



**Biodiversity and  
Conservation Science**

# Swan Canning Riverpark Plastics Survey

Final Report to Department of Water and Environmental  
Regulation



Peter Novak

June 2023



Department of **Biodiversity,  
Conservation and Attractions**

Department of Biodiversity, Conservation and Attractions  
Locked Bag 104  
Bentley Delivery Centre WA 6983  
Phone: (08) 9219 9000  
Fax: (08) 9334 0498

[www.dbca.wa.gov.au](http://www.dbca.wa.gov.au)

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This report/document/publication was prepared by Peter Novak

Questions regarding the use of this material should be directed to:  
Principal Scientist  
Rivers and Estuaries Science Program  
Department of Biodiversity, Conservation and Attractions  
Locked Bag 104  
Bentley Delivery Centre WA 6983  
Phone: +61-8-9219 9000  
Email: [RESscience@dbca.wa.gov.au](mailto:RESscience@dbca.wa.gov.au)

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## Executive Summary

Plastic pollution presents a significant risk to riverine and estuarine environments. These environments may receive plastic pollution from the immediate local catchment including parklands, riverbank activities, and roads as material that is either washed down from the upstream catchment or arrives on tidal influx from nearshore marine areas. Once in aquatic environments, plastic may cause a range of harmful effects on aquatic life and reduce visual amenity of the environment. Known harmful effects may include reduction in fitness or starvation from plastic ingestion and entanglement and new evidence is emerging of the physiological impacts of plastic, including harmful effects on digestive enzyme production and oxidative stress. An understanding of what type of plastic is present in the environment, its prevalence, what drives its accumulation temporally and spatially in estuarine regions and beaches is vital information to develop mitigation programs and understand the potential for environmental impact.

This study sought to address these knowledge gaps and provide critical information to the WA Plan for Plastics, on the type and abundance of plastic found in the environment and provide a baseline of plastic pollution that can be revisited at a later date to assess the effectiveness of the Plan and any future mitigation programs. The WA Plan for Plastics is a policy initiative implemented by the Department of Water and Environmental Regulation. As of 2022 the policy provides two set regulations to ban the supply of targeted single-use and disposable plastics. The field work was conducted after the implementation of the lightweight plastic bag ban (1 July 2018) and prior to the implementation of stage 1 of the WA Plan for Plastics (July to October 2022).

This study sampled plastic abundance in both the beaches and surface water of the Swan Canning Estuary every three months commencing in March 2021 and concluding in December 2021. A total of 38 beach sites were sampled with a minimum of 12 in each of the three major estuary regions, including the Lower Swan Canning Estuary, Swan Estuary and the Canning Estuary. Of the 12 sites an equal number were on shorelines that faced north, south, east and west. Beach samples were collected using a method based on the “CSIRO Handbook of Survey Methodology: Plastic Leakage”. Within the same estuary regions, surface water samples were collected by conducting four replicate 10 minute tows in each of four sites using a manta tow net.

Beach samples were further processed in the laboratory to obtain weight and were subsampled for polymer type analysis. Surface water samples required a digestion process to remove non-plastic organic matter, before identification and quantification could be completed using a dissection microscope.

The beach surveys found plastic at every site on at least one occasion. Plastic accumulation was highest in June and September following winter rainfall and large storm surges which primarily deposited the plastic in the vegetated part of the beach. Beach orientation had a significant effect on plastic accumulation with much higher accumulation of plastic on south and western facing beaches in the Swan and Lower

Swan Canning estuaries. No such effect was observed in the Canning Estuary, which also recorded the lowest quantity of plastic debris. Five sites of significant plastic accumulation were identified, two in the lower Swan Canning Estuary and three in the Swan Estuary. Each of these sites were on south or western facing beaches. It was proposed that the sites in the Swan Estuary were impacted by the location on the windward side of Perth Water and the CBD, receiving wind driven plastic from these areas. The two sites in the Lower Swan Canning Estuary were both located far downstream in this region and likely accumulated a high amount of plastic due to their proximity to the Fremantle Harbour, tidal influence, and significant recreational boating activity in this region.

The most common plastic items found on the beaches consisted of expanded polystyrene (EPS), and fragmented hard and soft plastics. Of the items to be banned under the WA Plan for Plastics, EPS pieces (separate to EPS food and beverage containers) were the most commonly encountered item and found in the highest abundances and on most beaches. Other commonly found items were straws, thin film carry bags, food containers and EPS food containers and EPS cups, and hard plastic plates and bowls. The results showed consistency with global literature, with the most common polymer types identified in this study being expanded polystyrene (EPS), polypropylene polyethylene and polyethylene terephthalate in both soft plastics and clothing fibres.

Plastic was found in every surface water trawl in every location during this study. The highest quantity of plastic was found in Melville Water and the most downstream region, Point Walter to Stirling bridge. Plastic was lowest in March before increasing significantly in June and September during the winter, before abundance declined in December. The highest mean abundance of plastic was 53 pieces/KL in Melville Water during June. The most dominant type of plastic found in the study was filaments followed by fragments. Foam and soft plastic films were also found. Plastic microbeads were encountered but rarely. Microbeads are often made from polymers with a density greater than water and thus can sink and may not be found in surface water tows. Most plastic items found in the trawls were between 1-5 mm in size.

To conclude, this study has found plastic to be prevalent on the beaches and surface water of the estuary. Beach orientation is a key driver of plastic accumulation in the Lower Swan and Swan Estuaries, with much greater plastic accumulating on south and western facing beaches. The most prevalent items found on the beaches were fragmented EPS followed by fragmented hard and soft plastics. These fragmented plastics shows the fate of large plastic items that escape or are littered into the environment. Over time, plastic breaks up in to smaller and smaller pieces that litter the beaches and are likely swallowed by aquatic fauna including birds and fish. The prevalence of tiny plastic pieces in the surface water is further evidence of this and highlights the potential risk to aquatic fauna.

The items to be banned under the WA Plan for Plastics are significant items that were found commonly throughout the estuary. The removal of these items, particularly EPS in food packaging and general packaging should contribute to reducing the quantity of this material that ends up in the estuary.

However there remains considerable plastic in the estuary environment and clean ups may be effective at removing a portion of large plastic items, while technologies that remove plastic floating in surface waters, such as those used in Elizabeth Quay, can remove larger plastics. Finally, this study has also identified key problematic sites which could be targeted for further clean up events or ongoing management to remove plastic from the estuary. These sites included Mosman Park Foreshore, Jenalup beach near Point Walter, Point Frazer, and the western side of Burswood Peninsula.

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# 1 Introduction

Plastics are ubiquitous in aquatic environments. Large commercial or consumer plastics such as drink containers, synthetic rope, food containers/wrappers, synthetic clothing, and packaging and wrapping material enter aquatic environments from urban sources where, over time they break up or fragment into smaller and smaller pieces eventually becoming microplastics (fragments less than 5 mm). Commercial plastic resin pellets, also known as nurdles, are purposely manufactured between 1-5 mm in size and can be released directly into the environment from spills, poor site management or inappropriate activities. Both microplastics and macro-plastics can remain in the environment and negatively impact aquatic and terrestrial biota.

Once in the environment, plastics can cause a range of environmental hazards, primarily through entanglement and ingestion by biota which may lead to reduced fitness, illness, starvation, or malnutrition (Rochman et al., 2016; Roman et al., 2019). Additionally, in an aquatic environment, plastics are known to bind persistent organic contaminants such as organochlorine pesticides, polychlorinated biphenyls and polycyclic aromatic hydrocarbons, adsorbing high concentrations of these otherwise trace contaminants (Wardrop et al., 2016). When these plastics are ingested, the organism may be exposed to high concentrations of potentially harmful contaminants (Rainieri et al., 2018; Wardrop et al., 2016).

The Swan Canning Riverpark, situated wholly in the Perth Metropolitan Region supports productive and biodiverse floral and faunal communities. The system is exposed to a range of anthropogenic stressors including elevated nutrients and non-nutrient contaminants such as heavy metals, pesticides and hydrocarbons (Nice, 2022). Plastics have also become a known pollutant, with community-based surveys (eg: Tangaroa Blue) suggesting concerning levels of accumulation in some areas of the Riverpark.

The Western Australian Government has introduced regulations to reduce the known impacts of single-use plastics, by banning lightweight plastic shopping bags in July 2018, and developed the WA Plan for Plastics program ([Western Australia's Plan for Plastics | Western Australian Government \(www.wa.gov.au\)](https://www.wa.gov.au/government/policies/plastics)) which has introduced regulations to restrict a range of single use plastic items as provided below. Each of these dates marks the start of enforcement of regulation, with some carryover use still expected beyond this time.

- July 2022 – disposable plastic plates, straws, stirrers, cutlery, unlidded bowls and containers, thick plastic shopping bags, expanded polystyrene food containers and helium balloon releases;
- October 2022 – disposable plastic cups;
- September 2023 – loose fill expanded polystyrene packaging, expanded polystyrene cups, microbeads, cotton buds with plastics stems and degradable plastics;
- March 2024 – barrier/produce bags, coffee cups/lids, unlidded trays;
- September 2024 – takeaway food lids for bowls, trays, plates, and containers; and

- July 2025 – moulded expanded polystyrene packaging.

To help inform policy decisions and regulatory actions on single-use plastic items, the level of plastic pollution within urban environments and their potential impacts on fauna in Western Australia needs to be understood. This research will provide a repeatable baseline of plastics pollution in the Swan Canning Riverpark, which can be used to assess the success of current and future policy actions.

The establishment of baseline data on plastic pollution within the Riverpark will be used to identify the regions where plastic concentrations are greatest and assist with the identification of potential sources. The Department of Water and Environmental Regulation (DWER) has provided information on potential industrial sources of plastic resin pellets and plastic pollution to the Riverpark. DWER could use the information from this survey to investigate and develop programs for plastics manufacturers to improve the management of accidental release or illegal dumping of plastic pollution into the estuary.

The objective of this project was to determine the source, extent and distribution of plastic pollution in the Swan Canning Riverpark over a 12 month period.

Initial project aims were to:

- Determine the distribution, extent and type of plastic pollution found in the surface water and beaches (including coarse plastic) of the Swan Canning Riverpark.
- Establish if the distribution, extent and type of plastic found in the Swan Canning Riverpark varies between summer (low rainfall) and winter (high rainfall).
- Determine if the sources of plastic can be identified, specifically:
  - Can the main sources of plastic pollution, for example from commercial activities (i.e. plastic resin pellets (nurdles), commercial packaging) or consumer plastics (i.e. food packaging, cigarettes, health care products, single-use items), be identified by the type of plastic through visual identification or laboratory analysis?
  - Are there any regional differences in the abundances and sources of plastic pollution?

## 2 Methods

### 2.1 Beach surveys

Detailed sampling methods are provided in the Sampling and Analysis Plan in Appendix 1.

To determine the abundance of plastic pollution on beaches within the Swan Canning Riverpark, and the potential drivers for accumulation, 38 sites were selected across the Riverpark, with an equal number of north, south, west and east facing beaches in each Riverpark zone (lower Swan Canning, Canning and Swan Estuary).

Additionally, two sites with historic datasets (at Jenalup Beach near Point Walter and the beach at Vlamingh Reserve Mosman Park) were added bringing the total number of sites assessed to 38 (Figure 1, Table 1). To limit any subjectivity bias, sites were positioned at points every 2 km from the mouth of the estuary and those that met the directional criteria were retained with the aim of having sites consistently spaced around the estuary.

At each site a 100 m transect was measured along the shoreline and a two metre wide transect running perpendicular to the shoreline was spaced at intervals of 0 m, 50 m and 100 m. The length of each perpendicular transect varied, commencing at the water line and extending two metres into the vegetation.

To determine the horizontal distribution of plastic, each transect was divided into three subsections, where possible. The first subsection extended from the water line to immediately above the most recent strandline/high tide mark. Subsection 2 extended from the top of subsection 1 to the start of the vegetation. Subsection three extended two metres into the vegetation. Plastic and other anthropogenic debris 2-3 mm in size and greater were collected in each transect. Each item was identified and counted (see Appendix 2 Table A2.1 for item list).

At the completion of the three transects a final sweep of the entire 100 m beach transect was completed. The purpose of these whole site sweeps was to capture larger, less common items they may be under-represented in the finer scale transects. Items larger than ~30 mm were collected. These items were identified and counted.

All samples were taken to the laboratory where they were weighed, and a subsample was taken for polymer identification. The subsample was gained by collecting up to ten items visually and texturally different from each other in each sample. Items clearly identifiable as expanded polystyrene were not included as polymer type was known. Polymer identification was completed by Curtin University using Fourier transform infrared (FTIR) spectroscopy and the resultant spectra compared to an in-house reference library of 10 polymers.

## **2.1.1 Beach survey analyses**

### *2.1.1.1 Statistical analyses*

To determine the patterns of accumulation of anthropogenic debris on beaches, both standard beach transects and the whole site sweeps, a three-way permutation multivariate analysis of variance (PERMANOVA (Anderson et al., 2008)) was used with factors as region, orientation and sampling month. Data were initially grouped into 13 main debris types including: hard plastic, soft plastic, plastic rope/string/straps, metal, glass, rubber, cloth, timber, foam, paper, fishing, plastic resin pellets (nurdles), and other. Nurdles were excluded from the whole site sweep analysis as they were not targeted by the sampling. The data for the standard beach transects were log<sub>10</sub> transformed to reduce the influence of very high counts at some sites and debris types. The data from the whole site transects were square

root transformed due to a lower range in the variables than the standard beach transects. A Euclidean distance matrix was constructed using the transformed data prior to the PERMANOVA analysis. Pairwise tests were then used when effects were significant. To visualise the data and explore the influence of major plastic type on the differences between regions and beach orientation a Principal Components Analysis (PCA) was used using a log transformed data.

The distribution of plastic between the subsections was analysed using a univariate PERMANOVA to explore the differences in total plastic accumulation across three factors, region, orientation and subsection. The data were log transformed to reduce the influence of very high counts at some sites. A Euclidean distance matrix was then constructed and a three-way PERMANOVA was completed.

The PERMANOVA and PCA were completed using the Primer 7 software with the PERMANOVA package.

To explore the influence of shoreline characteristics on plastic accumulation on beaches in the Swan Canning estuary a multiple regression analysis was used. The dependant variable in this analysis was the count of all plastic that accumulated in each transect. The potential predictor variables were selected based on an a-priori hypothesis that estuary region, beach orientation, sampling month, bank height, length and slope, and vegetation or lack thereof would influence plastic accumulation. Where the predictor variable was categorical (e.g., beach orientation), it was converted to numeric by assigning a value from 1 to 4.

Firstly, a correlation matrix was constructed to explore the relationship between predictor variables. Most variables were weekly or moderately correlated ( $r < 0.65$ ) and so none were removed from the analysis.

The total count data were log<sub>10</sub> transformed to satisfy the assumptions of normality and variance homogeneity inherent in linear regression analysis. To determine the best set of predictors for the dependant variable we used best subsets multiple regression analysis. To avoid the over parameterisation of the model, Akaike Information Criterion (AIC) (Quinn & Keough, 2002) was used to select the best regression models (i.e. high model fit relative to the number of predictor variables). Standardised slope parameter estimates are given as these equate to the correlation co-efficient for each independent variable. Partial regression slope analysis outputs are also provided to determine the significant independent variables in the best subset model. Analyses were completed using R Studio “olsrr” and “Hmisc” packages.

#### *2.1.1.2 Ranking method*

To develop a ranking of the most abundant plastic types and the most frequently detected, the standard beach transect data for each site on each sampling occasion was pooled into a site total for each plastic type. The plastic type was from the total list of plastic types identified ( $n=135$ ) during the study. A mean for each plastic type was then calculated for each region from the site total for all sampling times. Thus, a single mean value for each plastic type for each region was obtained. The mean site

abundance data for each plastic category was then assembled in descending order with highest mean given a rank of 1 and so forth down the order.

Plastic categories were also sorted according to frequency of detection. This ranking was completed by using the pooled site count data as described above and counting the times it was detected (presence or absence) in each site on each sampling occasion. This value, total number of detections per region, was converted to a percentage by dividing by the number of samples (sites x time) and sorted in descending order.

The whole site sweep data were ranked using the same method with the need to pool transect data, as only one transect was completed at each site.

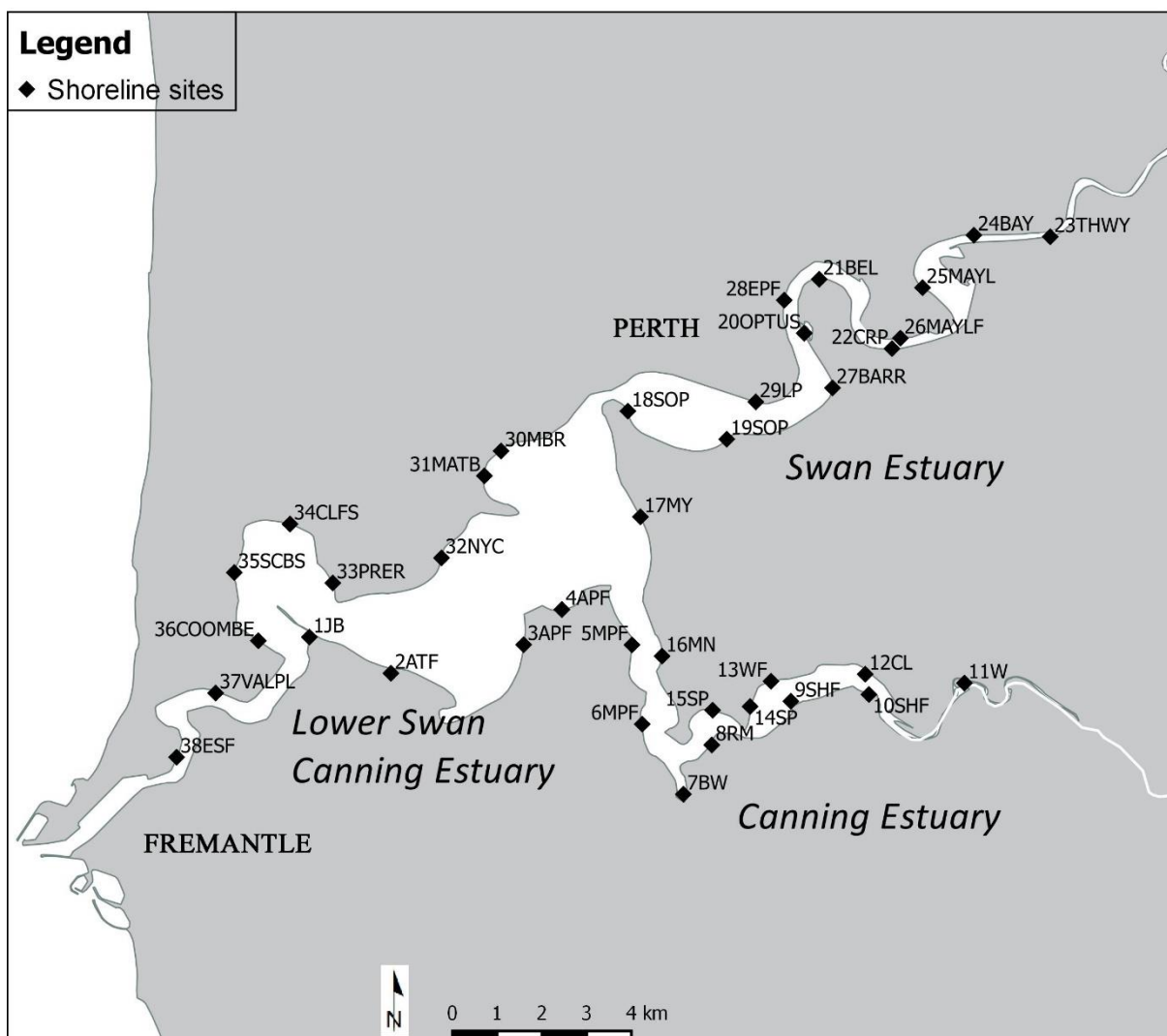


Figure 1. Map showing beach survey sites and major Riverpark zones.

*Table 1. List of sites, site codes and corresponding Riverpark zones.*

<b>Site code</b>	<b>Site name</b>	<b>Orientation</b>	<b>Estuary region</b>
1-JB	Jenalup Beach	West	Lower Swan Canning Estuary
2-ATF	Attadale foreshore	North	Lower Swan Canning Estuary
3-APF	Applecross foreshore	West	Lower Swan Canning Estuary
4-APF	Applecross foreshore	North	Lower Swan Canning Estuary
17-MY	Myili Reserve	West	Lower Swan Canning Estuary
30-MBR	Mounts Bay Road	South	Lower Swan Canning Estuary
31-MATB	Matilda Bay	East	Lower Swan Canning Estuary
32-NYC	Nedlands Yacht Club	East	Lower Swan Canning Estuary
33-PRER	Point Resolution Researve	West	Lower Swan Canning Estuary
34-CLFS	Claremont foreshore	South	Lower Swan Canning Estuary
35-SCBS	Scotch College Boat shed	East	Lower Swan Canning Estuary
36-COOMBE	The Coombe	North	Lower Swan Canning Estuary
37-VALPL	Vlamingh Parklands	South	Lower Swan Canning Estuary
38-ESF	East fremantle foreshore	East	Lower Swan Canning Estuary
5-MPF	Mount Pleasant foreshore	East	Canning Estuary
6-MPF	Mount Pleasant foreshore	East	Canning Estuary
7-BW	Bateman	North	Canning Estuary
8-RM	Rossmystone	West	Canning Estuary
9-SHF	Shelly foreshore	North	Canning Estuary
10-SHF	Shelly foreshore	North	Canning Estuary
11-W	Castledare	South	Canning Estuary
12-CL	Clontaff	West	Canning Estuary
13-WF	Wilson foreshore	South	Canning Estuary
14-SP	Salter Point	East	Canning Estuary
15-SP	Salter Point	South	Canning Estuary
16-MN	Manning	West	Canning Estuary
18-SOP	South Perth	East	Swan Estuary
19-SOP	South Perth	West	Swan Estuary
20-OPTUS	Optus stadium	West	Swan Estuary
21-BEL	Belmont	North	Swan Estuary
22-CRP	Cracknell Park	North	Swan Estuary
23-THWY	Tonkin Hwy	North	Swan Estuary
24-BAY	Bayswater	South	Swan Estuary
25-MAYL	Maylands	East	Swan Estuary
26-MAYLF	Maylands foreshore	South	Swan Estuary
27-BARR	Berringa Reserve replacement	West	Swan Estuary
28-EPF	East Perth foreshore	East	Swan Estuary
29-LP	Langley Park	South	Swan Estuary

## 2.2 Surface water surveys

A sampling program to quantify the plastic debris suspended in surface water targeted three major Riverpark zones, the Swan Estuary, Canning Estuary, and the Lower Swan Canning Estuary, which was divided into two sub-regions (1. Melville Water (MW) and 2. Stirling Bridge to Point Walter (STPW)). Sampling took place on four occasions during 2021, in the week following the beach surveys: March, June, September and December. A manta tow net with a net opening was 597 mm wide, 180 mm high with a net length of 4 m, a mesh size of 335  $\mu\text{m}$  with a slotted PVC zinc weighted cod end with 333  $\mu\text{m}$  mesh (e.g. Free et al., 2014; Sutton et al., 2016). To ensure the volume filtered could be quantified accurately, a mechanical flow meter (General Oceanics, model 2030) was installed in the mouth of the net. Immediately before and after each tow the counter readout was recorded.

In each estuary region four consecutive 10 minute tows were completed. After each tow the net was retrieved and washed down using an onboard deck wash on the outside of the net. The cod end was then emptied onto a 250  $\mu\text{m}$  metal sieve where large organic debris, jelly fish and any other fish or crustacean bycatch were rinsed using pre-sieved (250  $\mu\text{m}$  metal sieve) site water and returned to the water as soon as possible. The sample was then transferred to a pre-labelled glass jar and stored prior to laboratory analyses.

To quantify the plastics, each sample was sieved (250  $\mu\text{m}$  mesh) to remove excess water and remaining large organic debris, before digestion in a 1:1 by weight 30% hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) solution. Samples were left to digest at room temperature for a week before inspecting the samples. If the sample hadn't completely digested, it was re-sieved and fresh  $\text{H}_2\text{O}_2$  was added. Once most of the organic debris digested the sample was again sieved to remove the  $\text{H}_2\text{O}_2$  and returned to the sample jar. If samples contained a large quantity of plastic debris, they were subsampled (the maximum number of splits was four resulting a subsample of 1/16<sup>th</sup> of the original) using a Folsom Plankton Sample Splitter (Aquatic Research Instruments) to ensure samples could be processed within a reasonable timeframe. The subsample was then inspected under a dissection microscope and plastic pieces were identified as one of six types; fragment, filament, film, foam, microbead, other. They were measured and placed into the following size categories; 0.5-1 mm, 1-2 mm, 2-5 mm, 5-10 mm and >10 mm. Plastic pieces were then stored in a glass vial.

### 2.2.1 Surface water analysis

Surface water plastic counts were firstly converted to pieces per cubic metre (kilolitre) using the difference between the start and end counts from the mechanical flow meter installed at the mouth of the net during deployment. The following equations was used to calculate volume:

$$\text{Distance (m)} = \frac{\text{difference in COUNTs} \times \text{Rotor constant (26,873)}}{999999}$$

$$Volume (m^3) = \frac{net\ mouth\ area\ (0.00107m^2) \times distance\ (m)}{4}$$

The main aims of the plastic surface water trawls were to determine if plastic abundance differed between the four estuary regions and whether there was variance across the year. A two-way permutational multi-variate ANOVA (PERMANOVA) was applied, using a Euclidean distance similarity matrix, with region and sampling month as factors to explain variation in plastic abundance. Pairwise tests were then used when effects were significant. Data were square root transformed to reduce the influence of very high counts on the analysis. A Euclidean distance matrix was calculated on the transformed data prior to the PERMANOVA analysis.

To explore the influence of different plastic types between sites and region a principal components analysis was completed on the transformed data.



*Figure 2 A deployed manta tow net collecting plastic samples*



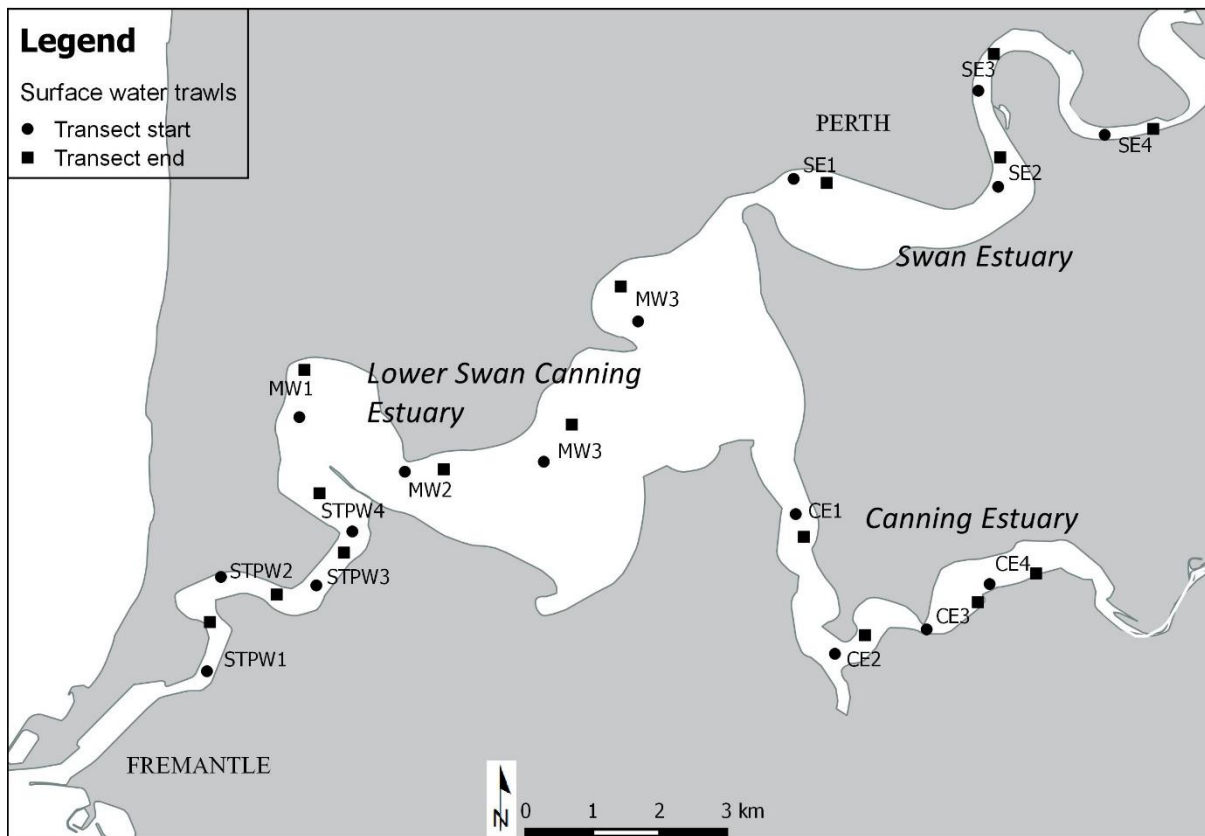


Figure 3. Surface water trawl sample locations. Note the Lower Swan Canning Estuary was subdivided into two smaller regions: Melville Water (MW) and Stirling Bridge to Point Walter (STPW).

## 3 Results and Discussion

### 3.1 Beach surveys – Standard transects

#### 3.1.1 Plastic abundance

Plastic debris was measured at all sites (Figure 4). Plastic abundance and composition varied significantly between the sampling months and was highest at most sites in June or September 2021 (Pseudo  $F_{3,455}$ ,  $P = 0.008$ ) (Figure 4). Pairwise tests indicated that June was significantly higher than both March and December ( $P = 0.023$  and  $P = 0.003$  respectively). The higher abundance of plastic in June and September likely reflected the accumulation of plastic from preceding high autumn and winter rainfall and associated storm surges. Plastic accumulation differed between the regions, but the difference was not consistent across the beach orientation (significant interaction effect between region and beach orientation, Pseudo  $F_{6,455} = 4.5732$ ,  $P = 0.001$ ) (Figure 5). In the Swan and Lower Swan Canning Estuary regions plastic accumulation was lowest in beaches facing East, followed by northern beaches, with the highest accumulation on south facing beaches. West facing beaches accumulated the second highest amount of plastic. In the Canning Estuary, plastic accumulation was very low in comparison to both the Lower Swan

Canning Estuary and the Swan Estuary. Additionally the beach orientation effect on plastic accumulation differed, west facing beaches accumulated the most, followed by northern beaches, east and finally south facing beaches.

Additionally, the composition of the plastic found in each region differed (Figure 5). In the Lower Swan Canning Estuary, foam, plastic straps, nurdles and fishing gear tended to dominate, particularly on south facing beaches, while in the Swan Estuary hard and soft plastics, and foams were dominant. In the Canning, hard and soft plastics, and foams were most prevalent but at much lower abundance than the other two regions. The principal components analysis further explored the relationship between beach orientation and region, and the different plastic types that contribute to the observed differences. Principal component (PC) 1 explained 54.1% of the variation and was most strongly influenced by foam, hard plastic and nurdles, while PC2 explained 10.5% of the variation and influenced primarily by foam, soft plastic and plastic straps (Figure 6). Most data points, particularly from north and eastern beaches were clustered in the right side of the figure and were characterised by lower abundances of most debris items (Figure 6). Sites on south and west facing shorelines particularly from the Lower Swan Canning Estuary and the Swan Estuary were distributed more widely along the x-axis, driven primarily by higher accumulation of foam, hard and soft plastics, nurdles and plastic straps. Foam strongly influenced the distribution of data points to the lower left of the image and the south facing sites from the Lower Swan Canning Estuary were positioned to the most extreme left of the figure resultant from the very high foam counts at south facing sites in this region.

Six sites, all in the Swan Estuary and Lower Swan Canning Estuary, had relatively high plastic abundance with five of these located on south or west facing beaches (Figure 4). These sites included 37-VALPL (south) in Mosman Park, 1-JB (west) near Point Walter, 29-LP (south) at Point Fraser in the CBD, 20-OPTUS (west) at foreshore in front of Optus Stadium and 27-BARR (west), the foreshore at Burswood. The prevailing wind direction in Perth is from the south and west (Masselink & Pattiaratchi, 2001). The sites 29-LP, 20-OPTUS and 27-BARR are all on the windward side of Perth Water and the CBD, suggesting that the high accumulation is a combination of orientation and location in proximity to the CBD and a significant recreation area of Perth Water which encapsulates the Langley Park and South Perth foreshores. The sixth site, 23-THWAY, that had elevated plastic accumulation had northward orientation. It should be noted that this site is located close to two large drains, the Airport South Main Drain (~500 m upstream) and Bayswater Main Drain (800 m downstream) and may receive debris flowing in from these drains.

### **3.1.2 Environmental drivers of plastic accumulation**

The multiple regression best subsets analysis revealed a significant model ( $p < 0.001$ , adjusted  $R^2 = 0.15$ , AIC = 803.6) that included five variables from the initial seven, and included estuary region, beach orientation, sampling month, bank height and vegetation height as the variables that best predicted plastic accumulation on the beaches. Four of the five variables were significant. Bank height ( $p = 0.001$ ) and vegetation height ( $p = 0.012$ ) had a positive effect on the plastic accumulation (standardised parameter estimates = 0.159 and 0.117 respectively) suggesting higher banks and vegetation can be associated with greater plastic accumulation.

Region ( $p < 0.001$ ) was negatively associated (-0.213) with plastic accumulation suggesting that plastic accumulation was greatest in the Lower Swan Canning Estuary (LSCE) (assigned dummy value (dv) of 1). Orientation ( $p < 0.001$ ) was also a significant predictor and was positively associated with plastic accumulation, suggesting that beaches facing south (dv=4) and west (dv=3) accumulated more plastic than those facing north (dv=1) or east (dv=2). Month was not a significant predictor ( $p = 0.09$ ) and was negatively associated with plastic accumulation.

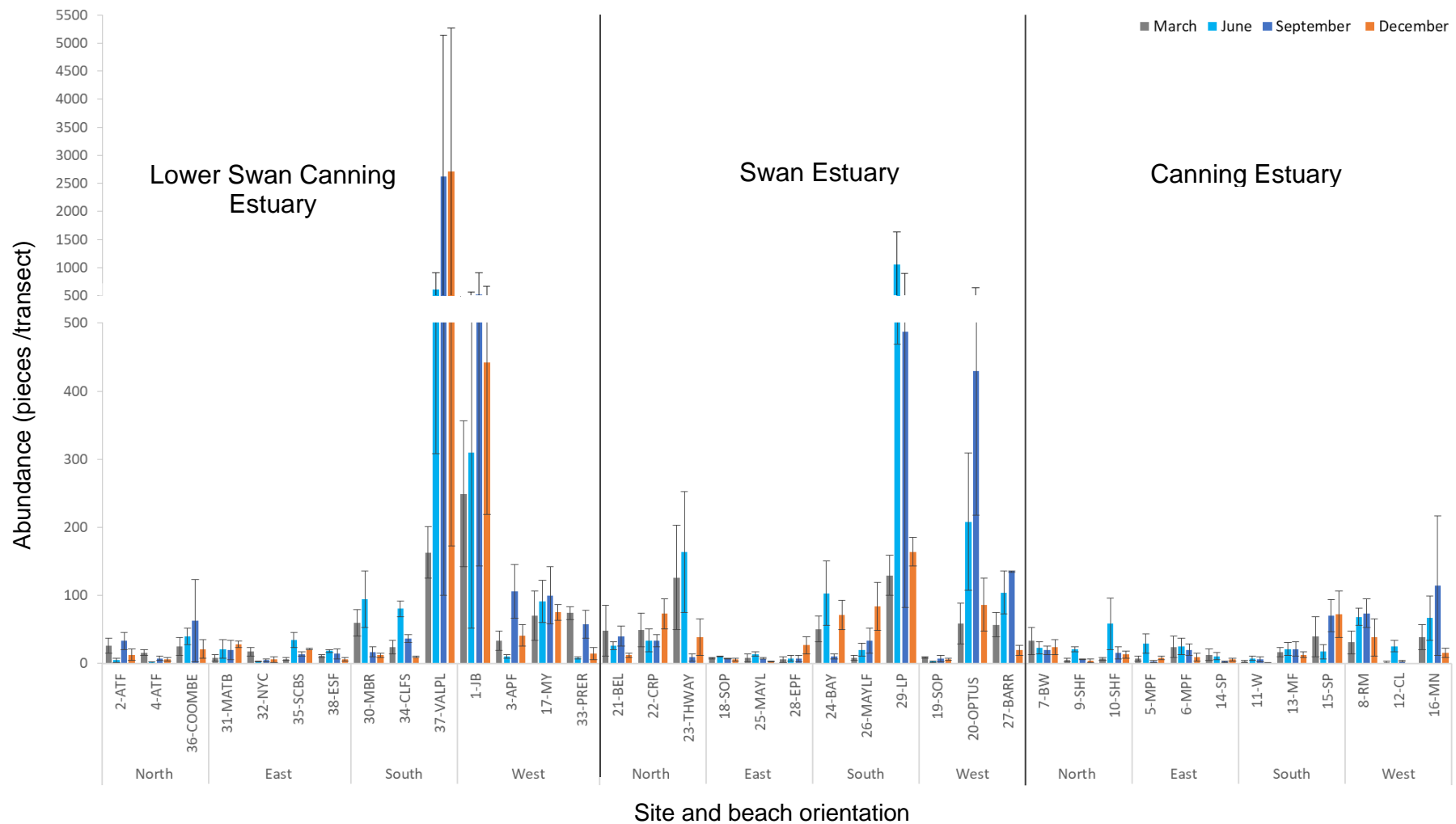


Figure 4. Abundance (mean pieces/transect) of anthropogenic debris items collected at sites in March, June, September and December 2021. Sites are grouped by region and beach orientation. Note the y-axis is split to facilitate interpretation.

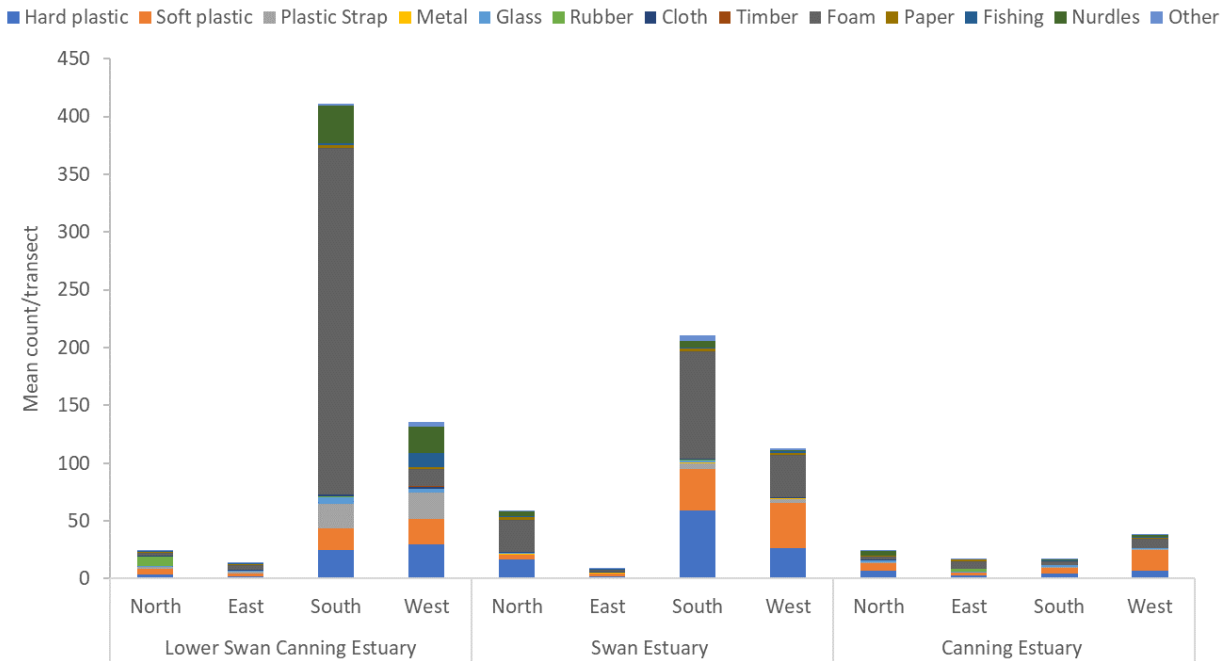


Figure 5. Mean debris abundance from standard beach transects showing the debris types found on each beach orientation in each respective estuary region.

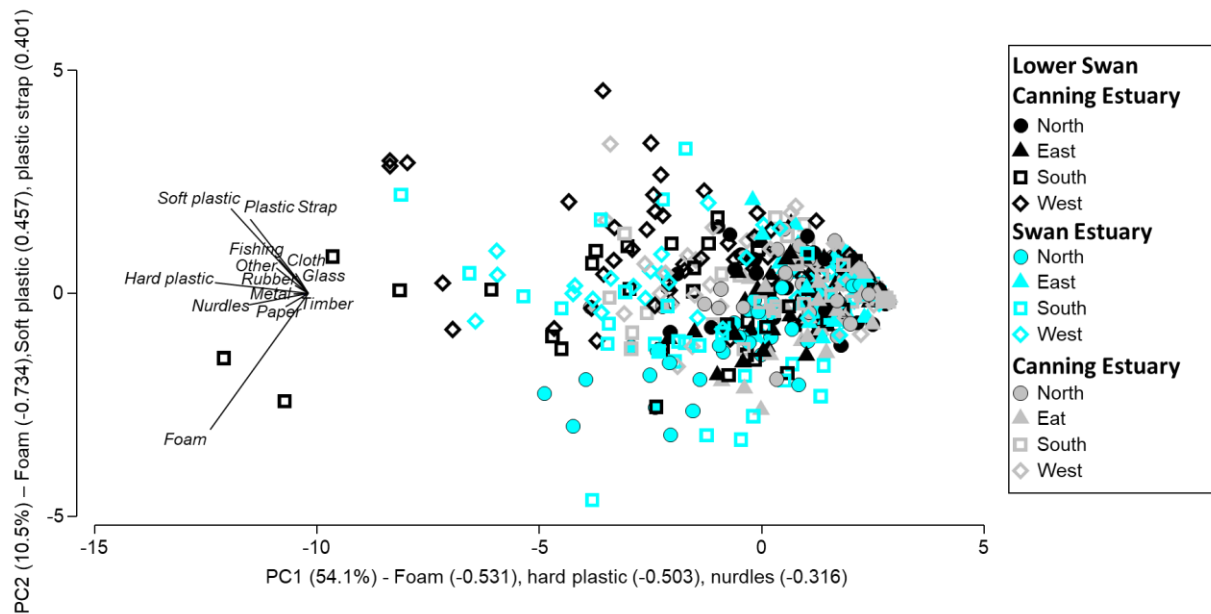


Figure 6. Principal component analysis of plastic abundance and type collected from each transect in each region and beach orientation. Factors contributing to principal component 1 (PC1) and PC2 are presented along the axes

### 3.2 Beach surveys - Whole site sweeps

The whole site sweeps targeted large (>30 mm) plastic debris along the full 100 m transect. The abundance of plastic was far lower than the standard beach transects, a result of only targeting large plastic items. Plastic was found in all whole site sweeps on every sampling occasion (Figure 7). The abundance and composition of the plastic varied significantly (pseudo  $F_{3, 151} = 6.1558$ ,  $P = 0.001$ ) across the different beach orientations with greater plastic abundance typically found at beaches facing south and/or west (Figure 7 and Figure 8). Pairwise comparisons indicated that west facing beaches were most different, and significantly differed from all other orientations ( $P < 0.007$ ), whilst south facing beaches were different from east ( $P = 0.02$ ) and west facing beaches ( $P = 0.007$ ) but not north facing beaches ( $P = 0.288$ ). Furthermore, plastic abundance and composition changed significantly between the sampling months (Pseudo  $F_{3, 151} = 0.015$ ,  $P = 0.015$ ) with plastic accumulation showing a distinct monthly pattern. Plastic abundance was significantly lowest in March ( $P < 0.03$ ), increased in June and remained high in September before a reduction in December (Figure 8). No other combination of months were significantly different ( $P > 0.236$ ). The distribution of plastic across the sites was more uniform than the standard beach transects. However, some of the six sites that were identified as having high plastic accumulation in the standard beach transects, also showed greater plastic accumulation across the whole site sweep. These were the 20-OPTUS and 27-BARR sites, which are in close proximity to the Burswood Peninsula, and the 37-VALPL and 1-JB sites. In addition, site 8-RM, also had elevated plastic accumulation across the whole of site relative to other Canning sites (Figure 8) but had low levels in the standard beach transects (Figure 4). It was noted that items collected in this whole of site sweep were mainly comprised of larger items showing little to no wear, therefore suggesting that these items had recently been blown or washed into the site. The much higher quantities of plastic at 20-OPTUS and 27-BARR may reflect their position on the upwind side of the Perth CBD and Perth Water capturing plastic that blows across from these locations. They are also situated in a busy public recreation area and plastic may be sourced from the immediate area.

Plastic composition was dominated by hard and soft fragmented plastics which comprised over 50% of the total plastic debris in every region. Expanded polystyrene foam was also prevalent and the highest abundances were found in beaches facing west and south (Figure 8).

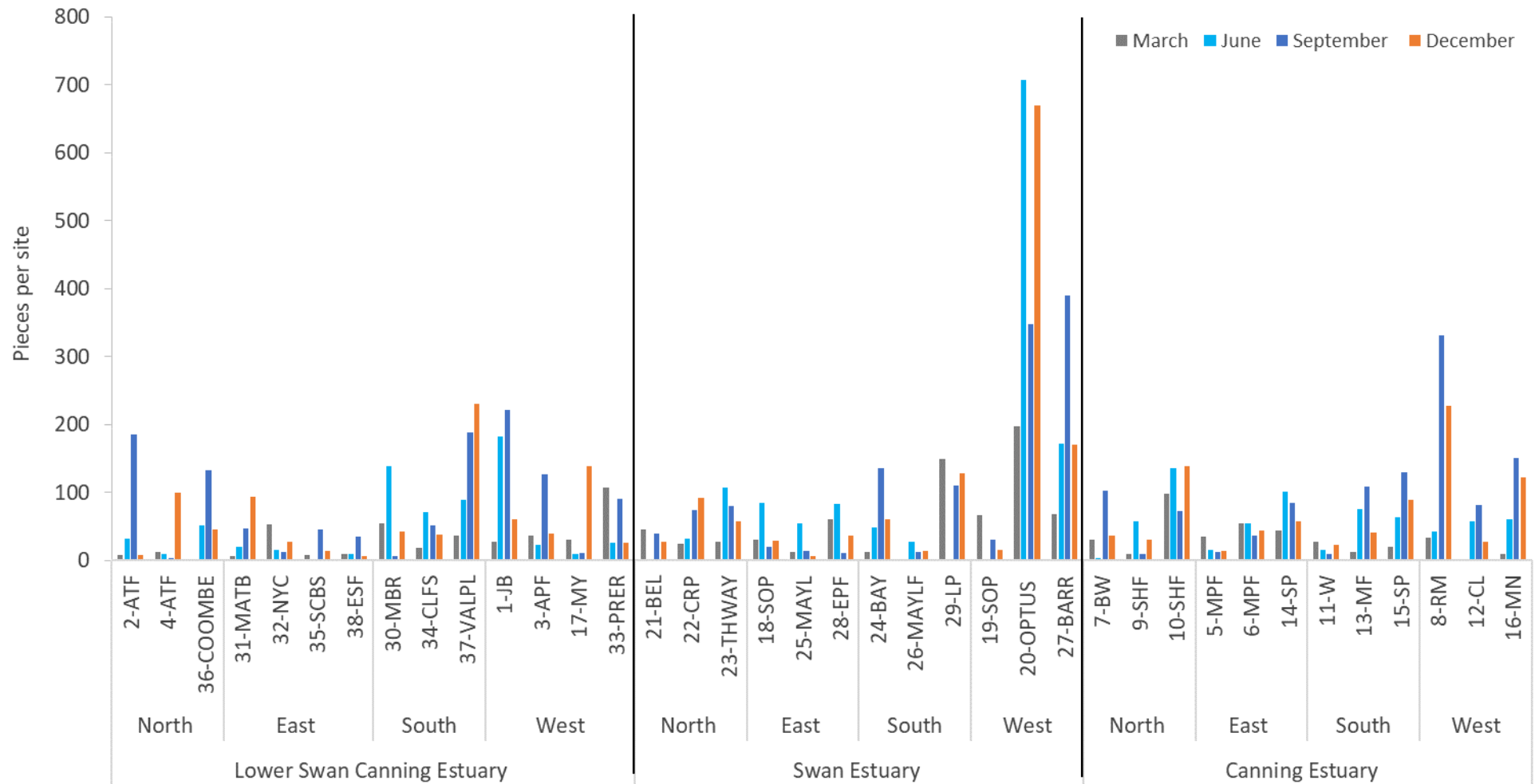


Figure 7. Abundance (n/site) of large (>30 mm) plastic debris items collected at sites in March, June, September and December 2021. Sites are grouped by region and beach orientation.

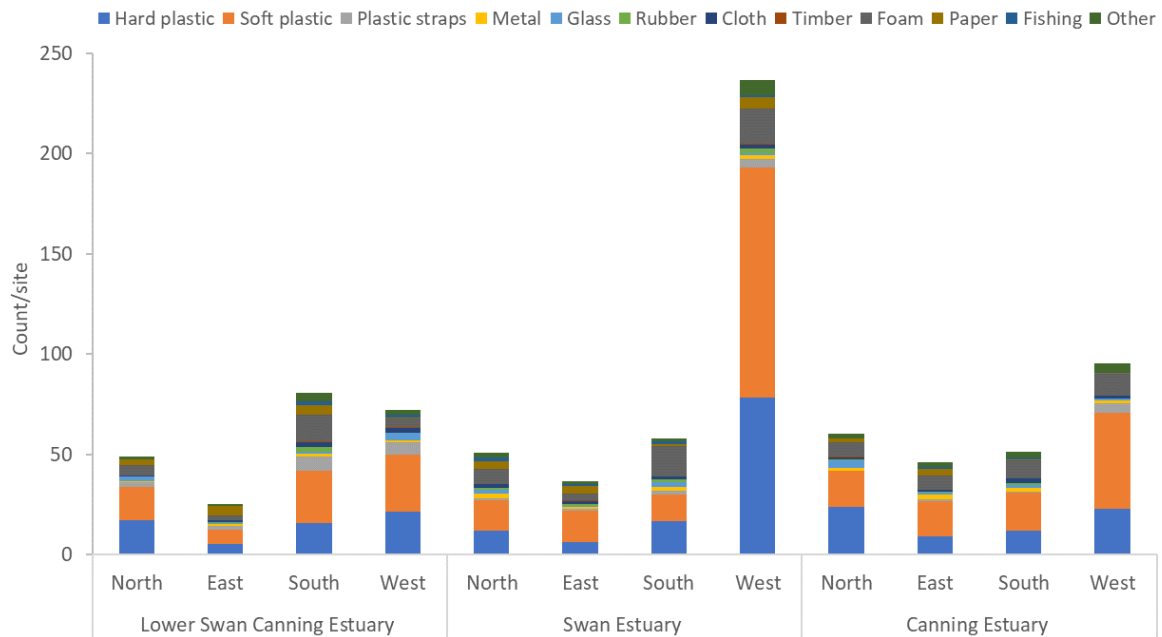


Figure 8. Mean debris abundance from whole site sweeps showing the amount of each debris type found on each beach orientation in each estuary region.

### 3.2.1 Horizontal distribution of plastic

The distribution of plastic in the subsections varied significantly across regions, orientation and month (interaction – Pseudo  $F_{12,1068} = 2.833$ ,  $P = 0.001$ ) (Figure 9). In south and west facing beaches plastic accumulated in the greatest amount in subsection three (i.e. within the vegetation), however high abundances were also found in subsection 2 (S2) on beaches in the Lower Swan Canning Estuary (Figure 9). Conversely, in east facing beaches, irrespective of region, there was no pattern in the accumulation of plastic debris in the different subsections. The pattern was more varied in north facing beaches. North facing beaches in the Lower Swan Canning Estuary and Canning Estuary plastic tended to increase in abundance from subsection 1 (S1) to subsection 3 (S3), whereas in the Swan estuary there was little difference between the subsections.

In the regions and beaches with the greatest abundance of plastic, west and south facing shores in the Lower Swan Canning Estuary and Swan Estuary, most plastic was found in the vegetated upper bank (S3) (Figure 9). This is consistent with that found by (Olivelli et al., 2020) using the same method. However, while vegetated upper banks captured the largest quantity of plastic, the reduction in plastic at these sites in December and low plastics accumulation in March suggests this accumulated plastic may only remain at the site temporarily. The loss of plastic may be a result of a shift in prevailing winds with onset of summer, debris being removed by community groups during litter clean-ups or the debris being grown over by rapid growth in vegetation in late spring and early summer. This final factor was observed by the author at one site (29-LP) in December where the rapid growth of sedges had started to cover plastic captured in the vegetation.



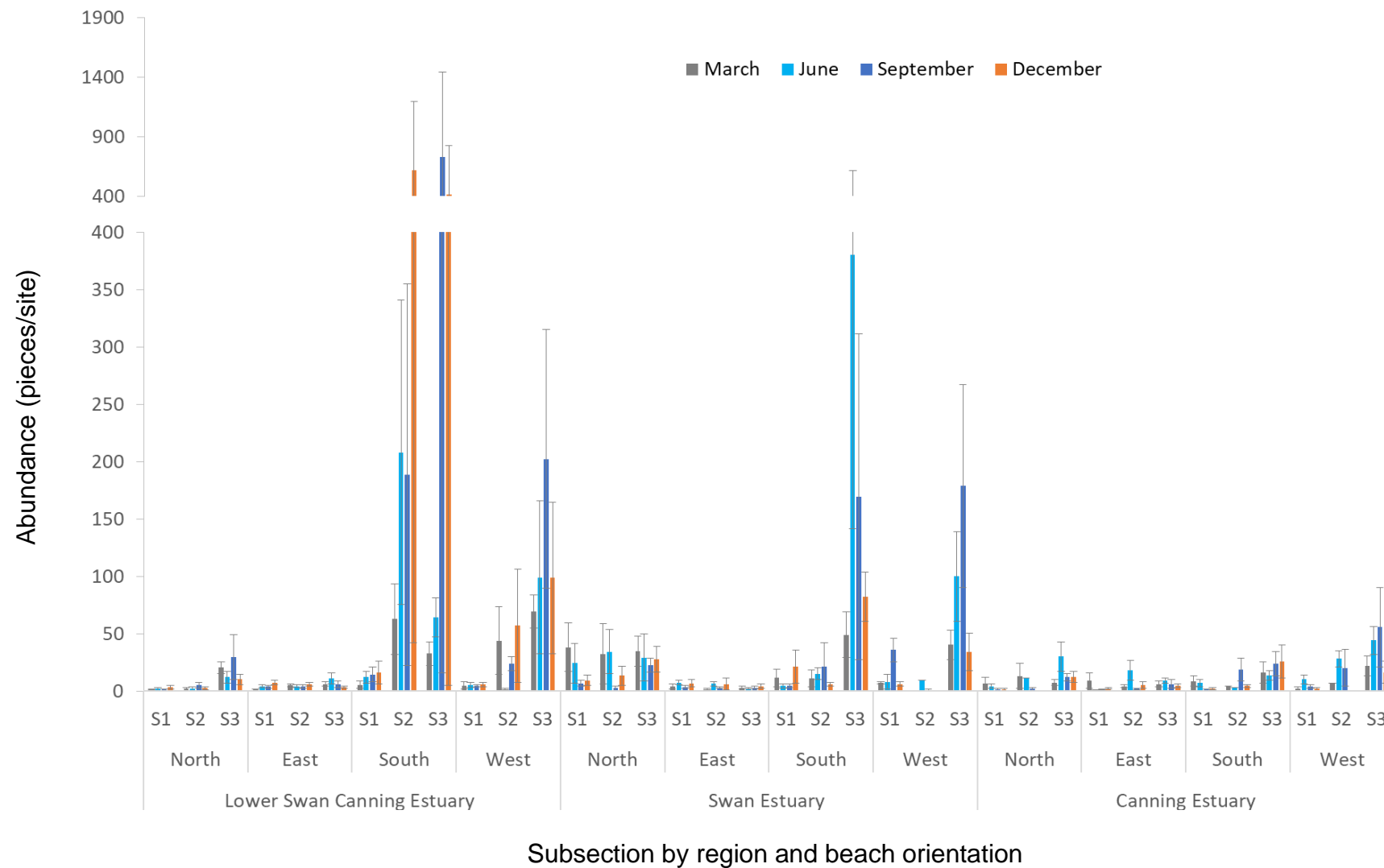


Figure 9. Horizontal distribution of plastic as mean pieces/subsection collected in subsections, S1, S2 and S3 of plastic in each region and beach orientation

### 3.2.2 Types of debris

#### 3.2.2.1 *Standard beach transects*

The complete ranking by both mean site count (and standard error) and frequency of detection of all the debris items found on the beaches is provided in Appendix 3-Table A1-A4. The variability in rankings between the mean site count and frequency of detection is because the mean site count can be impacted by extremes in counts (i.e. very high or very low) of particular materials. Whereas frequency of detection is determined by the percentage of sample times that items were found and is based on presence/absence data.

The most numerous types of plastic found with the Swan Canning Estuary varied across the estuary regions. In the Lower Swan Canning Estuary, plastic debris was far more abundant than other regions (Figure 4 and 5) with the most dominant types of plastic debris being expanded polystyrene (EPS) pieces (157 per site), EPS beans (83 per site), and plastic resin pellets (nurdles) (46 per site) (Figure 10). Hard plastic fragments (39 per site) and rope fragments (32 per site) were also very common (Figure 10). As a measure of the distribution of plastic items, the percentage of sampling times and sites where the items were found, revealed hard and soft plastic fragments were the most widespread, found at 96% of sites in the Lower Swan Canning, across all sampling periods (Figure 11). EPS fragments were third most widespread, found at 88% all sites on all sampling occasions, followed by rope fragment and unknown foams found at 82% and 77% of sites on all sampling periods respectively.

In the Swan Estuary the most numerous plastic types were hard plastic (59 per site), EPS pieces (53 per site), and soft plastics (34 per site), while EPS beans (24 per site) and EPS cup and plates (17 per site) were also prevalent (Figure 10). While numerically these items were most prevalent, the most widespread plastics in the Swan Estuary were hard and soft plastics and EPS foam detected at 96%, 92% and 88% of sampling times and sites, respectively (Figure 11). Other widespread items were hard plastic bottle caps (73%), and food wrappers (73%).

In the Canning Estuary, soft (18 per site) and hard plastics (12 per site) and EPS foams (8 per site) were most abundant (Figure 10), followed by EPS beans (5 per site) and food wrappers (3 per site). The most widely detected plastic items in this region were hard (89.6%) and soft plastics (81.3%), food wrappers (66.7%), EPS foams (64.6%) and EPS beans (54.2%) (Figure 11).

Of the items to be banned in the WA Plan for Plastics, the most abundant items were consistently EPS foam, EPS cups and plates, and straws. The most widespread items were EPS foam, straws and thin film carry bags. A complete list ranking items in order of mean abundance per site and frequency of detection is provided in the Appendix 3 Table A3.1 and A3.2 respectively. Items banned under the WA Plan for Plastics are identified in bold text.

### 3.2.2.2 *Whole site sweeps*

In the Lower Swan Canning Estuary, the most numerous items found were soft (9 per site) and hard plastics (7 per site) and food wrappers (5 per site) (Figure 12). Other common items were plastic bottle caps (5 per site), rope and straps (4 per site) and large EPS pieces (3 per site). These five items were also the most widespread with the percentage of detection following the same order, with soft plastic present in 80.4% of sampling times and sites, hard plastic in 76.8%, food wrappers in 73.2%, plastic bottle caps in 67.9%, rope and straps in 64.3% and EPS foam fragments in 62.5% of sites and times (Figure 13).

In the Swan Estuary the most abundant plastic items were soft plastic (17 per site), food wrappers (12 per site), bottle caps (11 per site), hard plastic (8 per site), EPS foam (6 per site) and straws (5 per site) (Figure 12). The most widespread plastics were bottle caps in 81.3%, hard and soft plastic, both at 79.2%, food wrappers in 75%, EPS foam in 66.7% and straws in 56.3% of sites and times (Figure 13)

In the Canning estuary the most abundant plastics items were soft plastic (mean of 12 per site), hard plastic (8 per site), food wrappers (6 per site), EPS foam (6 per site) and bottle caps (5 per site) (Figure 12). The most widespread items across all sites and sampling times were food wrappers at 91.7%, soft plastic at 83.3%, hard plastic at 77.1%, plastic bottle caps at 75%, EPS foam at 70.8% and thin film carry bags 58.3% (Figure 13).

Items to be banned under the WA Plan for plastics were commonly encountered in the whole site sweeps. The most abundant items across the regions included EPS foam, EPS cup/plates/bowls and straws. Other commonly encountered items included plastic stemmed cotton buds, hard plastic food containers, and thin film carry bags. A complete list ranking items in order of mean abundance per site and frequency of detection is provided in the Appendix 3 Table A3.3 and A3.4 respectively. Items banned under the WA Plan for Plastics are identified in bold text

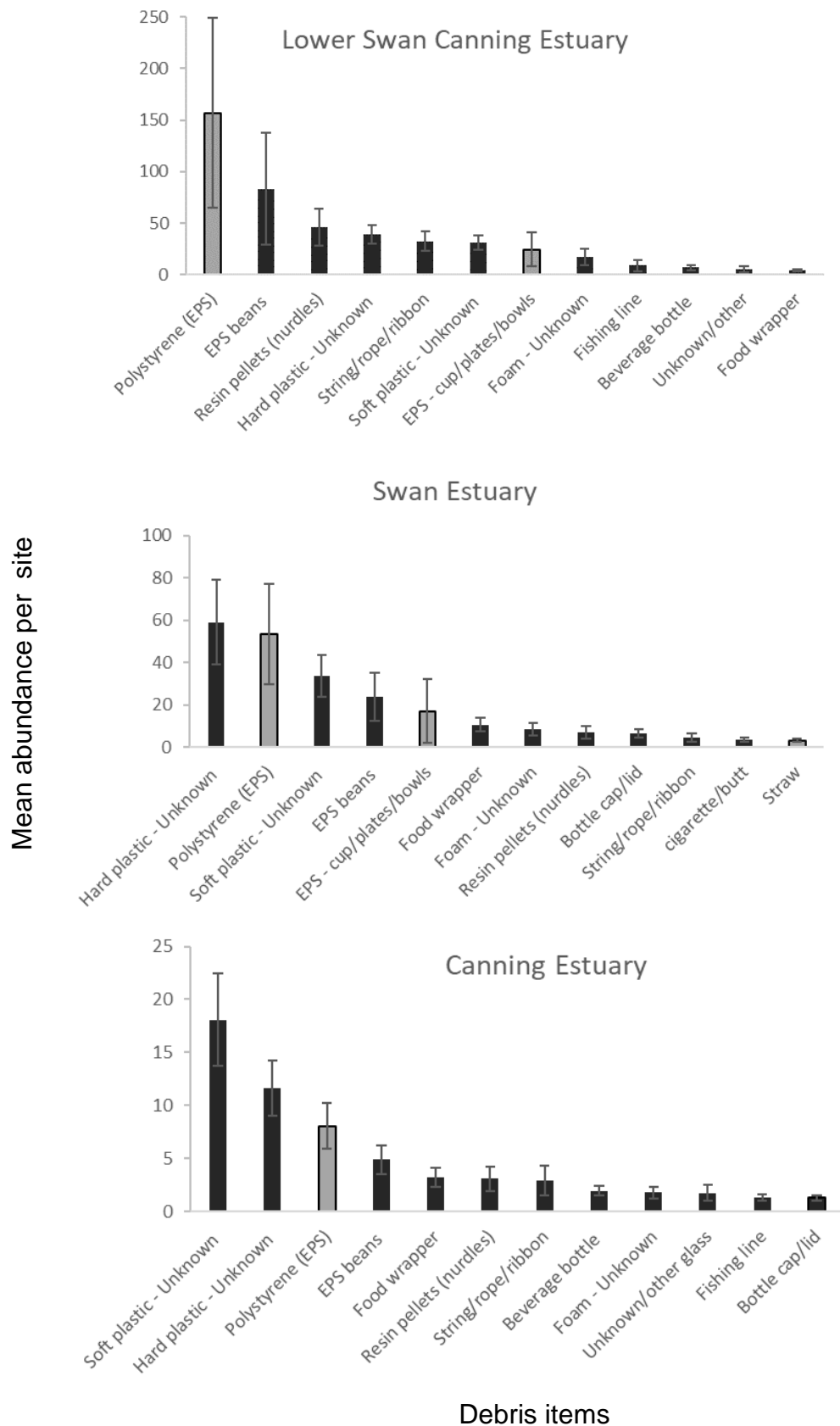


Figure 10. Mean debris abundance per site in each estuary region. Note the y axis scale change. Items that are or will be banned under the WA Plan for Plastics were identified by grey fill.

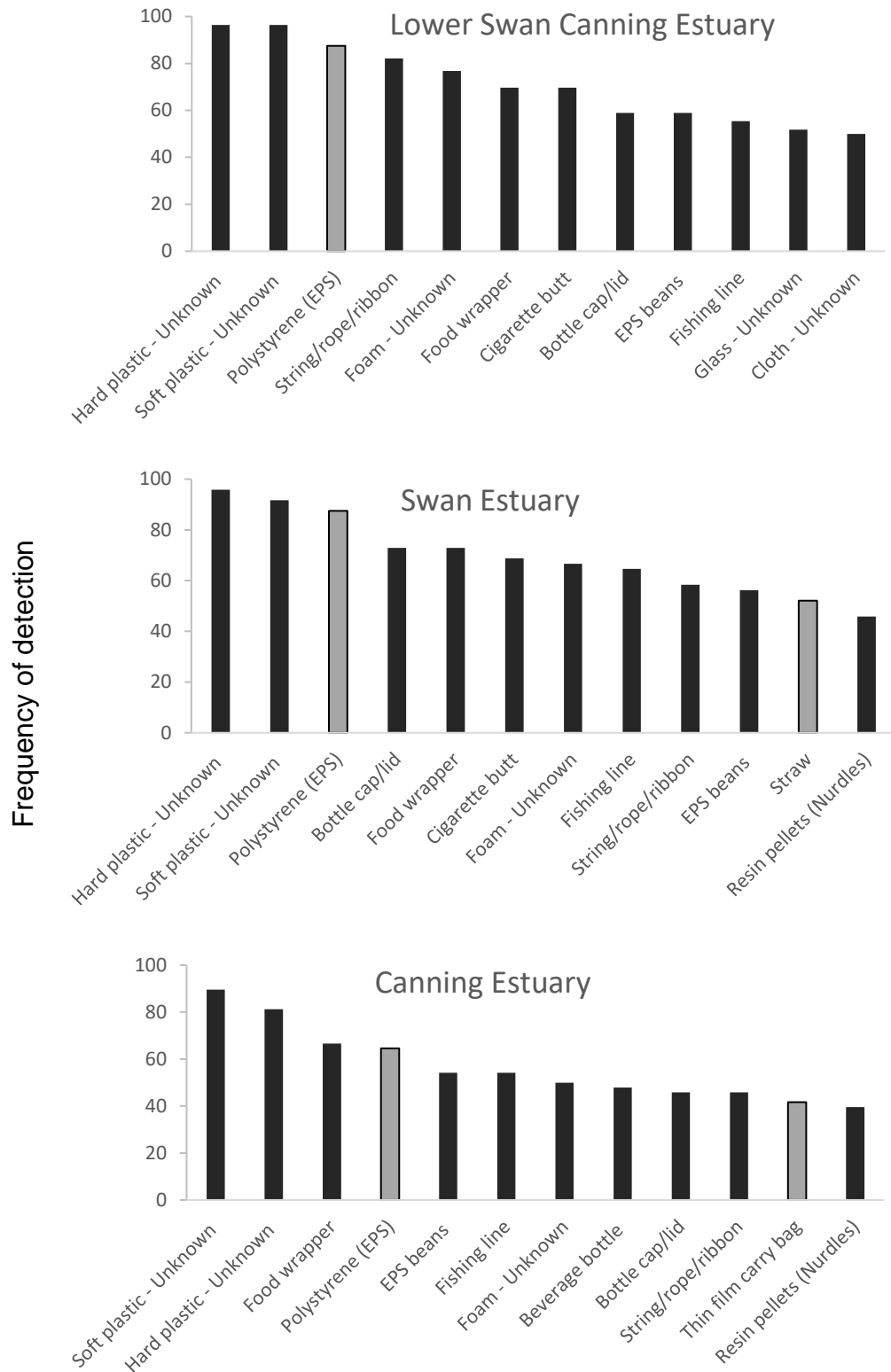


Figure 11. Percentage of sampling times and sites where a plastic material was detected for the standard beach transects. Items that are or will be banned under the WA Plan for Plastics were identified by grey fill.

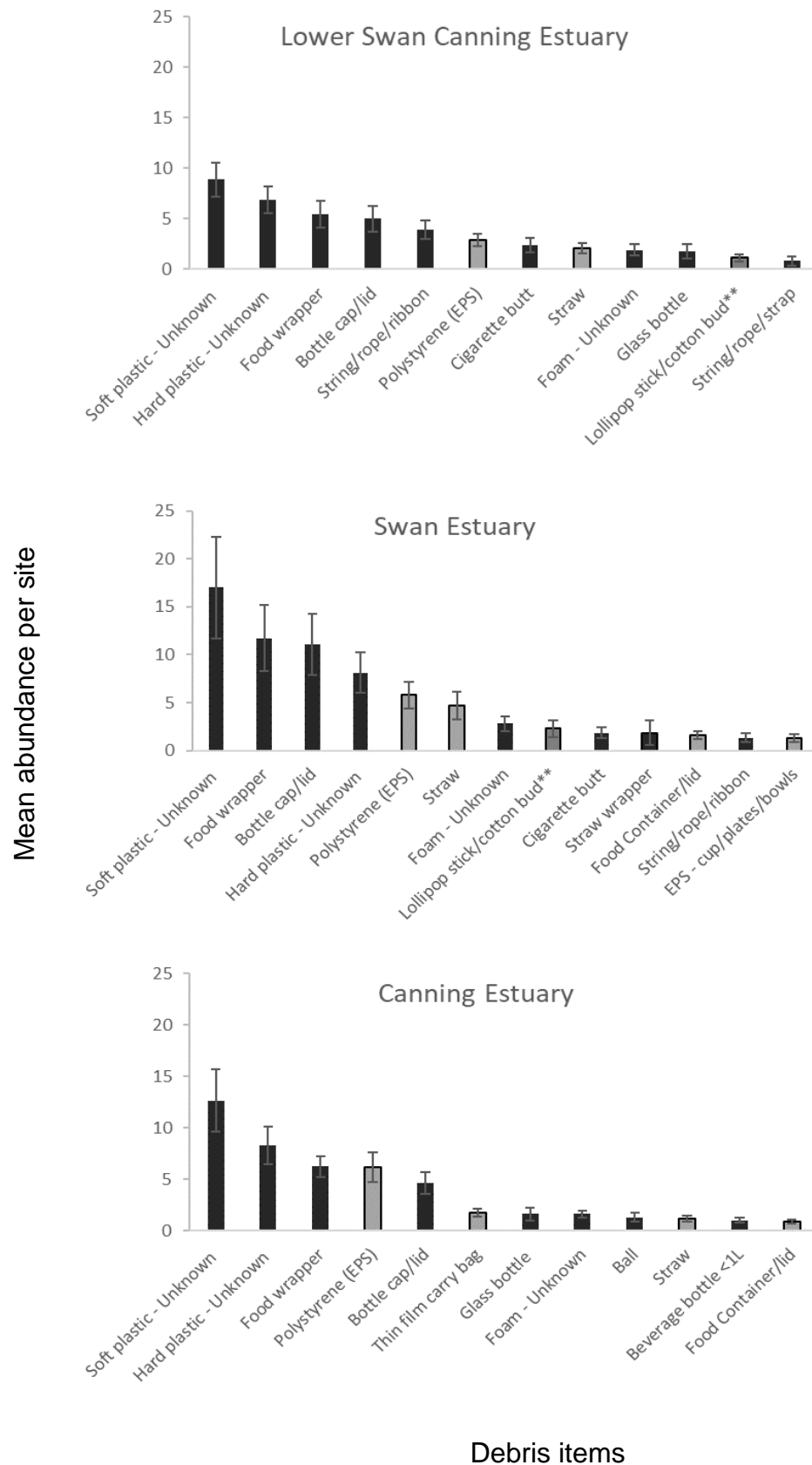
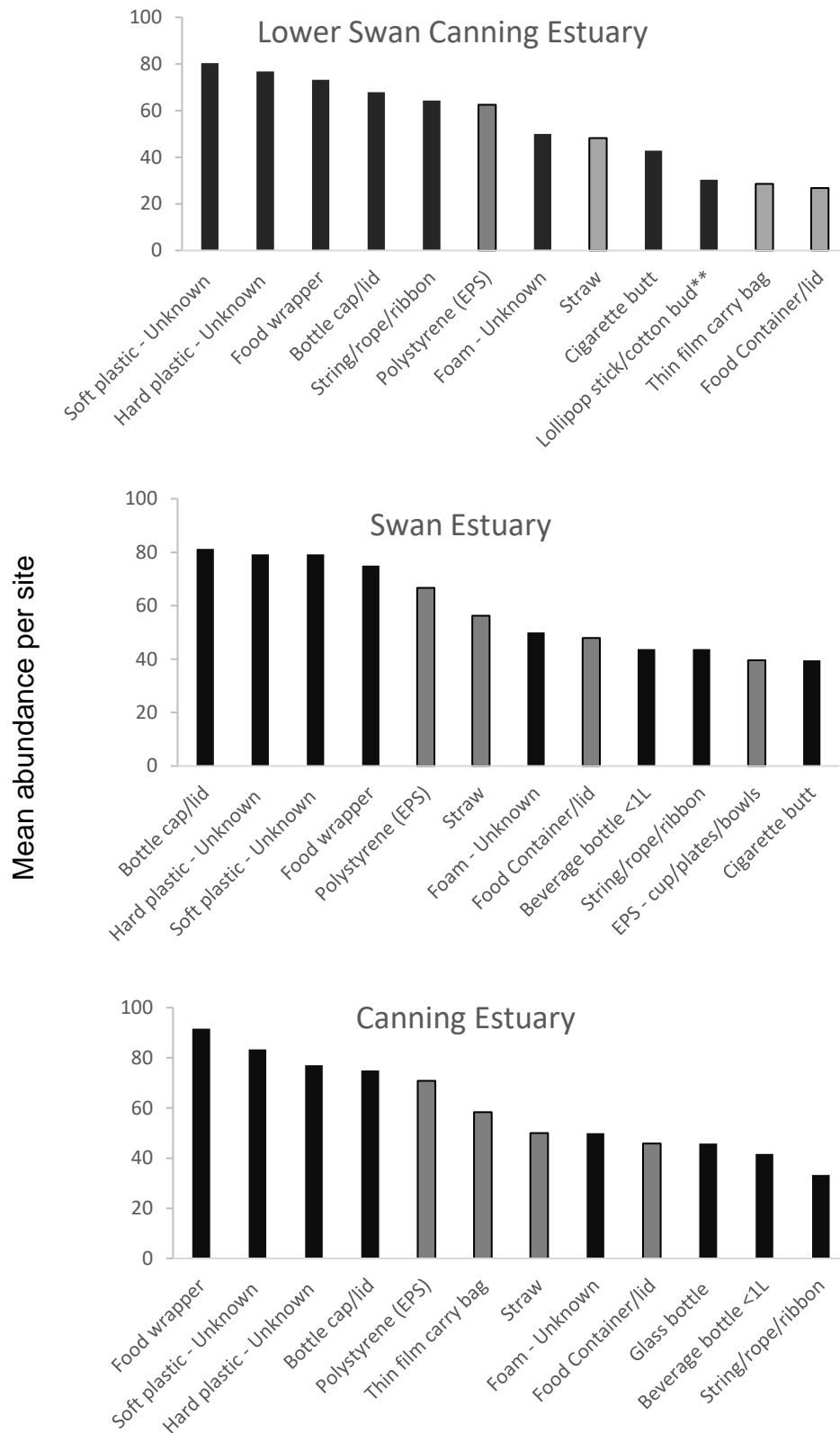


Figure 12. Mean debris abundance per site in each estuary region for whole site sweeps. Items that are or will be banned under the WA Plan for Plastics are identified by grey fill.



#### Debris items

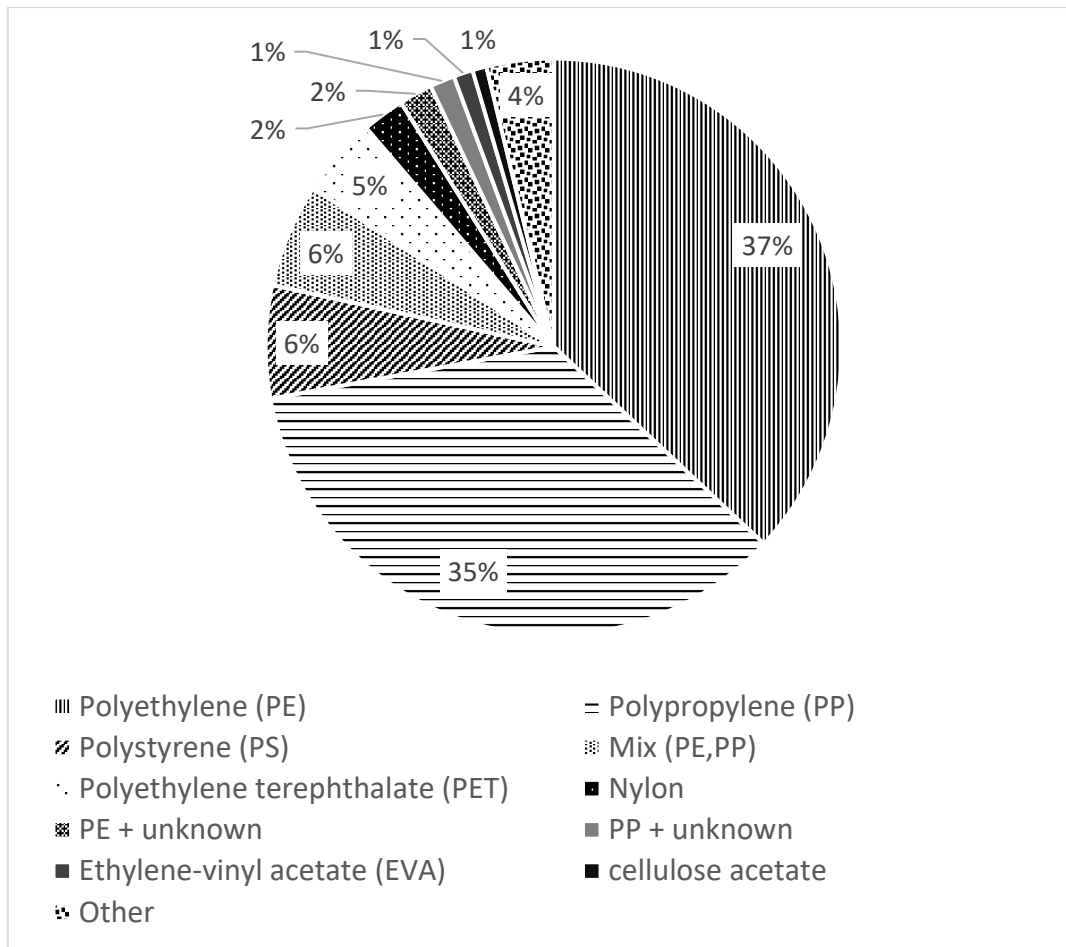
*Figure 13. Percentage of sampling times and sites where a plastic material was detected for the whole site sweeps. Items that are or will be banned under the WA Plan for Plastics are identified by grey fill.*

### 3.2.3 Polymer types

The dominant polymer types found within the Swan Canning Estuary during the beach surveys were polyethylene (PE) and polypropylene (PP) (Figure 14). It should be noted that polystyrene (PS) was the most commonly found item within the Swan Canning Estuary (as expanded polystyrene), however it was under-represented here as PS materials are clearly identifiable, e.g. expanded polystyrene, and were not sent for polymer type analysis. PE and PP were also commonly found in a mixture of the two polymers (Figure 14). These two polymer types are the most widely produced plastics globally and have accounted for over 50% of plastic production since the 1950s (Geyer et al., 2017).

PP, PE and a mixture of the two compounds were the most prevalent polymers in six of the 11 major material types (hard plastics, soft plastic, rope and straps, nurdles, fishing gear, and unidentified plastics) (Table 2). Foams were primarily comprised of PS, PE and ethylene-vinyl acetate (EVA). Fishing line and nets were comprised primarily of nylon, and PE. Cloth material was primarily polyethylene terephthalate (PET) with other polymers evident in minor amounts. PET is the fourth most produced plastic polymer globally and the main constituent of polyester (Geyer et al., 2017). Both PET and nylon have a density greater than seawater (Vermeiren et al., 2016) but were found deposited on the estuary beaches suggesting these dense polymer types are still transported by the estuarine currents and wind. Materials identified as rubber in the field were identified primarily as latex, but also commonly as PE and non-plastic organic material. Cigarette butts were identified as cellulose acetate, a common cigarette filter product, while paper and other non-plastic materials were identified likely from the paper surrounding the filter.





*Figure 14. Relative proportion of polymer types detected during the beach surveys for all plastic types combined.*

*Table 2. Polymer types of major plastic material categories*

Hard plastic	n	Soft plastic	n	Cigarette butts	n
Polypropylene (PP)	206	Polyethylene (PE)	99	cellulose acetate	8
Polyethylene (PE)	135	Polypropylene (PP)	86	not plastic	8
Mix (PE, PP)	25	Polyethylene terephthalate (PET)	15	cellulose, natural	1
Polystyrene (PS)	14	PE + unknown	7		
PP + unknown	10	Mix (PE,PP)	5	<b>Cloth</b>	
PE + unknown organic	7	PP + unknown	3	Polyethylene terephthalate (PET)	18
Nylon	4	Polystyrene (PS)	3	Polypropylene (PP)	5
polyvinyl chloride (PVC)	3	Ethylene-vinyl acetate (EVA)	3	Nylon	3
PE + PVA	2	PE + PVA	2	Organic	2
Ethylene-vinyl acetate (EVA)	2	Nylon	2	PP + unknown	1
Polyethylene terephthalate (PET)	1	polyvinyl chloride (PVC)	1	Polystyrene (PS)	1
Nylon + polyamide	1	Nitrile	1	Mix (PETE, PE)	1
Mix (PP,ester)	1			Polyurethane (PU)	1
Carbonyl	1			Mix (nylon, cotton)	1
Ester	1				
		<b>Rope and straps</b>		<b>Rubber</b>	
<b>Foam</b>		Polypropylene (PP)	33	Latex	7
Polystyrene (PS)*	44	Mix (PE,PP)	23	Polyethylene (PE)	6
Polyethylene (PE)	39	Polyethylene (PE)	19	Organic	5
Ethylene-vinyl acetate (EVA)	6	PETE	10	Mix (PE,PP)	3
PE + unknown	4	Nylon	3	Rubber	2
Polypropylene (PP)	1	PE + PVA	1	PE + unknown	1
PVC blend (with PMMA)	1			Polystyrene (PS)	1
strong carbonyl	1			Polyethylene terephthalate (PET)	1
		<b>Fishing line/nets</b>		EVA + PE blend	1
<b>Plastic resin pellets (nurdle)</b>		Nylon	11	Silicone	1
Polyethylene (PE)	44	Polyethylene (PE)	3		
Polypropylene (PP)	17	Mix (PE,PP)	2	<b>Unidentified materials</b>	
				Polyethylene (PE)	25
<b>Fishing gear</b>				Polypropylene (PP)	4
Polyethylene (PE)	4			Mix (PE,PP)	1
Polypropylene (PP)	3			Nylon	1
Polystyrene (PS)	1			Polyurethane (PU)	1
Nylon	1				
Mix (PS,PP,PE)	1				
PMMA blend	1				
strong carbonyl	1				

### 3.3 Surface water

Plastic pieces were found in every trawl in every region. The greatest component of the plastic debris found in the trawls was plastic filaments which were consistently greater than 50% of the total (Figure 15). The second most common item was plastic fragments. Film and foam were found at every region but rarely in the Canning Estuary (CE). Microbeads were found primarily in Melville Water (MW), Stirling Bridge to Point Walter (STPW) and the Swan Estuary (SE). Eighty percent (80%) of the plastic items identified were between 1-5 mm in size (Figure 16).

During sampling in MW and STPW axial convergence zones were often observed where a combination current driven by wind or tide can create large areas of water with a still calm appearance (Nunes & Simpson, 1985). These regions accumulated buoyant material including macroalgae and seagrass fragment, and plastic, and often the individual tows that traversed these zones captured much more plastic than tows that didn't. It has been noted by others that these convergence zones may potentially expose foraging seabirds and fish to higher plastic concentrations (Cohen et al., 2019; Fossi et al., 2017).

Plastic abundance differed significantly between regions (Pseudo  $F_{3, 63} = 2.4554$ ,  $P = 0.035$ ) and month of sampling (Pseudo  $F_{3, 63} = 6.4407$ ,  $P = 0.001$ ). There was no interaction effect between region and month of sampling suggesting that changes in plastic abundance occurred consistently over time and region (Pseudo  $F_{9, 63} = 0.74976$ ,  $P = 0.759$ ) (Figure 15).

Plastic abundance was lowest in March across all regions ( $P < 0.002$  for pairwise comparisons with June, September, and December) before increasing significantly in June ( $P = 0.001$ ) and remaining high in September before a significant reduction in December ( $P = 0.006$ ) (Figure 15).

Film and foam both increased in June and declined in abundance in September. Across the study the highest concentrations were observed in MW which was significantly higher than concentrations in both CE ( $P = 0.046$ ) and the SE ( $P = 0.0148$ ). These broad patterns are further supported by the PCA analysis which shows separation occurring by region and a clustering of data collected in March and December (Figure 17).

The June data was separated by others based on a greater contribution of fragments, films and foam and a grouping of SE and CE data while STPW and MW were distant from the other regions due to a large increase in plastic abundance at these sites in June. Whereas September and December were characterised by a reduction in fragments, films and foam and greater contribution of filaments. The PCA was a very good fit for the data with PC1 describing 76.5% of the variation in the data and PC2 described a further 19.7% (Figure 17).

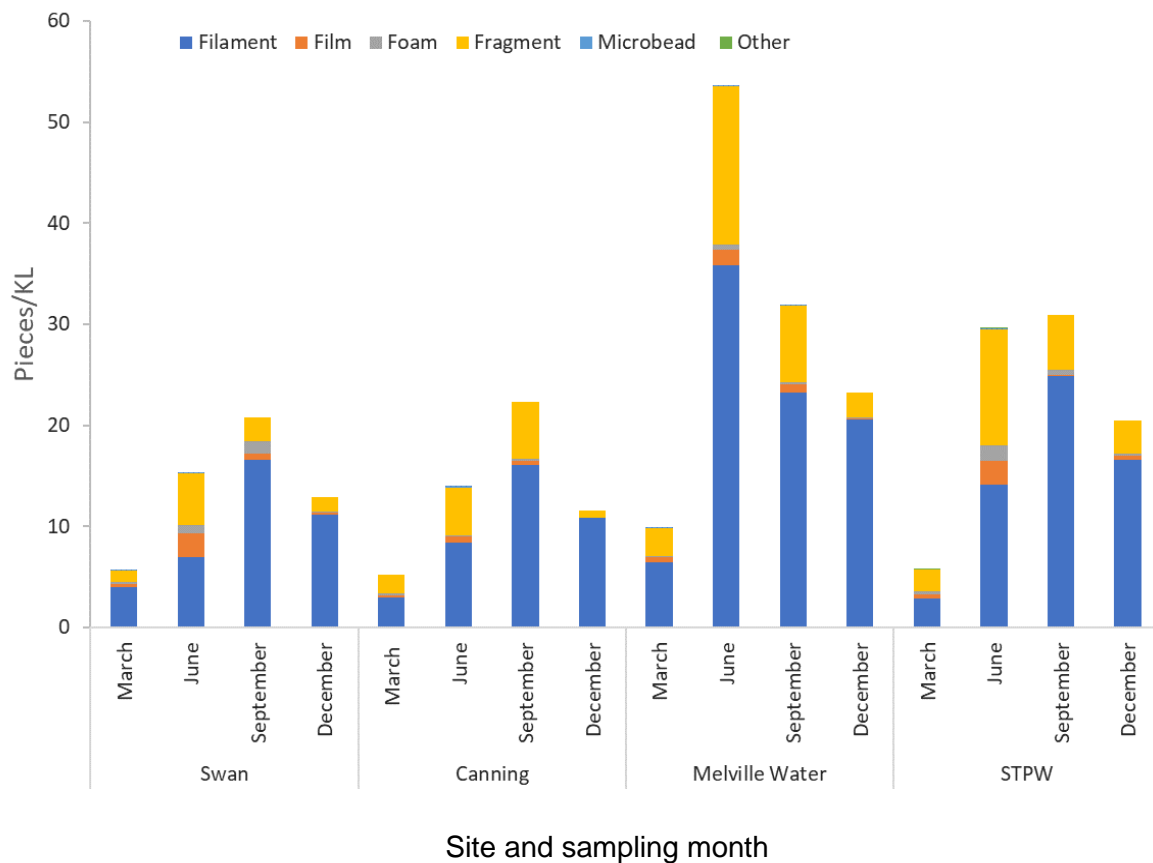


Figure 15. Mean trawl plastic composition per region and sampling period.

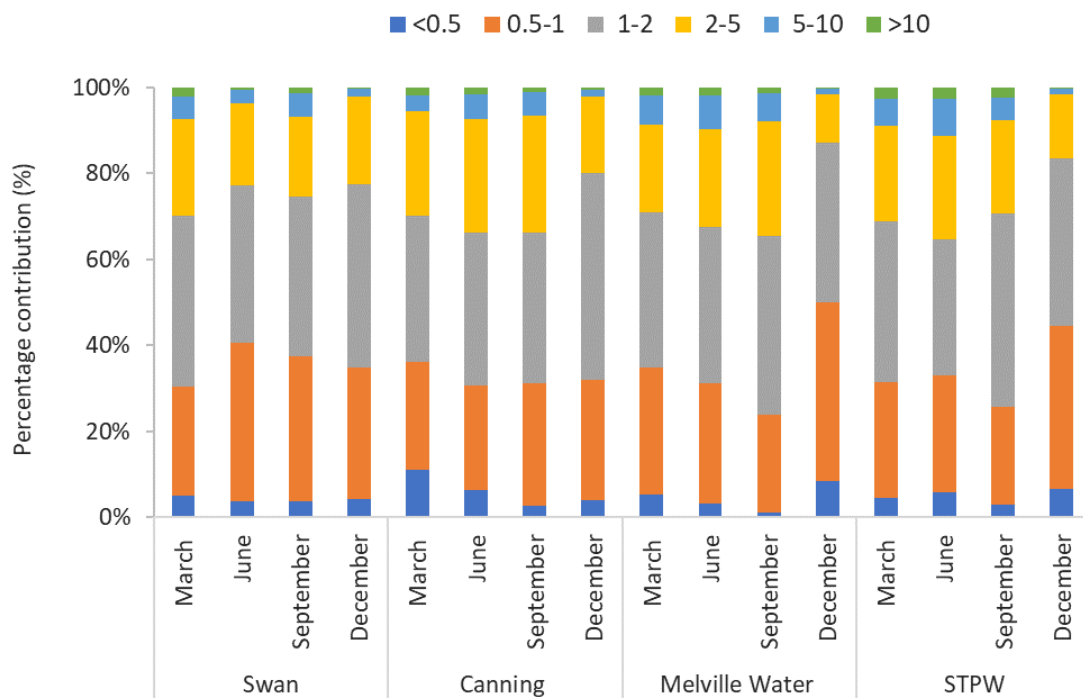


Figure 16. Plastic debris sizes as a percentage of the total encountered in each region.

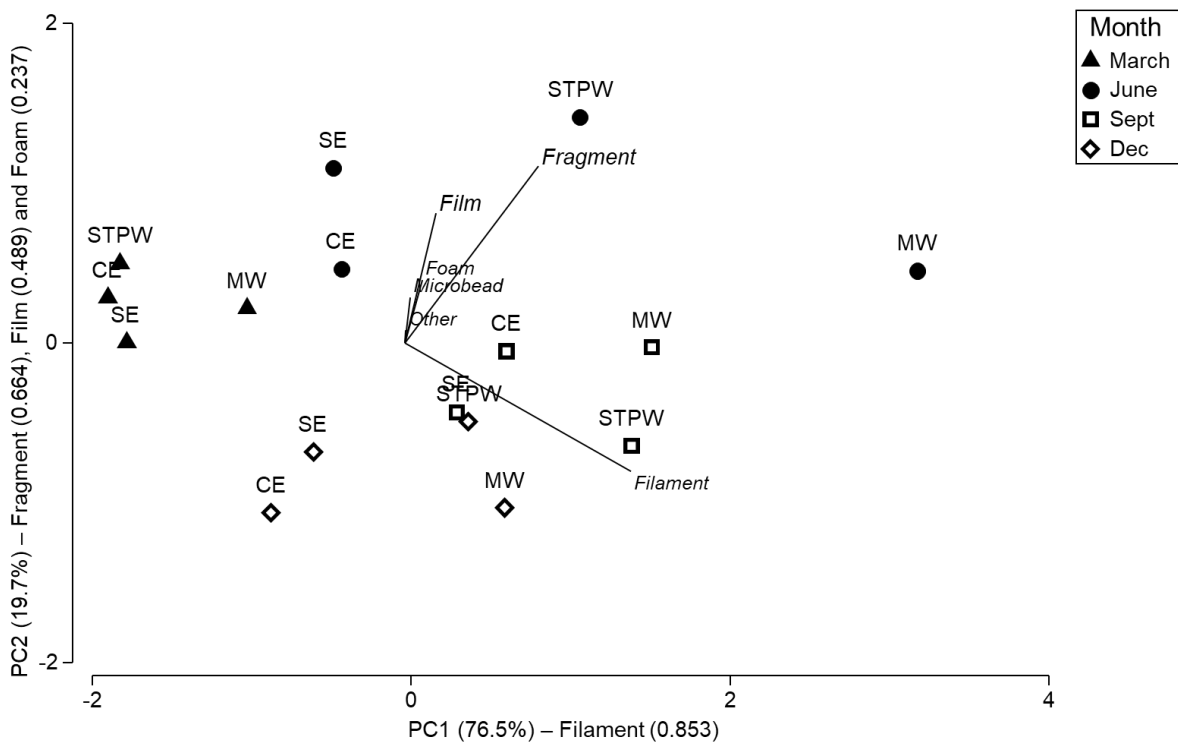


Figure 17. Principal component analysis of plastic abundance and type data collected from each region on each sample time. Factors contributing to principal component I (PCI) and PCII are presented along the axes. SE = Swan Estuary, CE = Canning Estuary, MW = Melville Water, and STPW = Stirling Bridge to Point Walter.

## 4 Conclusions

This project constitutes the first comprehensive baseline assessment of plastic abundance, distribution, and accumulation patterns in the Swan Canning Estuary. The quarterly survey of 38 shorelines throughout the Swan Canning Estuary revealed that plastic debris was present throughout the estuary. Plastic accumulation varied from over 2,500 pieces per transect to less than 10. Plastic accumulation varied according to estuary location and beach orientation, with shorelines in the Swan Estuary and Lower Swan Canning Estuary accumulating more plastic than the Canning Estuary. Additionally, beaches that faced into the prevailing winds, south and west, accumulated a greater quantity of plastic and this plastic accumulated further up into beach vegetation. Five shoreline locations were identified to have far greater plastic accumulation than other shorelines which is suggested to be a result of a combination of factors including orientation, all are west or south facing beaches, high banks with vegetation, proximity to the CBD, or at the lowest section of the estuary near Fremantle Harbour.

The beach surveys revealed that the most abundant plastic types were expanded polystyrene products including whole and fragmented packaging, cups, plates, bowls, and large beans, and fragmented hard and soft plastics. The fragmented components of expanded polystyrene and hard and soft plastics constituted broken-up pieces of larger plastic items that have been weathered and fractured into smaller and smaller pieces. These fragmented plastics demonstrate the fate of large plastic items that escape or are littered into the environment. Over time, plastic breaks up into smaller and smaller pieces which may impact biota through incidental or targeted ingestion and may cause a range of potential harmful effects such as reduction in fitness through filling the stomach and reducing the urge to feed (Pierce et al., 2004), digestive enzyme impacts (Trestrail et al., 2021) and oxidative stress (Yu et al., 2018).

The items to be restricted by Stages 1 and 2 of the WA Plan for Plastics were commonly found throughout the estuary and included EPS pieces (separate to EPS food and beverage containers), straws, thin film carry bags, food containers and EPS food containers and EPS cup, plates and bowls. The restriction of these items, particularly EPS in food packaging and general packaging should contribute to reducing the quantity of this material that ends up in the estuary.

The sampling of surface water using a manta tow net revealed plastic debris was commonly encountered at each of the four sites in the estuary on every sampling occasion. Filaments were the most abundant plastic found in the trawls reflecting the influence of sources such as clothing, cloth, geotextiles, rope and fishing line. Fragments were the second most dominant plastic found in the tows and reflects the composition of plastics found in the estuary shorelines.

A key result was the confirmation of significant seasonal trends of plastic abundance in surface water. The greatest quantity of plastic was found in June and September following substantial rainfall events. These data suggest that there was a gradual reduction in plastic abundance in surface water throughout the drier months which

resulted in the lowest plastic abundances observed in March. Additionally, axial convergence zones within the estuary were observed concentrating floating plastic along with other buoyant debris potentially exposing foraging seabirds and fish to higher plastic concentrations.

The critical next step in this work is to determine the polymer type of these microplastics. While material collected during the beach surveys was large and easy to identify with a FTIR, the microplastics samples collected through the surface water trawls is difficult. There was potential for error in misidentifying materials, particularly filaments, as plastic, when they may be natural fibres (Crutchett et al., 2020). While every attempt is made to ensure the plastics were identified correctly, until polymer identification is readily available it is difficult to accurately determine more precisely the amount of plastic, and its polymer type.

This research has provided a baseline of the amount and types of plastic present in the estuary, both on the shoreline and surface water. This information has been collected to provide critical information as a baseline of plastic pollution prior to the implementation of the WA Plan for Plastics and regulatory bans on multiple single-use plastic items. This research will also be beneficial to other plastic mitigation programs including DBCA's Plastic Free Riverpark Program which aims to reduce the availability of single-use plastics in the Riverpark.

This project has also provided a method which can be used to repeat the work to measure the effectiveness of such policy responses in the future and the effectiveness of regulatory bans under the WA Plan for Plastics and the Container Deposit Scheme.

While a comprehensive survey of 38 sites was completed in the current study, this number of sites could be refined in future work to focus on the most problematic locations including but not necessarily limited to sites on Mosman Park Foreshore (37 VALPL), Jenalup beach near Point Walter (1 JB), Point Fraser (29 LP), and the western side of Burswood Peninsula (27 BARR, 29 LP). Additionally, these locations could be targeted for further clean up events or ongoing management to remove plastic from the estuary.

While this study has quantified the amount of plastic in the Swan Canning Estuary and described the patterns of accumulation it did not aim to determine the sources of plastic pollution. While this can be partially inferred from the data collected, it was not the purpose of the study and further work may be required to explore the plastic debris in urban drains particularly during first flush events and direct inputs from major roads near the estuary.

# Appendices

## Appendix 1. Sampling and Analysis Plan

### Beach surveys

#### Site selection

Equal number of north, south, west and east facing beaches in each estuary region (lower Swan Canning, Canning and Swan Estuary) resulting in a total of 36 sites (Table A1.1). To limit any subjective bias, sites were positioned at points every 2 km from the mouth of the estuary and those that meet the directional criteria were retained with the aim of having sites consistently spaced around the estuary.

*Table A1.1. Site development showing number of sites in each restrictive beach region. The \* denotes additional site with historic data.*

	WF	SF	EF	NF	Total
LSCE	4*	3	4*	3	14
SE	3	3	3	3	12
CE	3	3	3	3	12
<b>total</b>	<b>10</b>	<b>9</b>	<b>10</b>	<b>9</b>	<b>38</b>
without extra sites	9	9	9	9	36

### Sampling Method

#### Setting up the site

When arriving at each site start by placing the first flag in the sand at the approximately starting location (transects do not need to start at exactly the same place). Using the 50 m tape measure out the 100 m transect by following the water line as best as possible. Place a flag at the 50 m mark and the 100 m mark. Avoid walking heavily in the area surrounding the 0 m, 50m and 100m marks, this is where the survey transects will be located.

Fill out the Site Data Sheet. GPS the access point, scribe GSP co-ordinates. Or if access is across the entire site write this in the form.

#### Setting up each beach transect

Place a flag on the water line, in line with the flag marking the 0 m, 50, or 100 m mark. Measure perpendicular from the waterline to the end of the most recent



strandline, place a flag here, continue measuring to the start of the vegetation, place a flag here, measure a further 2 m into the vegetation placing a flag at the end (Figure A1.1). Record the following measurements in the River Transect data sheet:

- Total transect length
- S1 – length from waterline to the top of the most recent high tide mark
- S2 – length from the top of the most recent high tide mark to the vegetation.  
Note that this is not the historical/storm wrack line, which will generally be higher up the beach and consist of far more debris.
- S3 – length of vegetation surveyed – this will generally be 2 m unless there is an obstruction.

Once the subsections are marked out place a metal bucket in each one, this is for the collection of plastic debris.

There will be times when one or more the sections will not be present. In some instances there may be a section of beach but the strand line is not visible or hidden in the vegetation (Figure A1.2). In this case S1 will be the distance from the water line to the vegetation, there will be no S2 and S3 will extend for the 2 m and incorporate the strandline. On occasion the water line will be at the vegetation. In this case the transect is only 2 m long and may incorporate the strandline (Figure A1.3).

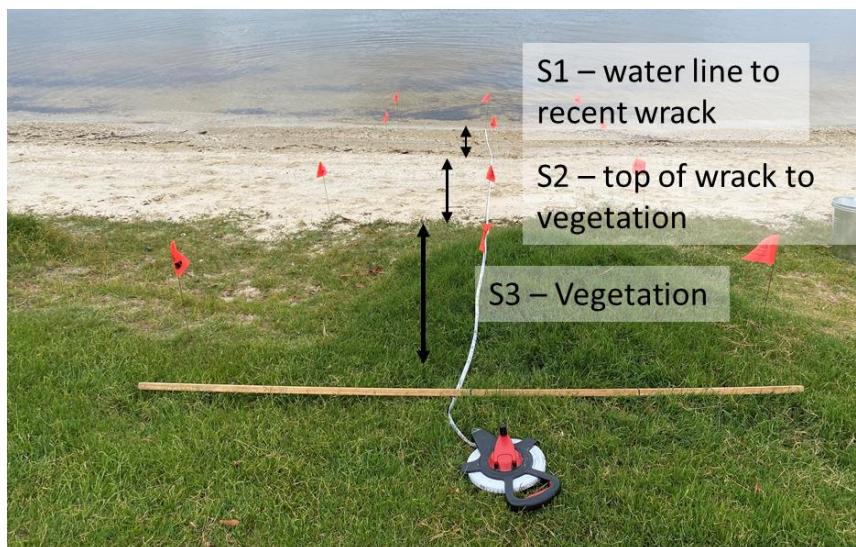


Figure A1.1. Idealised transect set-up

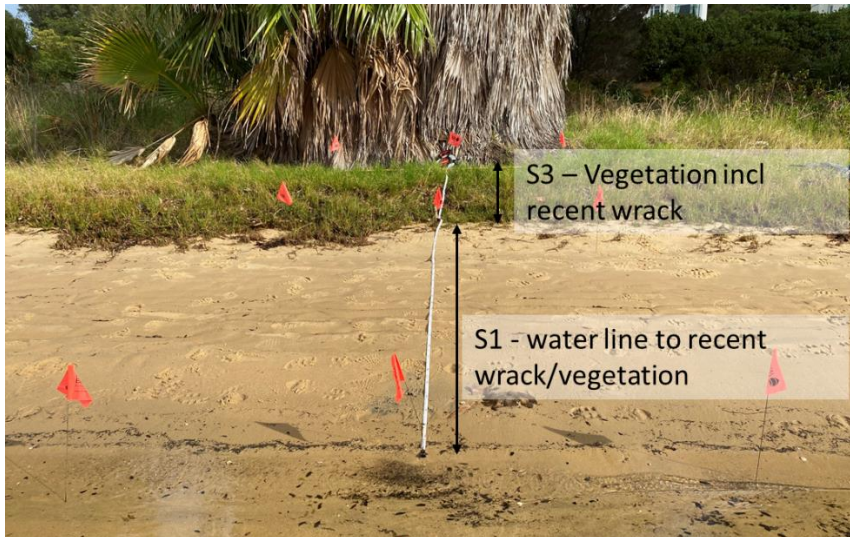


Figure A1.2. Potential site set up. No S2 is apparent. Recent wrack line is obscured by the vegetation



Figure A1.3. Potential site set up. There is no S1 or S2. Vegetation starts at the water line.

Using the 2 m wide wooden pole place the centre mark (black texta mark) on the tape and mark the 2 m transect width at the water line and then again at the start of each section and the end of the transect (see Figure A1.1).

Once the transect is marked out, take a GPS waypoint at the start and end of the transect and fill in the River Transect data sheet. To measure bank angle and slope use the two wooden poles and the inclinometer. The method is:

- One person holds the thick pole as vertically as possible on the waters edge.
- The other person takes the longer thin pole and the range finder. The pole is placed at the end of the transect directly in line with person 1.

- Press the power button (Figure A1.4). The display should look like the image below (Figure A1.5). If it does not, press the mode button (Figure A4) until it does.
- Hold the range finder at the 1.5 m mark on the tall pole (Figure 1.6).
- Look through the range finder and focus the cross hairs on the 1.5 m mark on the thick pole.
- Press the measurement button. Record the middle and the bottom measurements.
  - o The top measurement is distance
  - o The middle is bank height
  - o The bottom is bank slope
- Sometime if the distance is less than 3 m the range finder can't calculate bank height. It will still provide bank slope. Record bank slope and estimate bank height, note that it is an estimate.



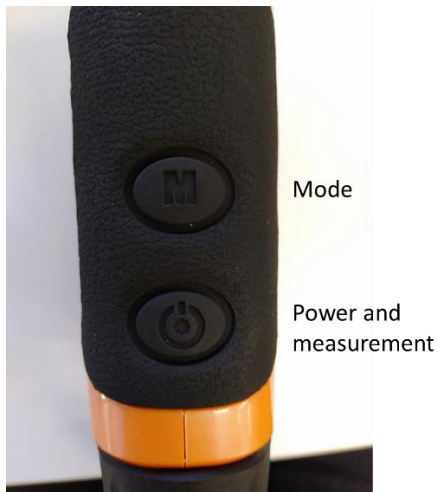


Figure A1.4.

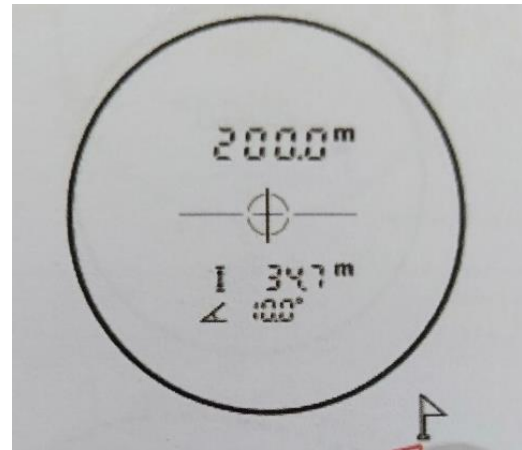


Figure A1.5.



Figure A1.6. Taking bank height and slope measurements.

Ensure the River Transect data sheet is filled in completely.

## Sample collection

The final step before the collection of plastic debris can commence is to divide the transect into 10 equal intervals. This information will be provided to the CSIRO and is the first group of boxes to fill in on the count data sheet.

So, if the transect is 10 m long there will be 10 intervals each of 1 m long. There is room to calculate the intervals on the data collection sheet. In each subsection the sampler commences looking for plastic debris and the first piece they see in each interval is identified using the ID codes on the count datasheet and sized using the size chart. This information is recorded in the interval section of the count datasheet. Continue until all the CSIRO subsections are completed. Make sure each of the plastic pieces are counted in the appropriate subsection too (S1, S2, S3).

One approach is to:

- Start sampling at the water line in S1.
- Layout the 2 m wide pole at the end of the first CSIRO interval. Start to search for plastic.
- The first piece you find in that CSIRO interval is to be sized, ID'd (CSIRO subsection data) and counted (in the S1 column).
- Continue to search for all plastic in that area. All plastic you collect needs to be ID'd and counted (use a tally system), then place into the metal bucket for the corresponding subsection.
- Once you are confident you have collected as much as you can see then move the wooden pole to the next CSIRO interval and repeat.
- Ensure everything from each subsection is counted, ID and recorded on the count data sheet. Before moving to the next subsection.
- Remember the focus of sampling is to collect plastic fragments bigger than 1-5 mm. There will be times where there will be too much small plastic debris to count and ID in a reasonable time. In this case you will need to subsample. See the method below for completing a subsample (see below).
- Once the transect is completed, the contents in each bucket needs to be bagged.
- Label the bag using large print with the:
  - o Date
  - o Site code
- Fold over the top of each bag and using the bulldog clips attached all the bags together.

## Subsampling method

Sometimes there will be too much small plastic in an area to count within a reasonable time frame. In these instances, you need to subsample. To subsample:

- You will need to measure the area that will be subsampled. For instance, it is often the historical debris line / wrack line where subsampling will often be required.

- Measure the length of the area along the transect line.
- For example, if the transect is 10 m, and you need subsample the historical wrack line which start at 7.5 m and finishes at 8.5 m, the length of the area to be subsampled is 1 m. If it is continuous along the width of the transect then the area to be subsampled will be 1 m (long) x 2 m (wide), giving an area of 2 m<sup>2</sup>. Record these measurements and this total area in the box on the River Transect data sheet.
- Assemble the 0.5 m x 0.5 m quadrat.
- Place as randomly as possible (throw over shoulder, close eyes and drop, use random number generator on phone) it in the area to be subsampled.
- Conduct the count and ID in this subsampled area.
- If the area to be subsampled occupies the entire subsection, for example S2, then only count the area in the quadrat, this subsection is then complete. The count data will go in the sample count data sheet as the other subsections.
- However, if the area to be subsampled is only a small part of the subsection then use a new count data sheet, record the site name, date, samplers, transect number and add that it is subsample for the respective subsection. Count as per usual the remainder of the subsection.
- The length of the transect that was subsampled is not to be counted any further. In the example given above, the remainder of the area between 7.5 m and 8.5 m will not be sampled.
- It is important to remember that area the quadrat falls and is counted and ID'd is to be representative of the area identified for subsampling for example the 7.5 m to 8.5 m in the example above. If there was a large boulder or thick sedge bush that break up the area to subsampled then record as close as possible the area that is consistent with what you are subsampling. For example, if the large sedge bush covered 0.5 m<sup>2</sup>, then note this in River Transect data sheet and subtract from the total area subsampled.

## SAFETY

**Please remember you are sorting rubbish**, use the gloves provided particularly if you are sorting through material you can't see though very well. There is a risk of cuts and abrasions from broken glass or metal cans and needle stick injury. If a syringe is found, have someone open the sharps box, then using gloves, pick it up from the non-needle end and carefully place into the sharps bin. Tighten securely. Make sure you are familiar with the Job Safety Analysis (JSA).

## Whole site sweep

Once the three transects are completed at each site. A sweep of the area for large plastic item needs to be conducted. The purpose is to collect all large debris items within the same bank width (the length of the transects the bank area) covered by the transects across the full 100 m site. To do this:

- Using the metal buckets walk the length of the site with one person in the lower half and the other in the upper half of the bank.
- Collect any large (5 cm or bigger) pieces of plastic, which may include:

- Plastic bottles
- Bags
- Plastic cutlery
- Cups, plates
- Drink cans
- Plastic bottle lids
- Food wrappers
- Plastic sheet
- Foam sheets
- Toys
- This shouldn't take long, if you find you bending over and looking closely for plastic then that is too much. It should be conducted at slow to moderate walk.
- When it is completed, ID and count the debris found. Data should be recorded in the Whole Site count data sheet.
- Bag it up, label bag as:
  - Date
  - Site code – WS

## Equipment

- Site data sheet – 1 per site
- River Transect data sheet – 3 per site
- Count data sheet – 4 per site
- 1 x 2 m long wooden pole
- 1 x 1.8 m wooden pole
- Flags – minimum of 20
- 50 m measuring tape
- GPS
- Digital inclinometer
- Sample bags - 1 per transect section and 1 whole site transect = 10 per site
- Bull dog clips
- Forceps
- Small metal rake
- Small metal pole
- Gloves, robust
- Disposable gloves
- Tongs
- 0.5 m quadrat
- 3 x metal buckets

## Appendix 2. All items identified

Table A2.1. Complete list of items identified during the field sampling

General category ID		Code	General category ID		Code	General category ID		Code
Hard plastic	Pipe/PVC	H1	Cloth	String/rope/strap	C1	Other	Drill tailing	O10
Hard plastic	Beverage bottle <1L	H2	Cloth	Clothing/towel	C2	Other	Paint fragment	O11
Hard plastic	Other bottle	H3	Cloth	Wipes/cloths	C3	Other	Button	O12
Hard plastic	Bottle cap/lid	H4	Cloth	Insulation/stuffing	C4	Other	Fibre glass	O13
Hard plastic	Food container	H5	Cloth	Unknown/other	C5	Other	Tape	O14
Hard plastic	plate/bowl	H6	Timber	Wood/timber	T1	Other	disposable glove	O15
Hard plastic	Utensils	H6.2	Timber	Utensils/food stick	T2	Other	Sequins	O16
Hard plastic	Stirrers	H6.3	Timber	Bottle cork	T3	Other	Band aid	O17
Hard plastic	Cups	H6.4	Timber	Pallet	T4	Other	Plastic coated wire	O18
Hard plastic	Bucket/crete	H7	Timber	Unknown/other	T5	Other	Ceramic filter	O19
Hard plastic	Lighter	H8	Foam	Food container	D1	Other	Brush	O20
Hard plastic	Lollipop stick	H9	Foam	Cup/plates/bowls	D2	Other	Beads	O21
Hard plastic	Earbud	H9.2	Foam	Polystyrene	D3	Other	Ball	O22
Hard plastic	unknown/other hard	H10	Foam	Unknown/other	D4	Other	Beads	O23
Soft plastic	Thin film carry bag	S1	Paper	cigarette/butt	P1	Other	Glass Bottle Lid	O24
Soft plastic	Food wrapper	S2	Paper	paper/cardboard	P2	Other	Cigarette Packet	O25
Soft plastic	sheeting	S3	Paper	Magazine/newspaper	P3	Other	Fertiliser Pellet	O26
Soft plastic	Cup/lid	S4	Paper	Bag	P4	Other	Plastic bottle Cork	O27
Soft plastic	Straw	S5	Paper	Box	P5	Other	Wall Plug	O28
Soft plastic	unknown/other soft	S6	Paper	Food container/box	P6	Other	Plastic Toy	O29
Soft plastic	Thick plastic bag	S7	Paper	Food wrapper/bag	P7	Other	Dummy	O30
Soft plastic	Bag	S8	Paper	Beverage container	P8	Other	Plastic bike valve	O31
Soft plastic	Straw wrapper	S9	Paper	cups	P9	Other	Silcone	O32
Soft plastic	Bait bag	S10	Paper	plates/bowls	P10	Other	Metal Ring Pull	O33
Soft plastic	Ice bag	S11	Paper	unknown/other	P11	Other	Toothbrush	O34
Soft plastic	Dog poo bag	S12	Fishing	Net	F1	Other	Glasses	O35
Soft plastic	ZipLock Bag	O27	Fishing	Fishing line	F2	Other	Corn Starch Pins	O36
Plastic straps	String/rope/ribbon	BP1	Fishing	fishing lure	F3	Other	Breathlyzer Tube	O37
Plastic straps	packing strap	BP2	Fishing	Buoys/floats	F4	Other	Silcone	O38
Plastic straps	Cable ties	BP3	Fishing	glow stick	F5	Other	Tarp	O39
Plastic straps	unknown/other strap	BP4	Fishing	Fishhook/sinker	F6	Other	Sticker	O40
Metal	Pipe	M1	Fishing	unknown/other	F7	Other	Mouthguard	O41
Metal	Wire	M2	Miscellaneous	Battery	Z1	Other	Mask	O42
Metal	Aerosol	M3	Miscellaneous	Brick/cement	Z2	Other	Nerf Toy	O43
Metal	Beverage can	M4	Miscellaneous	Carpet	Z3	Other	Confetti	O44
Metal	Food can/tin	M5	Miscellaneous	Ceramic	Z4	Other	Hair Tie	O45
Metal	Lid/cap	M6	Miscellaneous	E waste	Z5	Other	Stubby holder	O46
Metal	Food wrapper	M7	Miscellaneous	Furniture	Z6	Other	Whipper Snipper Line	O47
Metal	Aluminium foil	M8	Miscellaneous	Appliances	Z7	Other	glow stick - non fishing	O48
Metal	Bucket/drum	M9	Miscellaneous	Large car parts	Z8	Other	sprinkler	O49
Metal	unknown/other hard	M10	Miscellaneous	Large boat parts	Z9	Other	condom	O50
Metal	unknown/other soft	M11	Miscellaneous	Bag/box dom. Waste	Z10			
Glass	Beverage bottle	G1	Miscellaneous	Nurdles	Z11			
Glass	Jar	G2	Other	soft tubing	O1			
Glass	lightglobe/tube	G3	Other	Pencil/pen	O2			
Glass	Unknown/other glass	G4	Other	shot gun wadding	O3			
Rubber	Thong/shoe	R1	Other	burnt foam	O4			
Rubber	tyre	R2	Other	Broom bristle	O6			
Rubber	Balloon	R3	Other	Fruit sticker	O7			
Rubber	Rubber Band	R4	Other	ear plug	O8			
Rubber	Unknown/other	R5	Other	Astro turf	O9			



## Appendix 3. Full regional debris ranking results

Table A3.1. Mean abundance of each identified item in standard beach transects in each region across all time periods. Grey highlight items are items to be banned under the WA Plan for Plastics. \* Balloon releases are banned, not balloons.

\*\*Cotton buds with plastic sticks are banned.

Ranking	Lower Swan Canning Estuary				Swan Estuary				Canning Estuary			
	Category	Sub-category	Mean	SE	Category	Sub-category	Mean	SE	Category	Sub-category	Mean	SE
1	Foam	Polystyrene (EPS)	156.86	92.33	Hard Plastic	Hard plastic - Unknown	59.13	19.98	Soft plastic	Soft plastic - Unknown	18.08	4.33
2	Foam	EPS beans	83.30	54.53	Foam	Polystyrene (EPS)	53.42	23.89	Hard Plastic	Hard plastic - Unknown	11.67	2.60
3	Miscellaneous	Resin pellets (nurdles)	46.05	17.81	Soft plastic	Soft plastic - Unknown	33.67	9.72	Foam	Polystyrene (EPS)	8.06	2.13
4	Hard Plastic	Hard plastic - Unknown	38.95	8.84	Foam	EPS beans	23.88	11.52	Foam	EPS beans	4.88	1.36
5	Plastic straps	String/rope/ribbon	32.40	9.52	Foam	EPS - cup/plates/bowls	17.06	15.18	Soft plastic	Food wrapper	3.19	0.90
6	Soft plastic	Soft plastic - Unknown	31.23	6.69	Soft plastic	Food wrapper	10.72	3.16	Miscellaneous	Resin pellets (nurdles)	3.08	1.13
7	Foam	EPS - cup/plates/bowls	24.36	16.42	Foam	Foam - Unknown	8.29	2.98	Plastic straps	String/rope/ribbon	2.90	1.37
8	Foam	Foam - Unknown	17.05	7.79	Miscellaneous	Resin pellets (nurdles)	7.25	2.98	Glass	Beverage bottle	1.94	0.47
9	Fishing	Fishing line	8.74	5.24	Hard Plastic	Bottle cap/lid	6.48	1.96	Foam	Foam - Unknown	1.77	0.52
10	Glass	Beverage bottle	6.99	2.59	Plastic straps	String/rope/ribbon	4.47	1.92	Glass	Unknown/other glass	1.75	0.72
11	Rubber	Unknown/other	5.00	3.12	Paper	cigarette/butt	3.42	1.02	Fishing	Fishing line	1.31	0.30
12	Soft plastic	Food wrapper	3.92	0.76	Soft plastic	Straw	3.27	0.87	Hard Plastic	Bottle cap/lid	1.27	0.28
13	Paper	cigarette/butt	3.77	1.10	Fishing	Fishing line	2.00	0.44	Paper	cigarette/butt	1.25	0.33
14	Hard Plastic	Cotton bud stick	3.16	2.49	Hard Plastic	Food Container/lid	1.54	0.63	Rubber	Unknown/other	1.08	0.98
15	Hard Plastic	Bottle cap/lid	2.65	0.63	Glass	Unknown/other glass	1.33	0.48	Soft plastic	Thin film carry bag	1.00	0.23
16	Glass	Unknown/other glass	2.37	0.60	Glass	Beverage bottle	1.21	0.48	Foam	EPS - cup/plates/bowls	0.75	0.29
17	Foam	EPS - Food container	2.01	1.71	Soft plastic	sheeting	1.15	0.69	Cloth	Unknown/other	0.63	0.18
18	Cloth	Unknown/other	1.44	0.36	Soft plastic	Straw wrapper	1.06	0.54	Soft plastic	Straw	0.60	0.14
19	other	burnt foam	1.43	0.92	other	Pen/pen/texta	1.02	0.83	Cloth	String/rope/strap	0.46	0.15
20	Fishing	fishing lure	1.38	1.25	Soft plastic	Thin film carry bag	0.94	0.29	other	Tape	0.35	0.13
21	other	Drill tailing	1.34	0.42	Soft plastic	Cup/lid	0.83	0.35	Hard Plastic	Utensils	0.29	0.23
22	Soft plastic	Straw	1.32	0.27	Hard Plastic	Lollipop stick/cotton bud stick**	0.81	0.30	Soft plastic	sheeting	0.25	0.13
23	Hard Plastic	Lollipop stick/cotton bud stick**	0.86	0.38	Metal	Aluminium foil	0.77	0.29	Cloth	Clothing/towel	0.25	0.10
24	Cloth	String/rope/strap	0.79	0.20	Paper	unknown/other	0.71	0.44	Hard Plastic	Other bottle	0.23	0.12
25	Soft plastic	sheeting	0.70	0.24	other	Drill tailing	0.71	0.31	Hard Plastic	Food Container/lid	0.21	0.11
26	Miscellaneous	Brick/cement	0.70	0.42	Plastic straps	packing strap	0.67	0.50	Hard Plastic	Lollipop stick/cotton bud stick**	0.21	0.07
27	Metal	Wire	0.57	0.54	Hard Plastic	Cotton bud stick	0.65	0.43	Soft plastic	Other bag	0.21	0.11
28	Metal	Aluminium foil	0.57	0.23	Soft plastic	ZipLock Bag	0.56	0.27	Plastic straps	packing strap	0.21	0.07
29	Soft plastic	Thin film carry bag	0.52	0.20	Rubber	Balloon*	0.54	0.27	Soft plastic	Cup/lid	0.19	0.07
30	Plastic straps	packing strap	0.50	0.23	other	Broom bristle	0.50	0.30	Soft plastic	ZipLock Bag	0.19	0.07
31	Miscellaneous	Ceramic	0.44	0.26	other	Whipper snipper cord	0.50	0.50	Paper	paper/cardboard	0.19	0.08
32	Plastic straps	unknown/other strap	0.41	0.15	Rubber	Rubber Band	0.42	0.25	other	Drill tailing	0.17	0.08
33	Soft plastic	Straw wrapper	0.41	0.22	other	Syringe	0.42	0.16	Plastic straps	unknown/other strap	0.15	0.08
34	Hard Plastic	Food Container/lid	0.37	0.11	Cloth	Unknown/other	0.33	0.10	Metal	Beverage can	0.15	0.07
35	Soft plastic	ZipLock Bag	0.37	0.25	other	Cigarette packet	0.31	0.27	Metal	Lid/cap	0.15	0.07
36	Cloth	Insulation/stuffing	0.36	0.18	Hard Plastic	Cups	0.29	0.13	Timber	Wood/timber	0.15	0.09
37	Rubber	Rubber Band	0.35	0.17	other	Tape	0.29	0.11	other	Ball	0.15	0.06
38	Fishing	glow stick	0.35	0.12	Hard Plastic	Utensils	0.27	0.09	Metal	Aluminium foil	0.13	0.05
39	other	Tape	0.34	0.10	Foam	EPS - Food container	0.25	0.15	other	Fruit sticker	0.13	0.08
40	other	Fertiliser Pellet	0.30	0.12	other	Fruit sticker	0.25	0.09	other	Corn starch pins	0.13	0.13
41	Paper	unknown/other	0.27	0.09	Metal	unknown/other hard	0.21	0.10	Hard Plastic	Beverage bottle <1L	0.10	0.05
42	Metal	unknown/other hard	0.25	0.11	Rubber	Unknown/other	0.21	0.07	Soft plastic	Thick plastic bag	0.10	0.05
43	other	Band aid	0.24	0.14	Cloth	Clothing/towel	0.21	0.07	Cloth	Insulation/stuffing	0.10	0.07
44	Soft plastic	Other bag	0.22	0.14	Hard Plastic	Pipe/PVC	0.19	0.10	Paper	unknown/other	0.10	0.04
45	Soft plastic	Thick plastic bag	0.20	0.09	Hard Plastic	Beverage bottle <1L	0.19	0.07	Fishing	unknown/other	0.10	0.07
46	Metal	Food wrapper	0.20	0.06	Plastic straps	unknown/other strap	0.19	0.09	other	Pen/pen/texta	0.10	0.05
47	Timber	Unknown/other	0.20	0.10	Metal	Lid/cap	0.19	0.08	Hard Plastic	Pipe/PVC	0.08	0.05
48	other	ear plug	0.18	0.10	Cloth	String/rope/strap	0.19	0.07	Soft plastic	Straw wrapper	0.08	0.04
49	Soft plastic	Cup/lid	0.16	0.05	Cloth	Wipes/cloths	0.19	0.08	Cloth	Wipes/cloths	0.08	0.04
50	Rubber	Balloon*	0.16	0.08	Cloth	Insulation/stuffing	0.19	0.08	Fishing	fishing lure	0.08	0.04
51	Paper	paper/cardboard	0.16	0.06	Hard Plastic	Lighter	0.17	0.07	other	Cigarette packet	0.08	0.05
52	other	Plastic coated wire	0.16	0.11	Soft plastic	Dog litter bag	0.15	0.06	other	Tarp	0.08	0.05
53	Metal	Lid/cap	0.14	0.05	Metal	Food wrapper	0.15	0.06	Hard Plastic	Cotton bud stick	0.06	0.06
54	Timber	Bottle cork	0.14	0.08	Timber	Bottle cork	0.15	0.08	Soft plastic	Dog litter bag	0.06	0.04
55	other	Broom bristle	0.14	0.08	Fishing	fishing lure	0.15	0.06	Fishing	Net	0.06	0.04
56	Cloth	Clothing/towel	0.13	0.06	other	Ball	0.15	0.07	Miscellaneous	Brick/cement	0.06	0.05
57	Timber	Wood/timber	0.13	0.07	Soft plastic	Other bag	0.13	0.07	other	Broom bristle	0.06	0.04
58	Plastic straps	Cable ties	0.09	0.04	Metal	Wire	0.13	0.05	other	Band aid	0.06	0.04
59	Metal	unknown/other soft	0.09	0.05	Fishing	Fishhook/sinker	0.13	0.06	Hard Plastic	Plate/bowl	0.04	0.03
60	other	Fruit sticker	0.09	0.05	Hard Plastic	Other bottle	0.10	0.05	Hard Plastic	Cups	0.04	0.03
61	other	Ceramic filter	0.09	0.09	Hard Plastic	Stirrers	0.10	0.07	Soft plastic	Bait Bag	0.04	0.03
62	Hard Plastic	Utensils	0.07	0.03	Metal	Beverage can	0.10	0.04	Plastic straps	Cable ties	0.04	0.03
63	Soft plastic	Ice Bag	0.07	0.04	Fishing	unknown/other	0.10	0.05	Metal	Wire	0.04	0.03
64	Fishing	Net	0.07	0.04	Soft plastic	Bait Bag	0.08	0.07	Metal	unknown/other hard	0.04	0.03
65	other	Astro turf	0.07	0.03	Plastic straps	Cable ties	0.08	0.05	Metal	unknown/other soft	0.04	0.03
66	other	Plastic cork	0.07	0.04	Metal	unknown/other soft	0.08	0.04	Rubber	Rubber Band	0.04	0.03
67	Hard Plastic	Lighter	0.05	0.03	Glass	Jar	0.08	0.07	Foam	EPS - Food container	0.04	0.03
68	Soft plastic	Dog litter bag	0.05	0.03	Rubber	Thong/shoe	0.08	0.04	Miscellaneous	Ceramic	0.04	0.03
69	Rubber	Thong/shoe	0.05	0.03	Paper	paper/cardboard	0.08	0.05	other	burnt foam	0.04	0.04
70	Miscellaneous	Carpet	0.05	0.05	Fishing	Net	0.08	0.07	other	Paint fragment	0.04	0.03
71	other	Pen/pen/texta	0.05	0.03	Timber	Wood/timber	0.06	0.04	other	Plastic coated wire	0.04	0.03
72	other	Sequins	0.05	0.03	Fishing	Buoys/floats	0.06	0.04	Hard Plastic	Stirrers	0.02	0.02
73	other	Plastic Toy	0.05	0.04	Fishing	glow stick	0.06	0.04	Metal	Pipe	0.02	0.02
74	Hard Plastic	Beverage bottle <1L	0.04	0.03	Miscellaneous	Brick/cement	0.06	0.05	Metal	Food wrapper	0.02	0.02
75	Hard Plastic	Other bottle	0.04	0.03	Miscellaneous	Ceramic	0.06	0.05	Glass	Jar	0.02	0.02
76	Hard Plastic	Plate/bowl	0.04	0.04	other	shot gun wadding	0.06	0.04	Rubber	tyre	0.02	0.02
77	Hard Plastic	Stirrers	0.04	0.03	other	Band aid	0.06	0.04	Timber	Bottle cork	0.02	0.02

Table A3.1. Continued

Ranking	Lower Swan Canning Estuary				Swan Estuary				Canning Estuary			
	Category	Sub-category	Mean	SE	Category	Sub-category	Mean	SE	Category	Sub-category	Mean	SE
78	Hard Plastic	Cups	0.04	0.03	other	Plastic coated wire	0.06	0.04	Paper	Magazine/newspaper	0.02	0.02
79	Soft plastic	Bait Bag	0.04	0.03	other	Plastic Toy	0.06	0.04	Paper	Food wrapper/bag	0.02	0.02
80	Metal	Beverage can	0.04	0.03	Hard Plastic	Bucket/crete	0.04	0.03	Fishing	glow stick	0.02	0.02
81	Metal	Bucket/drum	0.04	0.03	Timber	Utensils/food stick	0.04	0.04	Fishing	Fishhook/sinker	0.02	0.02
82	Timber	Utensils/food stick	0.04	0.03	Paper	Magazine/newspaper	0.04	0.04	other	soft tubing	0.02	0.02
83	Fishing	Buoys/floats	0.04	0.04	other	soft tubing	0.04	0.04	other	ear plug	0.02	0.02
84	Fishing	unknown/other	0.04	0.03	other	disposable glove	0.04	0.03	other	disposable glove	0.02	0.02
85	other	soft tubing	0.04	0.03	Soft plastic	Thick plastic bag	0.02	0.02	other	Ceramic filter	0.02	0.02
86	other	Fibre glass	0.04	0.03	Soft plastic	Ice Bag	0.02	0.02	other	Brush/comb	0.02	0.02
87	Metal	Aerosol	0.02	0.02	Metal	Aerosol	0.02	0.02	other	Beads	0.02	0.02
88	Metal	Food can/tin	0.02	0.02	Metal	Food can/tin	0.02	0.02	other	Golf Ball	0.02	0.02
89	Glass	lightglobe/tube	0.02	0.02	Miscellaneous	E waste	0.02	0.02	other	Glow stick non fishing	0.02	0.02
90	Cloth	Wipes/cloths	0.02	0.02	Miscellaneous	Bag/box dom. Waste	0.02	0.02	other	Syringe	0.02	0.02
91	Paper	Bag	0.02	0.02	other	burnt foam	0.02	0.02	other	Whipper sniper cord	0.02	0.02
92	Paper	cups	0.02	0.02	other	Astro turf	0.02	0.02	Hard Plastic	Bucket/crete	0.00	0.00
93	other	shot gun wadding	0.02	0.02	other	Button	0.02	0.02	Hard Plastic	Lighter	0.00	0.00
94	other	Paint fragment	0.02	0.02	other	Fibre glass	0.02	0.02	Soft plastic	Ice Bag	0.00	0.00
95	other	disposable glove	0.02	0.02	other	Sequins	0.02	0.02	Metal	Aerosol	0.00	0.00
96	other	Brush/comb	0.02	0.02	other	Wall Plug	0.02	0.02	Metal	Food can/tin	0.00	0.00
97	other	Ball	0.02	0.02	other	Plastic cork	0.02	0.02	Metal	Bucket/drum	0.00	0.00
98	other	Wall Plug	0.02	0.02	other	Mask	0.02	0.02	Glass	lightglobe/tube	0.00	0.00
99	other	Tooth brush	0.02	0.02	other	Nerf Toy	0.02	0.02	Rubber	Thong/shoe	0.00	0.00
100	other	Glasses	0.02	0.02	Hard Plastic	Plate/bowl	0.00	0.00	Rubber	Balloon*	0.00	0.00
101	other	Tarp	0.02	0.02	Metal	Pipe	0.00	0.00	Timber	Utensils/food stick	0.00	0.00
102	other	Mask	0.02	0.02	Metal	Bucket/drum	0.00	0.00	Timber	Pallet	0.00	0.00
103	other	Nerf Toy	0.02	0.02	Glass	lightglobe/tube	0.00	0.00	Timber	Unknown/other	0.00	0.00
104	other	Confetti	0.02	0.02	Rubber	tyre	0.00	0.00	Paper	Bag	0.00	0.00
105	Hard Plastic	Pipe/PVC	0.00	0.00	Timber	Pallet	0.00	0.00	Paper	Box	0.00	0.00
106	Hard Plastic	Bucket/crete	0.00	0.00	Timber	Unknown/other	0.00	0.00	Paper	Food container/box	0.00	0.00
107	Metal	Pipe	0.00	0.00	Paper	Bag	0.00	0.00	Paper	Beverage container	0.00	0.00
108	Glass	Jar	0.00	0.00	Paper	Box	0.00	0.00	Paper	cups	0.00	0.00
109	Rubber	tyre	0.00	0.00	Paper	Food container/box	0.00	0.00	Paper	plates/bowls	0.00	0.00
110	Timber	Pallet	0.00	0.00	Paper	Food wrapper/bag	0.00	0.00	Fishing	Buoys/floats	0.00	0.00
111	Paper	Magazine/newspaper	0.00	0.00	Paper	Beverage container	0.00	0.00	Miscellaneous	Battery	0.00	0.00
112	Paper	Box	0.00	0.00	Paper	cups	0.00	0.00	Miscellaneous	Carpet	0.00	0.00
113	Paper	Food container/box	0.00	0.00	Paper	plates/bowls	0.00	0.00	Miscellaneous	E waste	0.00	0.00
114	Paper	Food wrapper/bag	0.00	0.00	Miscellaneous	Battery	0.00	0.00	Miscellaneous	Furniture	0.00	0.00
115	Paper	Beverage container	0.00	0.00	Miscellaneous	Carpet	0.00	0.00	Miscellaneous	Appliances	0.00	0.00
116	Paper	plates/bowls	0.00	0.00	Miscellaneous	Furniture	0.00	0.00	Miscellaneous	Large car parts	0.00	0.00
117	Fishing	Fishhook/sinker	0.00	0.00	Miscellaneous	Appliances	0.00	0.00	Miscellaneous	Large boat parts	0.00	0.00
118	Miscellaneous	Battery	0.00	0.00	Miscellaneous	Large car parts	0.00	0.00	Miscellaneous	Bag/box dom. Waste	0.00	0.00
119	Miscellaneous	E waste	0.00	0.00	Miscellaneous	Large boat parts	0.00	0.00	other	shot gun wadding	0.00	0.00
120	Miscellaneous	Furniture	0.00	0.00	other	ear plug	0.00	0.00	other	Astro turf	0.00	0.00
121	Miscellaneous	Appliances	0.00	0.00	other	Paint fragment	0.00	0.00	other	Button	0.00	0.00
122	Miscellaneous	Large car parts	0.00	0.00	other	Ceramic filter	0.00	0.00	other	Fibre glass	0.00	0.00
123	Miscellaneous	Large boat parts	0.00	0.00	other	Brush/comb	0.00	0.00	other	Sequins	0.00	0.00
124	Miscellaneous	Bag/box dom. Waste	0.00	0.00	other	Beads	0.00	0.00	other	Fertiliser Pellet	0.00	0.00
125	other	Button	0.00	0.00	other	Fertiliser Pellet	0.00	0.00	other	Wall Plug	0.00	0.00
126	other	Beads	0.00	0.00	other	Dummy	0.00	0.00	other	Plastic Toy	0.00	0.00
127	other	Cigarette packet	0.00	0.00	other	Tooth brush	0.00	0.00	other	Dummy	0.00	0.00
128	other	Dummy	0.00	0.00	other	Glasses	0.00	0.00	other	Plastic cork	0.00	0.00
129	other	Corn starch pins	0.00	0.00	other	Corn starch pins	0.00	0.00	other	Tooth brush	0.00	0.00
130	other	Golf Ball	0.00	0.00	other	Golf Ball	0.00	0.00	other	Glasses	0.00	0.00
131	other	Glow stick non fishing	0.00	0.00	other	Tarp	0.00	0.00	other	Mask	0.00	0.00
132	other	Condom	0.00	0.00	other	Confetti	0.00	0.00	other	Nerf Toy	0.00	0.00
133	other	Syringe	0.00	0.00	other	Glow stick non fishing	0.00	0.00	other	Confetti	0.00	0.00
134	other	Whipper sniper cord	0.00	0.00	other	Condom	0.00	0.00	other	Condom	0.00	0.00
135	other	Bubble wrap	0.00	0.00	other	Bubble wrap	0.00	0.00	other	Bubble wrap	0.00	0.00

**Table A3.2. Frequency of detection (as a percentage) of each identified item in standard beach transects in each region across all time periods. Grey highlighted items are items to be banned under the WA Plan for Plastics. \* Balloon releases are banned, not balloons. \*\*Cotton buds with plastic sticks are banned.**

Lower Swan Canning Estuary				Swan Estuary				Canning Estuary			
Ranking	Category	Sub-category	Freq of detection	Category	Sub-category	Freq of detection	Category	Sub-category	Freq of detection		
1	Hard Plastic	Hard plastic - Unknown	96.4	Hard Plastic	Hard plastic - Unknown	95.8	Soft plastic	Soft plastic - Unknown	89.6		
2	Soft plastic	Soft plastic - Unknown	96.4	Soft plastic	Soft plastic - Unknown	91.7	Hard Plastic	Hard plastic - Unknown	81.3		
3	<b>Foam</b>	<b>Polystyrene (EPS)</b>	<b>87.5</b>	<b>Foam</b>	<b>Polystyrene (EPS)</b>	<b>87.5</b>	Soft plastic	Food wrapper	66.7		
4	Plastic straps	String/rope/ribbon	82.1	Hard Plastic	Bottle cap/lid	72.9	<b>Foam</b>	<b>Polystyrene (EPS)</b>	<b>64.6</b>		
5	Foam	Foam - Unknown	76.8	Soft plastic	Food wrapper	72.9	Foam	EPS beans	54.2		
6	Soft plastic	Food wrapper	69.6	Paper	Cigarette butt	68.8	Fishing	Fishing line	54.2		
7	Paper	Cigarette butt	69.6	Foam	Foam - Unknown	66.7	Foam	Foam - Unknown	50.0		
8	Hard Plastic	Bottle cap/lid	58.9	Fishing	Fishing line	64.6	Glass	Beverage bottle	47.9		
9	Foam	EPS beans	58.9	Plastic straps	String/rope/ribbon	58.3	Hard Plastic	Bottle cap/lid	45.8		
10	Fishing	Fishing line	55.4	Foam	EPS beans	56.3	Plastic straps	String/rope/ribbon	45.8		
11	Glass	Glass - Unknown	51.8	<b>Soft plastic</b>	<b>Straw</b>	<b>52.1</b>	<b>Soft plastic</b>	<b>Thin film carry bag</b>	<b>41.7</b>		
12	Cloth	Cloth - Unknown	50.0	Miscellaneous	Resin pellets (Nurdles)	45.8	Miscellaneous	Resin pellets (Nurdles)	39.6		
13	Miscellaneous	Resin pellets (Nurdles)	48.2	<b>Soft plastic</b>	<b>Thin film carry bag</b>	<b>39.6</b>	Paper	Cigarette butt	37.5		
14	<b>Soft plastic</b>	<b>Straw</b>	<b>44.6</b>	Glass	Glass - Unknown	39.6	<b>Soft plastic</b>	<b>Straw</b>	<b>35.4</b>		
15	Glass	Beverage bottle	41.1	<b>Foam</b>	<b>EPS - cup/plates/bowls</b>	<b>39.6</b>	Glass	Glass - Unknown	33.3		
16	Cloth	String/rope/strap	41.1	<b>Hard Plastic</b>	<b>Food Container/lid</b>	<b>33.3</b>	Cloth	Cloth - Unknown	31.3		
17	other	Drill tailing	35.7	<b>Hard Plastic</b>	<b>Lollipop stick/cotton bud stick**</b>	<b>29.2</b>	Cloth	String/rope/strap	25.0		
18	<b>Hard Plastic</b>	<b>Lollipop stick/cotton bud stick**</b>	<b>28.6</b>	Metal	Aluminium foil	29.2	<b>Foam</b>	<b>EPS - cup/plates/bowls</b>	<b>25.0</b>		
19	<b>Soft plastic</b>	<b>Thin film carry bag</b>	<b>26.8</b>	Glass	Beverage bottle	27.1	Plastic straps	packing strap	18.8		
20	<b>Hard Plastic</b>	<b>Food Container/lid</b>	<b>23.2</b>	Cloth	Cloth - Unknown	25.0	other	Tape	18.8		
21	Soft plastic	sheeting	23.2	Paper	unknown/other	22.9	<b>Hard Plastic</b>	<b>Lollipop stick/cotton bud stick**</b>	<b>16.7</b>		
22	Plastic straps	packing strap	21.4	other	Drill tailing	22.9	Soft plastic	Cup/lid	14.6		
23	Plastic straps	unknown/other strap	21.4	Soft plastic	sheeting	20.8	Soft plastic	ZipLock Bag	14.6		
24	other	Tape	21.4	<b>Soft plastic</b>	<b>Cup/lid</b>	<b>20.8</b>	Cloth	Clothing/towel	14.6		
25	Metal	Aluminium foil	19.6	<b>Soft plastic</b>	<b>Straw wrapper</b>	<b>20.8</b>	Paper	paper/cardboard	14.6		
26	Rubber	Unknown/other	19.6	other	Syringe	20.8	Hard Plastic	Other bottle	12.5		
27	<b>Foam</b>	<b>EPS - cup/plates/bowls</b>	<b>19.6</b>	<b>Hard Plastic</b>	<b>Utensils</b>	<b>18.8</b>	<b>Hard Plastic</b>	<b>Food Container/lid</b>	<b>12.5</b>		
28	Paper	unknown/other	19.6	Soft plastic	ZipLock Bag	18.8	Metal	Aluminium foil	12.5		
29	Fishing	glow stick	19.6	Rubber	Rubber Band	18.8	other	Ball	12.5		
30	Metal	Food wrapper	17.9	other	Tape	18.8	<b>Soft plastic</b>	<b>Other bag</b>	<b>10.4</b>		
31	Miscellaneous	Ceramic	17.9	Plastic straps	packing strap	16.7	Metal	Beverage can	10.4		
32	<b>Soft plastic</b>	<b>Cup/lid</b>	<b>16.1</b>	Rubber	Unknown/other	16.7	Metal	Lid/cap	10.4		
33	Rubber	Rubber Band	14.3	Cloth	Clothing/towel	16.7	Rubber	Unknown/other	10.4		
34	Paper	paper/cardboard	14.3	other	Pen/pen/texta	16.7	Paper	unknown/other	10.4		
35	other	Fertiliser Pellet	14.3	other	Fruit sticker	16.7	other	Drill tailing	10.4		
36	<b>Hard Plastic</b>	<b>Cotton bud stick</b>	<b>12.5</b>	Hard Plastic	Beverage bottle <1L	14.6	Hard Plastic	Beverage bottle <1L	8.3		
37	<b>Soft plastic</b>	<b>Straw wrapper</b>	<b>12.5</b>	<b>Hard Plastic</b>	<b>Cups</b>	<b>14.6</b>	<b>Hard Plastic</b>	<b>Utensils</b>	<b>8.3</b>		
38	Soft plastic	ZipLock Bag	12.5	<b>Rubber</b>	<b>Balloon*</b>	<b>14.6</b>	Soft plastic	sheeting	8.3		
39	Metal	Lid/cap	12.5	Cloth	String/rope/strap	14.6	<b>Soft plastic</b>	<b>Thick plastic bag</b>	<b>8.3</b>		
40	Metal	unknown/other hard	12.5	Hard Plastic	Lighter	12.5	Soft plastic	Straw wrapper	8.3		
41	Cloth	Insulation/stuffing	12.5	Soft plastic	Dog litter bag	12.5	Plastic straps	unknown/other strap	8.3		
42	<b>Foam</b>	<b>EPS - Food container</b>	<b>12.5</b>	Metal	Wire	12.5	Cloth	Wipes/cloths	8.3		
43	Fishing	fishing lure	12.5	Metal	Lid/cap	12.5	Timber	Wood/timber	8.3		
44	<b>Soft plastic</b>	<b>Thick plastic bag</b>	<b>10.7</b>	Metal	Food wrapper	12.5	Fishing	fishing lure	8.3		
45	Miscellaneous	Brick/cement	10.7	Metal	unknown/other hard	12.5	other	Pen/pen/texta	8.3		
46	other	Band aid	10.7	Cloth	Wipes/cloths	12.5	Hard Plastic	Pipe/PVC	6.3		
47	Plastic straps	Cable ties	8.9	Cloth	Insulation/stuffing	12.5	Soft plastic	Dog litter bag	6.3		
48	<b>Rubber</b>	<b>Balloon*</b>	<b>8.9</b>	Fishing	fishing lure	12.5	Cloth	Insulation/stuffing	6.3		
49	Cloth	Clothing/towel	8.9	Hard Plastic	Pipe/PVC	10.4	Fishing	Net	6.3		
50	Timber	Unknown/other	8.9	<b>Hard Plastic</b>	<b>Cotton bud stick</b>	<b>10.4</b>	Fishing	unknown/other	6.3		
51	other	Broom bristle	8.9	Plastic straps	unknown/other strap	10.4	other	Broom bristle	6.3		
52	other	ear plug	8.9	Metal	Beverage can	10.4	other	Fruit sticker	6.3		
53	<b>Hard Plastic</b>	<b>Utensils</b>	<b>7.1</b>	<b>Foam</b>	<b>EPS - Food container</b>	<b>10.4</b>	other	Band aid	6.3		
54	Metal	unknown/other soft	7.1	Fishing	Fishhook/sinker	10.4	other	Cigarette packet	6.3		
55	Timber	Wood/timber	7.1	other	Broom bristle	10.4	other	Tarp	6.3		
56	Timber	Bottle cork	7.1	other	Ball	10.4	<b>Hard Plastic</b>	<b>Plate/bowl</b>	<b>4.2</b>		
57	other	burnt foam	7.1	Hard Plastic	Other bottle	8.3	<b>Hard Plastic</b>	<b>Cups</b>	<b>4.2</b>		
58	other	Fruit sticker	7.1	<b>Soft plastic</b>	<b>Other bag</b>	<b>8.3</b>	Soft plastic	Bait Bag	4.2		
59	other	Astro turf	7.1	Metal	unknown/other soft	8.3	Plastic straps	Cable ties	4.2		
60	other	Plastic coated wire	7.1	Rubber	Thong/shoe	8.3	Metal	Wire	4.2		
61	Hard Plastic	Lighter	5.4	Timber	Bottle cork	8.3	Metal	unknown/other hard	4.2		
62	<b>Soft plastic</b>	<b>Other bag</b>	<b>5.4</b>	Fishing	unknown/other	8.3	Metal	unknown/other soft	4.2		
63	Soft plastic	Ice Bag	5.4	<b>Hard Plastic</b>	<b>Stirrers</b>	<b>6.3</b>	Rubber	Rubber Band	4.2		
64	Soft plastic	Dog litter bag	5.4	Plastic straps	Cable ties	6.3	<b>Foam</b>	<b>EPS - Food container</b>	<b>4.2</b>		
65	Metal	Wire	5.4	Timber	Wood/timber	6.3	Miscellaneous	Brick/cement	4.2		
66	Rubber	Thong/shoe	5.4	Paper	paper/cardboard	6.3	Miscellaneous	Ceramic	4.2		
67	Fishing	Net	5.4	Fishing	Buoys/floats	6.3	other	Paint fragment	4.2		
68	other	Pen/pen/texta	5.4	Fishing	glow stick	6.3	other	Plastic coated wire	4.2		
69	other	Sequins	5.4	other	shot gun wadding	6.3	<b>Hard Plastic</b>	<b>Stirrers</b>	<b>2.1</b>		
70	other	Plastic cork	5.4	other	Band aid	6.3	<b>Hard Plastic</b>	<b>Cotton bud stick</b>	<b>2.1</b>		
71	Hard Plastic	Beverage bottle <1L	3.6	other	Plastic coated wire	6.3	Metal	Pipe	2.1		
72	Hard Plastic	Other bottle	3.6	other	Cigarette packet	6.3	Metal	Food wrapper	2.1		
73	<b>Hard Plastic</b>	<b>Stirrers</b>	<b>3.6</b>	other	Plastic Toy	6.3	Glass	Jar	2.1		
74	<b>Hard Plastic</b>	<b>Cups</b>	<b>3.6</b>	Hard Plastic	Bucket/crete	4.2	Rubber	tyre	2.1		
75	Soft plastic	Bait Bag	3.6	Soft plastic	Bait Bag	4.2	Timber	Bottle cork	2.1		
76	Metal	Beverage can	3.6	Glass	Jar	4.2	Paper	Magazine/newspaper	2.1		
77	Metal	Bucket/drum	3.6	Fishing	Net	4.2	Paper	Food wrapper/bag	2.1		

Table A3.2 Continued.

Lower Swan Canning Estuary				Swan Estuary			Canning Estuary		
Ranking	Category	Sub-category	Freq of detection	Category	Sub-category	Freq of detection	Category	Sub-category	Freq of detection
78	Timber	Utensils/food stick	3.6	Miscellaneous	Brick/cement	4.2	Fishing	glow stick	2.1
79	Fishing	unknown/other	3.6	Miscellaneous	Ceramic	4.2	Fishing	Fishhook/sinker	2.1
80	other	soft tubing	3.6	other	disposable glove	4.2	other	soft tubing	2.1
81	other	Fibre glass	3.6	<b>Soft plastic</b>	<b>Thick plastic bag</b>	<b>2.1</b>	other	burnt foam	2.1
82	other	Plastic Toy	3.6	Soft plastic	Ice Bag	2.1	other	ear plug	2.1
83	<b>Hard Plastic</b>	<b>Plate/bowl</b>	<b>1.8</b>	Metal	Aerosol	2.1	other	disposable glove	2.1
84	Metal	Aerosol	1.8	Metal	Food can/tin	2.1	other	Ceramic filter	2.1
85	Metal	Food can/tin	1.8	Timber	Utensils/food stick	2.1	other	Brush/comb	2.1
86	Glass	lightglobe/tube	1.8	Paper	Magazine/newspaper	2.1	other	Beads	2.1
87	Cloth	Wipes/cloths	1.8	Miscellaneous	E waste	2.1	other	Corn starch pins	2.1
88	Paper	Bag	1.8	Miscellaneous	Bag/box dom. Waste	2.1	other	Golf Ball	2.1
89	<b>Paper</b>	<b>cups</b>	<b>1.8</b>	other	soft tubing	2.1	other	Glow stick non fishing	2.1
90	Fishing	Buoys/floats	1.8	other	burnt foam	2.1	other	Syringe	2.1
91	Miscellaneous	Carpet	1.8	other	Astro turf	2.1	other	Whipper snipper cord	2.1
92	other	shot gun wadding	1.8	other	Button	2.1	Hard Plastic	Bucket/crete	0.0
93	other	Paint fragment	1.8	other	Fibre glass	2.1	Hard Plastic	Lighter	0.0
94	other	disposable glove	1.8	other	Sequins	2.1	Soft plastic	Ice Bag	0.0
95	other	Ceramic filter	1.8	other	Wall Plug	2.1	Metal	Aerosol	0.0
96	other	Brush/comb	1.8	other	Plastic cork	2.1	Metal	Food can/tin	0.0
97	other	Ball	1.8	other	Mask	2.1	Metal	Bucket/drum	0.0
98	other	Wall Plug	1.8	other	Nerf Toy	2.1	Glass	lightglobe/tube	0.0
99	other	Tooth brush	1.8	other	Whipper snipper cord	2.1	Rubber	Thong/shoe	0.0
100	other	Glasses	1.8	<b>Hard Plastic</b>	<b>Plate/bowl</b>	<b>0.0</b>	<b>Rubber</b>	<b>Balloon*</b>	<b>0.0</b>
101	other	Tarp	1.8	Metal	Pipe	0.0	Timber	Utensils/food stick	0.0
102	other	Mask	1.8	Metal	Bucket/drum	0.0	Timber	Pallet	0.0
103	other	Nerf Toy	1.8	Glass	lightglobe/tube	0.0	Timber	Unknown/other	0.0
104	other	Confetti	1.8	Rubber	tyre	0.0	Paper	Bag	0.0
105	Hard Plastic	Pipe/PVC	0.0	Timber	Pallet	0.0	Paper	Box	0.0
106	Hard Plastic	Bucket/crete	0.0	Timber	Unknown/other	0.0	Paper	Food container/box	0.0
107	Metal	Pipe	0.0	Paper	Bag	0.0	Paper	Beverage container	0.0
108	Glass	Jar	0.0	Paper	Box	0.0	<b>Paper</b>	<b>cups</b>	<b>0.0</b>
109	Rubber	tyre	0.0	Paper	Food container/box	0.0	<b>Paper</b>	<b>plates/bowls</b>	<b>0.0</b>
110	Timber	Pallet	0.0	Paper	Food wrapper/bag	0.0	Fishing	Buoys/floats	0.0
111	Paper	Magazine/newspaper	0.0	Paper	Beverage container	0.0	Miscellaneous	Battery	0.0
112	Paper	Box	0.0	<b>Paper</b>	<b>cups</b>	<b>0.0</b>	Miscellaneous	Carpet	0.0
113	<b>Paper</b>	<b>Food container/box</b>	<b>0.0</b>	<b>Paper</b>	<b>plates/bowls</b>	<b>0.0</b>	Miscellaneous	E waste	0.0
114	Paper	Food wrapper/bag	0.0	Miscellaneous	Battery	0.0	Miscellaneous	Furniture	0.0
115	Paper	Beverage container	0.0	Miscellaneous	Carpet	0.0	Miscellaneous	Appliances	0.0
116	<b>Paper</b>	<b>plates/bowls</b>	<b>0.0</b>	Miscellaneous	Furniture	0.0	Miscellaneous	Large car parts	0.0
117	Fishing	Fishhook/sinker	0.0	Miscellaneous	Appliances	0.0	Miscellaneous	Large boat parts	0.0
118	Miscellaneous	Battery	0.0	Miscellaneous	Large car parts	0.0	Miscellaneous	Bag/box dom. Waste	0.0
119	Miscellaneous	E waste	0.0	Miscellaneous	Large boat parts	0.0	other	shot gun wadding	0.0
120	Miscellaneous	Furniture	0.0	other	ear plug	0.0	other	Astro turf	0.0
121	Miscellaneous	Appliances	0.0	other	Paint fragment	0.0	other	Button	0.0
122	Miscellaneous	Large car parts	0.0	other	Ceramic filter	0.0	other	Fibre glass	0.0
123	Miscellaneous	Large boat parts	0.0	other	Brush/comb	0.0	other	Sequins	0.0
124	Miscellaneous	Bag/box dom. Waste	0.0	other	Beads	0.0	other	Fertiliser Pellet	0.0
125	other	Button	0.0	other	Fertiliser Pellet	0.0	other	Wall Plug	0.0
126	other	Beads	0.0	other	Dummy	0.0	other	Plastic Toy	0.0
127	other	Cigarette packet	0.0	other	Tooth brush	0.0	other	Dummy	0.0
128	other	Dummy	0.0	other	Glasses	0.0	other	Plastic cork	0.0
129	other	Corn starch pins	0.0	other	Corn starch pins	0.0	other	Tooth brush	0.0
130	other	Golf Ball	0.0	other	Golf Ball	0.0	other	Glasses	0.0
131	other	Glow stick non fishing	0.0	other	Tarp	0.0	other	Mask	0.0
132	other	Condom	0.0	other	Confetti	0.0	other	Nerf Toy	0.0
133	other	Syringe	0.0	other	Glow stick non fishing	0.0	other	Confetti	0.0
134	other	Whipper snipper cord	0.0	other	Condom	0.0	other	Condom	0.0
135	other	Bubble wrap	0.0	other	Bubble wrap	0.0	other	Bubble wrap	0.0

**Table A3.3. Mean abundance of each identified item in the whole site sweeps in each region across all time periods. Grey highlighted items are items to be banned under the WA Plan for Plastics. \*Balloon releases are banned, not balloons. \*\*Cotton buds with plastic sticks are banned.**

Ranking	Lower Swan Canning Estuary				Swan Estuary				Canning Estuary			
	Category	Sub-category	Mean	SE	Category	Sub-category	Mean	SE	Category	Sub-category	Mean	SE
1	Soft plastic	Soft plastic - Unknown	8.84	1.65	Soft plastic	Soft plastic - Unknown	17.00	5.31	Soft plastic	Soft plastic - Unknown	12.66	3.04
2	Hard Plastic	Hard plastic - Unknown	6.82	1.31	Soft plastic	Food wrapper	11.72	3.43	Hard Plastic	Hard plastic - Unknown	8.30	1.81
3	Soft plastic	Food wrapper	5.45	1.34	Hard Plastic	Bottle cap/lid	11.09	3.15	Soft plastic	Food wrapper	6.23	1.02
4	Hard Plastic	Bottle cap/lid	4.96	1.29	Hard Plastic	Hard plastic - Unknown	8.13	2.10	<b>Foam</b>	<b>Polystyrene (EPS)</b>	<b>6.17</b>	<b>1.41</b>
5	Plastic straps	String/rope/ribbon	3.88	0.90	<b>Foam</b>	<b>Polystyrene (EPS)</b>	<b>5.79</b>	<b>1.38</b>	Hard Plastic	Bottle cap/lid	4.62	1.04
6	<b>Foam</b>	<b>Polystyrene (EPS)</b>	<b>2.88</b>	<b>0.60</b>	<b>Soft plastic</b>	<b>Straw</b>	<b>4.70</b>	<b>1.41</b>	<b>Soft plastic</b>	<b>Thin film carry bag</b>	<b>1.79</b>	<b>0.37</b>
7	Paper	Cigarette butt	2.36	0.71	Foam	Foam - Unknown	2.81	0.81	Glass	Glass bottle	1.62	0.65
8	<b>Soft plastic</b>	<b>Straw</b>	<b>2.05</b>	<b>0.54</b>	<b>Hard Plastic</b>	<b>Lollipop stick/cotton bud stick**</b>	<b>2.30</b>	<b>0.91</b>	Foam	Foam - Unknown	1.62	0.35
9	Foam	Foam - Unknown	1.89	0.59	Paper	Cigarette butt	1.87	0.54	other	Ball	1.32	0.41
10	Glass	Glass bottle	1.73	0.73	<b>Soft plastic</b>	<b>Straw wrapper</b>	<b>1.85</b>	<b>1.26</b>	<b>Soft plastic</b>	<b>Straw</b>	<b>1.19</b>	<b>0.26</b>
11	<b>Hard Plastic</b>	<b>Lollipop stick/cotton bud stick**</b>	<b>1.11</b>	<b>0.37</b>	<b>Hard Plastic</b>	<b>Food Container/lid</b>	<b>1.64</b>	<b>0.43</b>	Hard Plastic	Beverage bottle <1L	1.02	0.23
12	Cloth	String/rope/strap	0.79	0.49	Plastic straps	String/rope/ribbon	1.36	0.44	<b>Hard Plastic</b>	<b>Food Container/lid</b>	<b>0.89</b>	<b>0.21</b>
13	<b>Soft plastic</b>	<b>Thin film carry bag</b>	<b>0.73</b>	<b>0.24</b>	<b>Foam</b>	<b>EPS - cup/plates/bowls</b>	<b>1.34</b>	<b>0.40</b>	Plastic straps	String/rope/ribbon	0.79	0.26
14	<b>Foam</b>	<b>EPS - cup/plates/bowls</b>	<b>0.64</b>	<b>0.22</b>	Hard Plastic	Beverage bottle <1L	1.26	0.42	Paper	Cigarette butt	0.72	0.28
15	<b>Hard Plastic</b>	<b>Food Container/lid</b>	<b>0.50</b>	<b>0.17</b>	<b>Hard Plastic</b>	<b>Cotton bud stick</b>	<b>1.15</b>	<b>0.92</b>	Metal	Lid/cap	0.68	0.29
16	Soft plastic	ZipLock Bag	0.46	0.13	<b>Soft plastic</b>	<b>Thin film carry bag</b>	<b>0.91</b>	<b>0.27</b>	<b>Foam</b>	<b>EPS - cup/plates/bowls</b>	<b>0.66</b>	<b>0.17</b>
17	other	Tape	0.45	0.15	Soft plastic	ZipLock Bag	0.89	0.54	Hard Plastic	Other bottle	0.55	0.19
18	Paper	unknown/other	0.39	0.15	Paper	unknown/other	0.85	0.38	Metal	Beverage can	0.55	0.15
19	Rubber	Rubber Band	0.38	0.29	<b>Soft plastic</b>	<b>Cup/lid</b>	<b>0.81</b>	<b>0.43</b>	Soft plastic	Bait Bag	0.49	0.14
20	Fishing	Fishing line	0.38	0.15	Glass	Beverage bottle	0.79	0.31	Cloth	String/rope/strap	0.40	0.26
21	<b>Hard Plastic</b>	<b>Cups</b>	<b>0.36</b>	<b>0.19</b>	Fishing	Fishing line	0.79	0.19	<b>Hard Plastic</b>	<b>Lollipop stick/cotton bud stick**</b>	<b>0.38</b>	<b>0.09</b>
22	<b>Foam</b>	<b>EPS - Food container</b>	<b>0.34</b>	<b>0.24</b>	<b>Hard Plastic</b>	<b>Cups</b>	<b>0.77</b>	<b>0.23</b>	<b>Soft plastic</b>	<b>Cup/lid</b>	<b>0.38</b>	<b>0.10</b>
23	Metal	Aluminium foil	0.30	0.09	Soft plastic	sheeting	0.74	0.25	Soft plastic	sheeting	0.36	0.30
24	<b>Hard Plastic</b>	<b>Utensils</b>	<b>0.29</b>	<b>0.07</b>	other	Syringe	0.72	0.48	Soft plastic	ZipLock Bag	0.36	0.10
25	Cloth	Clothing/towel	0.27	0.08	<b>Hard Plastic</b>	<b>Utensils</b>	<b>0.62</b>	<b>0.20</b>	Cloth	Clothing/towel	0.36	0.13
26	Soft plastic	sheeting	0.25	0.12	Hard Plastic	Lighter	0.55	0.26	other	Tape	0.36	0.11
27	<b>Soft plastic</b>	<b>Straw wrapper</b>	<b>0.25</b>	<b>0.09</b>	Cloth	Clothing/towel	0.55	0.20	<b>Soft plastic</b>	<b>Other bag</b>	<b>0.34</b>	<b>0.24</b>
28	Soft plastic	Ice Bag	0.25	0.23	Soft plastic	Bait Bag	0.53	0.13	Plastic straps	packing strap	0.34	0.17
29	Cloth	Wipes/cloths	0.25	0.13	Soft plastic	Dog litter bag	0.53	0.25	Paper	unknown/other	0.34	0.13
30	<b>Hard Plastic</b>	<b>Cotton bud stick</b>	<b>0.23</b>	<b>0.15</b>	Cloth	Wipes/cloths	0.51	0.17	<b>Soft plastic</b>	<b>Thick plastic bag</b>	<b>0.32</b>	<b>0.12</b>
31	Glass	Unknown/other glass	0.23	0.11	other	Pen/pen/texta	0.51	0.20	Rubber	Thong/shoe	0.32	0.11
32	other	shot gun wadding	0.23	0.08	Glass	Unknown/other glass	0.49	0.15	Hard Plastic	Lighter	0.28	0.08
33	Hard Plastic	Beverage bottle <1L	0.21	0.08	Metal	Beverage can	0.47	0.15	Cloth	Wipes/cloths	0.28	0.08
34	<b>Soft plastic</b>	<b>Cup/lid</b>	<b>0.21</b>	<b>0.07</b>	Metal	Lid/cap	0.47	0.11	Cloth	Unknown/other	0.23	0.08
35	Soft plastic	Bait Bag	0.21	0.12	other	Tape	0.47	0.13	Paper	paper/cardboard	0.23	0.09
36	Metal	Beverage can	0.21	0.08	Rubber	Unknown/other	0.45	0.20	Fishing	Fishing line	0.21	0.09
37	Paper	paper/cardboard	0.21	0.07	<b>Foam</b>	<b>EPS - Food container</b>	<b>0.45</b>	<b>0.35</b>	other	disposable glove	0.21	0.11
38	Fishing	glow stick	0.21	0.10	<b>Rubber</b>	<b>Balloon*</b>	<b>0.43</b>	<b>0.14</b>	<b>Hard Plastic</b>	<b>Utensils</b>	<b>0.19</b>	<b>0.07</b>
39	other	Ball	0.21	0.08	Hard Plastic	Other bottle	0.36	0.17	<b>Hard Plastic</b>	<b>Cups</b>	<b>0.19</b>	<b>0.07</b>
40	<b>Soft plastic</b>	<b>Thick plastic bag</b>	<b>0.20</b>	<b>0.09</b>	Cloth	String/rope/strap	0.36	0.22	<b>Soft plastic</b>	<b>Straw wrapper</b>	<b>0.19</b>	<b>0.08</b>
41	Plastic straps	unknown/other strap	0.18	0.07	<b>Paper</b>	<b>cups</b>	<b>0.30</b>	<b>0.13</b>	Metal	Aluminium foil	0.19	0.06
42	Metal	Lid/cap	0.18	0.07	other	disposable glove	0.30	0.12	other	Plastic Toy	0.19	0.07
43	Plastic straps	packing strap	0.16	0.07	Plastic straps	packing strap	0.28	0.12	Soft plastic	Dog litter bag	0.17	0.06
44	Metal	Food wrapper	0.16	0.08	Metal	Aluminium foil	0.28	0.10	<b>Hard Plastic</b>	<b>Plate/bowl</b>	<b>0.15</b>	<b>0.06</b>
45	Hard Plastic	Lighter	0.14	0.05	Cloth	Unknown/other	0.28	0.07	Metal	unknown/other hard	0.15	0.07
46	Rubber	Thong/shoe	0.14	0.08	Rubber	Thong/shoe	0.23	0.07	Rubber	Unknown/other	0.15	0.06
47	Cloth	Unknown/other	0.14	0.05	other	Ball	0.23	0.08	Hard Plastic	Bucket/crete	0.13	0.05
48	<b>Paper</b>	<b>cups</b>	<b>0.14</b>	<b>0.06</b>	Plastic straps	unknown/other strap	0.19	0.08	Glass	Unknown/other glass	0.13	0.11
49	other	Drill tailing	0.14	0.08	Paper	Food wrapper/bag	0.19	0.09	<b>Paper</b>	<b>cups</b>	<b>0.13</b>	<b>0.06</b>
50	Rubber	Unknown/other	0.13	0.06	<b>Soft plastic</b>	<b>Thick plastic bag</b>	<b>0.17</b>	<b>0.08</b>	Fishing	Buoys/floats	0.13	0.06
51	Fishing	fishing lure	0.13	0.04	Metal	Food wrapper	0.17	0.08	other	Pen/pen/texta	0.13	0.09
52	other	Pen/pen/texta	0.13	0.05	Metal	unknown/other hard	0.17	0.09	Plastic straps	unknown/other strap	0.11	0.06
53	other	Plastic Toy	0.13	0.08	other	Plastic Toy	0.17	0.07	Cloth	Insulation/stuffing	0.11	0.07
54	other	Mask	0.13	0.09	Hard Plastic	Pipe/PVC	0.17	0.10	Timber	Wood/timber	0.11	0.09
55	Hard Plastic	Other bottle	0.11	0.06	<b>Soft plastic</b>	<b>Other bag</b>	<b>0.15</b>	<b>0.15</b>	Timber	Bottle cork	0.11	0.05
56	Soft plastic	Dog litter bag	0.11	0.04	Plastic straps	Cable ties	0.15	0.07	Paper	Food wrapper/bag	0.11	0.05
57	<b>Rubber</b>	<b>Balloon*</b>	<b>0.11</b>	<b>0.06</b>	Fishing	Buoys/floats	0.15	0.07	Soft plastic	Ice Bag	0.09	0.04
58	Timber	Wood/timber	0.11	0.06	other	Cigarette packet	0.13	0.11	Metal	Food can/tin	0.09	0.05
59	Timber	Bottle cork	0.11	0.04	Metal	Aerosol	0.11	0.05	Fishing	fishing lure	0.09	0.04
60	Fishing	Buoys/floats	0.11	0.06	Paper	Food container/box	0.11	0.05	Hard Plastic	Pipe/PVC	0.08	0.04
61	other	burnt foam	0.11	0.08	Paper	Beverage container	0.11	0.11	Metal	Food wrapper	0.06	0.04
62	Plastic straps	Cable ties	0.09	0.04	Fishing	unknown/other	0.11	0.05	Paper	Beverage container	0.06	0.04
63	other	ear plug	0.09	0.04	other	Plastic coated wire	0.11	0.07	Fishing	glow stick	0.06	0.05
64	Miscellaneous	Ceramic	0.07	0.03	<b>Hard Plastic</b>	<b>Stirrers</b>	<b>0.09</b>	<b>0.04</b>	Fishing	Fishhook/sinker	0.06	0.05
65	other	soft tubing	0.07	0.03	Hard Plastic	Bucket/crete	0.09	0.04	Fishing	unknown/other	0.06	0.04
66	other	Band aid	0.07	0.04	Glass	Jar	0.09	0.07	other	Band aid	0.06	0.05
67	<b>Hard Plastic</b>	<b>Plate/bowl</b>	<b>0.05</b>	<b>0.03</b>	Rubber	Rubber Band	0.09	0.05	other	Plastic coated wire	0.06	0.04
68	Hard Plastic	Bucket/crete	0.05	0.03	Fishing	fishing lure	0.09	0.04	other	Cigarette packet	0.06	0.04
69	Metal	unknown/other hard	0.05	0.03	Fishing	Fishhook/sinker	0.09	0.05	other	Golf Ball	0.06	0.06
70	Glass	lightglobe/tube	0.05	0.03	other	Fruit sticker	0.09	0.05	other	Glow stick non fishing	0.06	0.06
71	Fishing	unknown/other	0.05	0.03	Soft plastic	Ice Bag	0.06	0.04	other	Syringe	0.06	0.04
72	other	Fruit sticker	0.05	0.04	Timber	Wood/timber	0.06	0.05	Plastic straps	Cable ties	0.04	0.03
73	other	disposable glove	0.05	0.03	Timber	Bottle cork	0.06	0.05	<b>Rubber</b>	<b>Balloon*</b>	<b>0.04</b>	<b>0.03</b>
74	Hard Plastic	Pipe/PVC	0.04	0.03	Fishing	glow stick	0.06	0.04	<b>Foam</b>	<b>EPS - Food container</b>	<b>0.04</b>	<b>0.03</b>
75	Metal	Food can/tin	0.04	0.03	other	ear plug	0.06	0.05	Paper	Food container/box	0.04	0.03
76	Metal	unknown/other soft	0.04	0.04	other	Whipper snipper cord	0.06	0.05	Miscellaneous	Brick/cement	0.04	0.03
77	Cloth	Insulation/stuffing	0.04	0.03	Metal	Wire	0.04	0.03	other	Condom	0.04	0.04

Table A3.3. Continued

Ranking	Lower Swan Canning Estuary				Swan Estuary				Canning Estuary			
	Category	Sub-category	Mean	SE	Category	Sub-category	Mean	SE	Category	Sub-category	Mean	SE
78	Paper	Food wrapper/bag	0.04	0.03	Metal	Food can/tin	0.04	0.03	other	Whipper snipper cord	0.04	0.03
79	other	Plastic coated wire	0.04	0.03	Paper	paper/cardboard	0.04	0.04	<b>Hard Plastic</b>	<b>Stirrers</b>	<b>0.02</b>	<b>0.02</b>
80	other	Nerf Toy	0.04	0.03	other	Bubble wrap	0.04	0.03	Metal	Wire	0.02	0.02
81	<b>Hard Plastic</b>	<b>Stirrers</b>	<b>0.02</b>	<b>0.02</b>	Metal	unknown/other soft	0.02	0.02	Metal	Aerosol	0.02	0.02
82	<b>Soft plastic</b>	<b>Other bag</b>	<b>0.02</b>	<b>0.02</b>	Cloth	Insulation/stuffing	0.02	0.02	Glass	Jar	0.02	0.02
83	Paper	Food container/box	0.02	0.02	Timber	Utensils/food stick	0.02	0.02	Rubber	Rubber Band	0.02	0.02
84	<b>Paper</b>	<b>Beverage container</b>	<b>0.02</b>	<b>0.02</b>	Timber	Unknown/other	0.02	0.02	other	soft tubing	0.02	0.02
85	Miscellaneous	Brick/cement	0.02	0.02	Fishing	Net	0.02	0.02	other	Broom bristle	0.02	0.02
86	Miscellaneous	Nurdles	0.02	0.02	Miscellaneous	Battery	0.02	0.02	other	Fruit sticker	0.02	0.02
87	other	Broom bristle	0.02	0.02	Miscellaneous	Appliances	0.02	0.02	other	ear plug	0.02	0.02
88	other	Paint fragment	0.02	0.02	Miscellaneous	Nurdles	0.02	0.02	other	Brush/comb	0.02	0.02
89	other	Cigarette packet	0.02	0.02	other	soft tubing	0.02	0.02	other	Dummy	0.02	0.02
90	other	Dummy	0.02	0.02	other	Drill tailing	0.02	0.02	other	Mask	0.02	0.02
91	other	Plastic cork	0.02	0.02	other	Paint fragment	0.02	0.02	<b>Hard Plastic</b>	<b>Cotton bud stick</b>	<b>0.00</b>	<b>0.00</b>
92	other	Glasses	0.02	0.02	other	Button	0.02	0.02	Metal	Pipe	0.00	0.00
93	other	Golf Ball	0.02	0.02	other	Band aid	0.02	0.02	Metal	Bucket/drum	0.00	0.00
94	Metal	Pipe	0.00	0.00	other	Wall Plug	0.02	0.02	Metal	unknown/other soft	0.00	0.00
95	Metal	Wire	0.00	0.00	other	Dummy	0.02	0.02	Glass	lightglobe/tube	0.00	0.00
96	Metal	Aerosol	0.00	0.00	other	Plastic cork	0.02	0.02	Rubber	tyre	0.00	0.00
97	Metal	Bucket/drum	0.00	0.00	other	Glasses	0.02	0.02	Timber	Utensils/food stick	0.00	0.00
98	Glass	Jar	0.00	0.00	other	Mask	0.02	0.02	Timber	Pallet	0.00	0.00
99	Rubber	tyre	0.00	0.00	<b>Hard Plastic</b>	<b>Plate/bowl</b>	<b>0.00</b>	<b>0.00</b>	Timber	Unknown/other	0.00	0.00
100	Timber	Utensils/food stick	0.00	0.00	Metal	Pipe	0.00	0.00	Paper	Magazine/newspaper	0.00	0.00
101	Timber	Pallet	0.00	0.00	Metal	Bucket/drum	0.00	0.00	Paper	Bag	0.00	0.00
102	Timber	Unknown/other	0.00	0.00	Glass	lightglobe/tube	0.00	0.00	Paper	Box	0.00	0.00
103	Paper	Magazine/newspaper	0.00	0.00	Rubber	tyre	0.00	0.00	<b>Paper</b>	<b>plates/bowls</b>	<b>0.00</b>	<b>0.00</b>
104	Paper	Bag	0.00	0.00	Timber	Pallet	0.00	0.00	Fishing	Net	0.00	0.00
105	Paper	Box	0.00	0.00	Paper	Magazine/newspaper	0.00	0.00	Miscellaneous	Battery	0.00	0.00
106	<b>Paper</b>	<b>plates/bowls</b>	<b>0.00</b>	<b>0.00</b>	Paper	Bag	0.00	0.00	Miscellaneous	Carpet	0.00	0.00
107	Fishing	Net	0.00	0.00	Paper	Box	0.00	0.00	Miscellaneous	Ceramic	0.00	0.00
108	Fishing	Fishhook/sinker	0.00	0.00	Paper	plates/bowls	0.00	0.00	Miscellaneous	E waste	0.00	0.00
109	Miscellaneous	Battery	0.00	0.00	Miscellaneous	Brick/cement	0.00	0.00	Miscellaneous	Furniture	0.00	0.00
110	Miscellaneous	Carpet	0.00	0.00	Miscellaneous	Carpet	0.00	0.00	Miscellaneous	Appliances	0.00	0.00
111	Miscellaneous	E waste	0.00	0.00	Miscellaneous	Ceramic	0.00	0.00	Miscellaneous	Large car parts	0.00	0.00
112	Miscellaneous	Furniture	0.00	0.00	Miscellaneous	E waste	0.00	0.00	Miscellaneous	Large boat parts	0.00	0.00
113	Miscellaneous	Appliances	0.00	0.00	Miscellaneous	Furniture	0.00	0.00	Miscellaneous	Bag/box dom. Waste	0.00	0.00
114	Miscellaneous	Large car parts	0.00	0.00	Miscellaneous	Large car parts	0.00	0.00	Miscellaneous	Nurdles	0.00	0.00
115	Miscellaneous	Large boat parts	0.00	0.00	Miscellaneous	Large boat parts	0.00	0.00	other	shot gun wadding	0.00	0.00
116	Miscellaneous	Bag/box dom. Waste	0.00	0.00	Miscellaneous	Bag/box dom. Waste	0.00	0.00	other	burnt foam	0.00	0.00
117	other	Astro turf	0.00	0.00	other	shot gun wadding	0.00	0.00	other	Astro turf	0.00	0.00
118	other	Button	0.00	0.00	other	burnt foam	0.00	0.00	other	Drill tailing	0.00	0.00
119	other	Fibre glass	0.00	0.00	other	Broom bristle	0.00	0.00	other	Paint fragment	0.00	0.00
120	other	Sequins	0.00	0.00	other	Astro turf	0.00	0.00	other	Button	0.00	0.00
121	other	Ceramic filter	0.00	0.00	other	Fibre glass	0.00	0.00	other	Fibre glass	0.00	0.00
122	other	Brush/comb	0.00	0.00	other	Sequins	0.00	0.00	other	Sequins	0.00	0.00
123	other	Beads	0.00	0.00	other	Ceramic filter	0.00	0.00	other	Ceramic filter	0.00	0.00
124	other	Fertiliser Pellet	0.00	0.00	other	Brush/comb	0.00	0.00	other	Beads	0.00	0.00
125	other	Wall Plug	0.00	0.00	other	Beads	0.00	0.00	other	Fertiliser Pellet	0.00	0.00
126	other	Tooth brush	0.00	0.00	other	Fertiliser Pellet	0.00	0.00	other	Wall Plug	0.00	0.00
127	other	Corn starch pins	0.00	0.00	other	Tooth brush	0.00	0.00	other	Plastic cork	0.00	0.00
128	other	Tarp	0.00	0.00	other	Corn starch pins	0.00	0.00	other	Tooth brush	0.00	0.00
129	other	Confetti	0.00	0.00	other	Golf Ball	0.00	0.00	other	Glasses	0.00	0.00
130	other	Glow stick non fishing	0.00	0.00	other	Tarp	0.00	0.00	other	Corn starch pins	0.00	0.00
131	other	Condom	0.00	0.00	other	Nerf Toy	0.00	0.00	other	Tarp	0.00	0.00
132	other	Syringe	0.00	0.00	other	Confetti	0.00	0.00	other	Nerf Toy	0.00	0.00
133	other	Whipper snipper cord	0.00	0.00	other	Glow stick non fishing	0.00	0.00	other	Confetti	0.00	0.00
134	other	Bubble wrap	0.00	0.00	other	Condom	0.00	0.00	other	Bubble wrap	0.00	0.00

**Table A3.4. Frequency of detection (as a percentage) of each identified item in the whole site sweep in each region across all time periods. Grey highlighted items with bold text are items to be banned under the WA Plan for Plastics. \*Balloon releases are banned, not balloons. \*\*Cotton buds with plastic sticks are banned.**

Lower Swan Canning Estuary				Swan Estuary			Canning Estuary		
Ranking	Category	Sub-category	Freq of detection	Category	Sub-category	Freq of detection	Category	Sub-category	Freq of detection
1	Soft plastic	Soft plastic - Unknown	80.4	Hard Plastic	Bottle cap/lid	81.3	Soft plastic	Food wrapper	91.7
2	Hard Plastic	Hard plastic - Unknown	76.8	Hard Plastic	Hard plastic - Unknown	79.2	Soft plastic	Soft plastic - Unknown	83.3
3	Soft plastic	Food wrapper	73.2	Soft plastic	Soft plastic - Unknown	79.2	Hard Plastic	Hard plastic - Unknown	77.1
4	Hard Plastic	Bottle cap/lid	67.9	Soft plastic	Food wrapper	75.0	Hard Plastic	Bottle cap/lid	75.0
5	Plastic straps	String/rope/ribbon	64.3	Foam	Polystyrene (EPS)	66.7	Foam	Polystyrene (EPS)	70.8
6	Foam	Polystyrene (EPS)	62.5	Soft plastic	Straw	56.3	Soft plastic	Thin film carry bag	58.3
7	Foam	Foam - Unknown	50.0	Foam	Foam - Unknown	50.0	Soft plastic	Straw	50.0
8	Soft plastic	Straw	48.2	Hard Plastic	Food Container/lid	47.9	Foam	Foam - Unknown	50.0
9	Paper	Cigarette butt	42.9	Hard Plastic	Beverage bottle <1L	43.8	Hard Plastic	Food Container/lid	45.8
10	Hard Plastic	Lollipop stick/cotton bud stick**	30.4	Plastic straps	String/rope/ribbon	43.8	Glass	Glass bottle	45.8
11	Soft plastic	Thin film carry bag	28.6	Foam	EPS - cup/plates/bowls	39.6	Hard Plastic	Beverage bottle <1L	41.7
12	Hard Plastic	Food Container/lid	26.8	Paper	Cigarette butt	39.6	Plastic straps	String/rope/ribbon	33.3
13	Hard Plastic	Utensils	26.8	Fishing	Fishing line	37.5	other	Ball	33.3
14	Soft plastic	ZipLock Bag	25.0	Soft plastic	Thin film carry bag	35.4	Hard Plastic	Lollipop stick/cotton bud stick**	31.3
15	Foam	EPS - cup/plates/bowls	25.0	Soft plastic	Bait Bag	35.4	Metal	Beverage can	31.3
16	Glass	Glass bottle	23.2	Metal	Lid/cap	35.4	Foam	EPS - cup/plates/bowls	31.3
17	other	Tape	23.2	Hard Plastic	Cups	31.3	Soft plastic	Bait Bag	29.2
18	Metal	Aluminium foil	21.4	Hard Plastic	Lollipop stick/cotton bud stick**	31.3	Soft plastic	ZipLock Bag	29.2
19	Cloth	Clothing/towel	19.6	Glass	Unknown/other glass	29.2	Soft plastic	Cup/lid	27.1
20	Paper	unknown/other	17.9	Hard Plastic	Utensils	27.1	Hard Plastic	Other bottle	25.0
21	Fishing	Fishing line	17.9	Metal	Beverage can	27.1	Hard Plastic	Lighter	25.0
22	other	shot gun wadding	17.9	Glass	Glass bottle	27.1	Metal	Lid/cap	25.0
23	Soft plastic	Cup/lid	16.1	Cloth	Clothing/towel	27.1	Paper	Cigarette butt	22.9
24	Soft plastic	Straw wrapper	16.1	other	Tape	27.1	other	Tape	22.9
25	Paper	paper/cardboard	16.1	Cloth	Unknown/other	25.0	Cloth	Wipes/cloths	20.8
26	other	Ball	16.1	Paper	unknown/other	25.0	Paper	unknown/other	20.8
27	Hard Plastic	Beverage bottle <1L	14.3	Rubber	Thong/shoe	22.9	Soft plastic	Thick plastic bag	18.8
28	Hard Plastic	Cups	14.3	Rubber	Balloon*	22.9	Metal	Aluminium foil	18.8
29	Hard Plastic	Lighter	14.3	other	Pen/pen/texta	22.9	Rubber	Thong/shoe	18.8
30	Metal	Beverage can	14.3	Hard Plastic	Lighter	20.8	Cloth	Clothing/towel	18.8
31	Cloth	Wipes/cloths	14.3	Soft plastic	sheeting	20.8	Cloth	Unknown/other	18.8
32	Soft plastic	sheeting	12.5	Soft plastic	Straw wrapper	20.8	Hard Plastic	Utensils	16.7
33	Plastic straps	unknown/other strap	12.5	Soft plastic	Dog litter bag	20.8	Hard Plastic	Cups	16.7
34	Metal	Lid/cap	12.5	Rubber	Unknown/other	20.8	Plastic straps	packing strap	16.7
35	Cloth	String/rope/strap	12.5	Cloth	Wipes/cloths	20.8	Paper	paper/cardboard	16.7
36	Cloth	Unknown/other	12.5	Soft plastic	ZipLock Bag	18.8	other	Plastic Toy	16.7
37	Fishing	fishing lure	12.5	Hard Plastic	Other bottle	16.7	Hard Plastic	Plate/bowl	14.6
38	Soft plastic	Thick plastic bag	10.7	Soft plastic	Cup/lid	16.7	Hard Plastic	Bucket/crete	14.6
39	Soft plastic	Dog litter bag	10.7	Metal	Aluminium foil	16.7	Soft plastic	Dog litter bag	14.6
40	Plastic straps	packing strap	10.7	Cloth	String/rope/strap	16.7	Fishing	Fishing line	14.6
41	Glass	Unknown/other glass	10.7	other	disposable glove	16.7	Soft plastic	Straw wrapper	12.5
42	Rubber	Rubber Band	10.7	other	Ball	16.7	Rubber	Unknown/other	12.5
43	Timber	Bottle cork	10.7	Paper	cups	14.6	Cloth	String/rope/strap	12.5
44	Paper	cups	10.7	Plastic straps	unknown/other strap	12.5	Fishing	Buoys/floats	12.5
45	Fishing	glow stick	10.7	Metal	Food wrapper	12.5	other	disposable glove	12.5
46	other	Pen/pen/texta	10.7	other	Plastic Toy	12.5	Soft plastic	sheeting	10.4
47	Plastic straps	Cable ties	8.9	Hard Plastic	Cotton bud stick	10.4	Soft plastic	Ice Bag	10.4
48	Metal	Food wrapper	8.9	Soft plastic	Thick plastic bag	10.4	Metal	unknown/other hard	10.4
49	Rubber	Thong/shoe	8.9	Plastic straps	packing strap	10.4	Timber	Bottle cork	10.4
50	Rubber	Unknown/other	8.9	Plastic straps	Cable ties	10.4	Paper	Food wrapper/bag	10.4
51	other	ear plug	8.9	Metal	unknown/other hard	10.4	Paper	cups	10.4
52	other	Drill tailing	8.9	Foam	EPS - Food container	10.4	Soft plastic	Other bag	8.3
53	Hard Plastic	Other bottle	7.1	Paper	Food container/box	10.4	Hard Plastic	Pipe/PVC	8.3
54	Soft plastic	Bait Bag	7.1	Paper	Food wrapper/bag	10.4	Plastic straps	unknown/other strap	8.3
55	Rubber	Balloon*	7.1	Fishing	Buoys/floats	10.4	Metal	Food can/tin	8.3
56	Timber	Wood/timber	7.1	other	Syringe	10.4	Fishing	fishing lure	8.3
57	Foam	EPS - Food container	7.1	Hard Plastic	Stirrers	8.3	Plastic straps	Cable ties	6.3
58	Fishing	Buoys/floats	7.1	Hard Plastic	Bucket/crete	8.3	Metal	Food wrapper	6.3
59	Miscellaneous	Ceramic	7.1	Metal	Aerosol	8.3	Cloth	Insulation/stuffing	6.3
60	other	soft tubing	7.1	Fishing	fishing lure	8.3	Paper	Beverage container	6.3
61	other	Plastic Toy	7.1	Fishing	unknown/other	8.3	Fishing	unknown/other	6.3
62	Hard Plastic	Plate/bowl	5.4	Hard Plastic	Pipe/PVC	6.3	other	Pen/pen/texta	6.3
63	Hard Plastic	Bucket/crete	5.4	Soft plastic	Ice Bag	6.3	other	Plastic coated wire	6.3
64	Hard Plastic	Cotton bud stick	5.4	Rubber	Rubber Band	6.3	other	Cigarette packet	6.3
65	Metal	unknown/other hard	5.4	Fishing	glow stick	6.3	other	Syringe	6.3
66	Glass	lightglobe/tube	5.4	Fishing	Fishhook/sinker	6.3	Glass	Unknown/other glass	4.2
67	Fishing	unknown/other	5.4	other	Fruit sticker	6.3	Rubber	Balloon*	4.2
68	other	disposable glove	5.4	other	Plastic coated wire	6.3	Timber	Wood/timber	4.2
69	other	Band aid	5.4	Metal	Wire	4.2	Foam	EPS - Food container	4.2
70	other	Mask	5.4	Metal	Food can/tin	4.2	Paper	Food container/box	4.2
71	Hard Plastic	Pipe/PVC	3.6	Glass	Jar	4.2	Fishing	glow stick	4.2
72	Soft plastic	Ice Bag	3.6	Cloth	Insulation/stuffing	4.2	Fishing	Fishhook/sinker	4.2
73	Metal	Food can/tin	3.6	Timber	Wood/timber	4.2	Miscellaneous	Brick/cement	4.2
74	Cloth	Insulation/stuffing	3.6	Timber	Bottle cork	4.2	other	Band aid	4.2
75	Paper	Food wrapper/bag	3.6	other	ear plug	4.2	other	Whipper snipper cord	4.2
76	other	burnt foam	3.6	other	Cigarette packet	4.2	Hard Plastic	Stirrers	2.1
77	other	Fruit sticker	3.6	other	Whipper snipper cord	4.2	Hard Plastic	Cotton bud stick	2.1

Table A3.4. Continued

Ranking	Lower Swan Canning Estuary			Swan Estuary			Canning Estuary		
	Category	Sub-category	Freq of detection	Category	Sub-category	Freq of detection	Category	Sub-category	Freq of detection
78	other	Plastic coated wire	3.6	other	Bubble wrap	4.2	Metal	Wire	2.1
79	other	Nerf Toy	3.6	<b>Soft plastic</b>	<b>Other bag</b>	<b>2.1</b>	Metal	Aerosol	2.1
80	<b>Hard Plastic</b>	<b>Stirrers</b>	<b>1.8</b>	Metal	unknown/other soft	2.1	Glass	Jar	2.1
81	<b>Soft plastic</b>	<b>Other bag</b>	<b>1.8</b>	Timber	Utensils/food stick	2.1	Rubber	tyre	2.1
82	Metal	unknown/other soft	1.8	Timber	Unknown/other	2.1	Rubber	Rubber Band	2.1
83	Paper	Food container/box	1.8	Paper	paper/cardboard	2.1	<b>Paper</b>	<b>plates/bowls</b>	<b>2.1</b>
84	<b>Paper</b>	<b>Beverage container</b>	<b>1.8</b>	<b>Paper</b>	<b>Beverage container</b>	<b>2.1</b>	other	soft tubing	2.1
85	Miscellaneous	Brick/cement	1.8	Fishing	Net	2.1	other	Broom bristle	2.1
86	Miscellaneous	Nurdles	1.8	Miscellaneous	Battery	2.1	other	Fruit sticker	2.1
87	other	Broom bristle	1.8	Miscellaneous	Appliances	2.1	other	ear plug	2.1
88	other	Paint fragment	1.8	Miscellaneous	Nurdles	2.1	other	Brush/comb	2.1
89	other	Cigarette packet	1.8	other	soft tubing	2.1	other	Dummy	2.1
90	other	Dummy	1.8	other	Drill tailing	2.1	other	Golf Ball	2.1
91	other	Plastic cork	1.8	other	Paint fragment	2.1	other	Mask	2.1
92	other	Glasses	1.8	other	Button	2.1	other	Glow stick non fishing	2.1
93	other	Golf Ball	1.8	other	Band aid	2.1	other	Condom	2.1
94	Metal	Pipe	0.0	other	Wall Plug	2.1	Metal	Pipe	0.0
95	Metal	Wire	0.0	other	Dummy	2.1	Metal	Bucket/drum	0.0
96	Metal	Aerosol	0.0	other	Plastic cork	2.1	Metal	unknown/other soft	0.0
97	Metal	Bucket/drum	0.0	other	Glasses	2.1	Glass	lightglobe/tube	0.0
98	Glass	Jar	0.0	other	Mask	2.1	Timber	Utensils/food stick	0.0
99	Rubber	tyre	0.0	<b>Hard Plastic</b>	<b>Plate/bowl</b>	<b>0.0</b>	Timber	Pallet	0.0
100	Timber	Utensils/food stick	0.0	Metal	Pipe	0.0	Timber	Unknown/other	0.0
101	Timber	Pallet	0.0	Metal	Bucket/drum	0.0	Paper	Magazine/newspaper	0.0
102	Timber	Unknown/other	0.0	Glass	lightglobe/tube	0.0	Paper	Bag	0.0
103	Paper	Magazine/newspaper	0.0	Rubber	tyre	0.0	Paper	Box	0.0
104	Paper	Bag	0.0	Timber	Pallet	0.0	Fishing	Net	0.0
105	Paper	Box	0.0	Paper	Magazine/newspaper	0.0	Miscellaneous	Battery	0.0
106	<b>Paper</b>	<b>plates/bowls</b>	<b>0.0</b>	Paper	Bag	0.0	Miscellaneous	Carpet	0.0
107	Fishing	Net	0.0	Paper	Box	0.0	Miscellaneous	Ceramic	0.0
108	Fishing	Fishhook/sinker	0.0	Paper	plates/bowls	0.0	Miscellaneous	E waste	0.0
109	Miscellaneous	Battery	0.0	Miscellaneous	Brick/cement	0.0	Miscellaneous	Furniture	0.0
110	Miscellaneous	Carpet	0.0	Miscellaneous	Carpet	0.0	Miscellaneous	Appliances	0.0
111	Miscellaneous	E waste	0.0	Miscellaneous	Ceramic	0.0	Miscellaneous	Large car parts	0.0
112	Miscellaneous	Furniture	0.0	Miscellaneous	E waste	0.0	Miscellaneous	Large boat parts	0.0
113	Miscellaneous	Appliances	0.0	Miscellaneous	Furniture	0.0	Miscellaneous	Bag/box dom. Waste	0.0
114	Miscellaneous	Large car parts	0.0	Miscellaneous	Large car parts	0.0	Miscellaneous	Nurdles	0.0
115	Miscellaneous	Large boat parts	0.0	Miscellaneous	Large boat parts	0.0	other	shot gun wadding	0.0
116	Miscellaneous	Bag/box dom. Waste	0.0	Miscellaneous	Bag/box dom. Waste	0.0	other	burnt foam	0.0
117	other	Astro turf	0.0	other	shot gun wadding	0.0	other	Astro turf	0.0
118	other	Button	0.0	other	burnt foam	0.0	other	Drill tailing	0.0
119	other	Fibre glass	0.0	other	Broom bristle	0.0	other	Paint fragment	0.0
120	other	Sequins	0.0	other	Astro turf	0.0	other	Button	0.0
121	other	Ceramic filter	0.0	other	Fibre glass	0.0	other	Fibre glass	0.0
122	other	Brush/comb	0.0	other	Sequins	0.0	other	Sequins	0.0
123	other	Beads	0.0	other	Ceramic filter	0.0	other	Ceramic filter	0.0
124	other	Fertiliser Pellet	0.0	other	Brush/comb	0.0	other	Beads	0.0
125	other	Wall Plug	0.0	other	Beads	0.0	other	Fertiliser Pellet	0.0
126	other	Tooth brush	0.0	other	Fertiliser Pellet	0.0	other	Wall Plug	0.0
127	other	Corn starch pins	0.0	other	Tooth brush	0.0	other	Plastic cork	0.0
128	other	Tarp	0.0	other	Corn starch pins	0.0	other	Tooth brush	0.0
129	other	Confetti	0.0	other	Golf Ball	0.0	other	Glasses	0.0
130	other	Glow stick non fishing	0.0	other	Tarp	0.0	other	Corn starch pins	0.0
131	other	Condom	0.0	other	Nerf Toy	0.0	other	Tarp	0.0
132	other	Syringe	0.0	other	Confetti	0.0	other	Nerf Toy	0.0
133	other	Whipper snipper cord	0.0	other	Glow stick non fishing	0.0	other	Confetti	0.0
134	other	Bubble wrap	0.0	other	Condom	0.0	other	Bubble wrap	0.0



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