gross pollutant trap installed at the corner of Goondoon Street and Lord Street is to intercept and reduce the amount of stormwater pollution entering Auckland Creek. The results of this 2018 study show that the trap is achieving this objective, retaining up to 80.69 % of the number of debris items entering the stormwater system, and up to 85.79 % of the total weight of debris items entering the stormwater system. These values are indicative of all debris items larger than 1 mm in size (the mesh size of the tube net), and there were likely debris items smaller than this (e.g. microplastics) that by-passed the trap and tube net. While the SPEL Baffle Box is not specifically designed to retain such small debris items, an awareness of the distribution and impact of such micro-debris in coastal and marine environments has increased in recent times (Wright et al 2013), and an understanding of their prominence in stormwater systems in the Gladstone region would help improve debris management capacity.

Across all sampling periods, plastics comprised the majority of sampled debris by number and by weight. In particular, hard plastic fragments, fibrous plastics (e.g. cigarette butts), polystyrene and sheet plastic (e.g. food wrappers) were typically in relatively high abundance in samples. This is consistent with previous marine and coastal debris survey work in the Gladstone area (Wilson & Cartraud 2014, Wilson & Hansler 2014) and indeed around the world (Vince & Hardesty 2017).

Sampling to determine trap efficacy was done twice (May and August, 2018) as a step toward gaining some indication of repeatability of trap performance, as well as in indication of performance in wet- vs dry-season conditions (the May sampling being associated with 155.0 mm of rain, while the August sampling being associated with 20.0 mm of rain). It was noted that the trap performed better in August compared to May, retaining 19.19 % more debris items, and 7.18 % more debris weight. Interpreting that the trap performs better in dry season conditions must be made cautiously, however, due to the difference in debris collection time between the two tests (50 days for the May test, and 104 days for the August test), and because only one wet season and one dry season test has so far been achieved. Nevertheless, it is possible that the improved overall performance of the trap in August may be due to the absence of large rain events typical of intense wet season storms, which may overfill the trap/pit infrastructure and create turbulence that allows debris to bypass the unit entirely. Continued testing and observation of the trap during rain events is needed to help determine reasons for differences in trap performance between seasons.

While overall retention of gross pollutants by the trap could exceed 80 %, there was clear variation in retention based on the type of debris. Fabric and polystyrene items were captured most efficiently for both sampling periods, with the number of items retained by the trap exceeding 85 %. The retention of other debris items, such as metal, wood, paper, and hard plastics, varied between sampling periods (e.g. less than 20 % retention of hard plastics in May, but over 80 % retention in August), making it difficult to currently ascertain the true trap efficacy for such items.

For many debris categories, the trap often captured a greater proportion of debris items by weight compared to individual pieces, suggesting the trap was most effective at capturing the heavier debris items during the sampling periods. This would make sense given the physical limitations on the mesh size that is able to be used in the trap design to capture debris without greatly impeding water flow. Smaller items would pass through the mesh to the pit environment, which may facilitate their transport out of the pit and into Auckland Creek during rainfall events that generate high water flow and turbulence within the Baffle Box structure. It should be noted that large items did occasionally by-pass the trap and were sampled in the tube net during the study. For example, during the August sampling period, a large piece of fabric weighing 4.7 grams by-passed the trap, which had otherwise retained 78 items of fabric collectively weighing 1.81 grams.

While the quantities and weights of debris items retained by the trap often varied between sampling times and debris categories, the multivariate comparison of the composition of debris revealed relatively similar compositions between the May and August tube net samples (70.83 % similarity). This suggests that the type and quantity of debris that isn't retained by the trap was relatively similar over time. This knowledge is useful as it suggests a relatively high degree of predictability of what items are by-passing the trap, and thus additional debris interception methods could be designed to capture these items and ultimately further reduce the introduction of debris into Auckland Creek. Additionally, all multivariate comparisons showed that hard plastics, polystyrene, and/or fibrous plastics consistently contributed the most to dissimilarities in the debris composition, further underscoring their importance for interpreting and managing stormwater debris.

A comparison of the debris items sampled in the current study to those sampled at the same outfall location in 2013 showed similar types of debris entering the stormwater system between years. In 2018, however, more items of wood, paper, fabric, rubber, polystyrene, and sheet plastic were sampled in the stormwater system compared to 2013 (Figure 11). Despite this increase, fewer of these items were ultimately sampled at the outfall in 2018 compared to 2013 due to their interception by the gross pollutant trap, further underscoring the utility of the trap for reducing the input of these debris items into Auckland Creek.

In conclusion, the gross pollutant trap installed at the corner of Goondoon Street and Lord Street, Gladstone, is capable of reducing the number and weight of stormwater debris items (greater than 1 mm in size) entering Auckland Creek by at least 80 %. Considerable variation in the retention of debris by the trap was observed between sampling times, which may be related to rainfall events associated with wet vs dry season conditions. While variation in retention also occurred among different debris types, the multivariate analysis of the items that ultimately by-passed the trap suggested relative consistency over time, which may facilitate the design of additional interception methods downstream of the installed trap.

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