Seafloor Litter Monitoring

International Bottom Trawl Survey 2018

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Summary

The Marine Strategy Framework Directive (MSFD) requires EU Member States to develop programmes of measures that aim to achieve or maintain Good Environmental Status (GES) in European Seas. In order to be able to evaluate the quality state of marine waters on a regular basis and the effects of the measures taken, monitoring program for MSFD descriptors and indicators have been established by the Member States.

GES is defined by 11 descriptors, of which Marine Litter is one. The Dutch monitoring program for this descriptor includes the collection of data on the presence, abundance and distribution of litter on the seafloor. According to the Dutch program, the data on seafloor litter must be collected during statutory task fish surveys using a standardised GOV fishing net as a part of the International Bottom Trawl Survey (IBTS), which is carried out yearly in the North Sea.

This report presents the results of the seafloor litter monitoring during the IBTS of Quarter 1 2018. Seafloor litter data have been collected annually since 2013, and the new data are presented with respect to the data collected in previous years. This is done for both the composition and the spatial distribution of the seafloor litter. The allocation of rectangles surveyed was redistributed amongst the countries participating in the IBTS in 2017, resulting in a different area covered by the Dutch survey compared to earlier years. Additional a extra rectangle was added to the Dutch survey in 2018.

In 2018, litter was caught in 80% of the hauls. The composition of this litter was similar compared to earlier years; more than 80% of the 162 items caught was plastic and these were mainly plastic sheets and various types of rope and fishing lines. The majority of these items was, as in previous years, small (<25 cm^2). The haul with the highest amount of litter items was close to the German coast, with 20 separate items recorded. Ten of the 11 empty hauls were located in the northern part of the area surveyed (close to the UK coast), while one was at the southern end, between the UK and the Netherlands.

Due to the spatial change in the allocation of the survey area in 2017, and the semi-random sampling in a grid cell, it is difficult to compare the data between years. With this in mind, when comparing the mean and median values across the years, the values from this year were the lowest since recording began in 2013. However, it should be noted that the net used (GOV) is not designed to catch litter and as such has only a small probability (<5%) of catching a litter item when it is present in the trawl path. Thus, the fact that these items are caught indicates that it is likely that there are many more items in the trawl path and that current values are a large underestimation of the actual litter present. Consequently, the degree of litter pollution on the seafloor is probably much larger than presented in this report.

1 Introduction

The European Marine Strategy Framework Directive (MSFD 2008/56/EC) dictates that EU Member States are obligated to establish and implement measures to achieve or maintain good environmental status (GES) in their national marine waters. This GES is defined by 11 descriptors, of which one of these, Descriptor 10, is Marine Litter. In order to be able to achieve GES by 2020 for Marine Litter, it is necessary that "Properties and quantities of marine litter, including their degradation products such as small plastic particles down to micro-plastics do not cause harm to the coastal and marine environment and their volume decreases over time." (MSFD 2008/56/EC).

The oceans are of significant socio-economic importance, providing jobs, food and recreation to much of the world's population (Costanza 1999). Yet anthropogenic pollution abounds in our oceans, with marine litter threating wildlife, hindering human activities and reducing the recreational value of our coasts (Fleet et al. 2009).
Sources of marine litter can be sea- or land-based, although it is widely assumed that the latter represents an overwhelming majority of the litter (Jambeck et al. 2015). Land-based sources of marine litter include sewage and river outlets, landfills and recreational activities on the coast (Viega et al. 2016). Shipping, fisheries, offshore installations and illegal dumping all constitute some of the sources of sea-based marine litter (Viega et al. 2016).
Plastics represent the major portion of this pollution (Galgani et al. 2015), and according to Jambeck et al. (2015) between 5 and 13 million metric tonnes of post-consumer plastic entered the oceans solely from land-based sources in 2010. This has impacts on marine fauna through effects such as entanglement and ingestion (Kühn et al*.* 2015). The former may impeded movement and inflict injury, thus reducing an animal's ability to avoid predators or acquire food, and increasing the potential for drowning. Consumption of marine debris (both intentional and accidental) may cause a suppressed appetite or blockage of the gastrointestinal tract leading to malnutrition and in some cases may even be lethal (Kühn et al*.* 2015). Litter in the ocean can also have detrimental effects on marine flora through smothering and crushing, resulting in reduced sunlight and the development of anoxic conditions on the seafloor (Kühn et al*.* 2015).

Various initiatives to reduce litter in the environment have been instigated or are currently under discussion. For example, in 2013 the law on dumping of garbage by marine vessels was changed from "all garbage may be dumped except" into "no garbage may be dumped except". Another instance is the ban or taxation on single-use plastic carrier bags in shops and supermarkets in many countries. In the Netherlands, this was introduced in January 2016. Recently, there has been a significant increase in awareness surrounding marine litter, with particular focus on plastics. In the Netherlands, initiatives include "Green Deal" on both Clean Beaches and Fishery for a Clean Sea. The Green deal on Fishery include the "Fishing for litter" program by KIMO to bring bycatch litter to land for recycling or processing, as well as studies to reduce loss from netting material.

Such measures can help towards achieving GES, but the MSFD also requires the monitoring of the progress of these measures. This is interpreted as a requirement to monitor the amount of litter in the marine environment and where possible monitor potential effects of the measures taken to reduce the amount of litter as well. The requirements for monitoring are divided in a number of categories: monitoring litter in the water column, washed ashore, in biota and deposited on the seafloor. The monitoring of litter washed ashore results in the indicator on Beach litter (Ospar commission 2010, Schulz et al. 2017), and monitoring in biota in the indicator Plastic particles in fulmar stomachs (Van Franeker et al. 2017). The beach litter monitoring indicates that a large part of the North Sea litter washes a shore on beaches near the Skaggerak. Additionally to these two indicators, there is the indicator Seabed litter to describe the litter deposited on the seafloor (Ospar commission 2017).

This report describes the methods used and data collected in 2018 for the Dutch part of the monitoring of litter deposited on the seafloor as commissioned by Rijkswaterstaat (RWS). The OSPAR commission proposed to collect this type of data by using the catches of the International Bottom Trawl Survey (IBTS). This is an internationally coordinated survey covering the Greater North Sea, providing a good platform for internationally collecting litter data, despite the fact that the sampling gear is not optimal for sampling litter. Previous work (van Hal & de Vries 2013, van der Sluis & van Hal 2014) showed that the Netherlands catches seafloor litter during statutory task fish surveys (e.g. IBTS and Beam Trawl Survey) on board of the Dutch research vessel Tridens II and registering of this litter could be done following the protocol for collecting data on marine litter as developed by working groups of the International Council for the Exploration of the Sea (ICES) (e.g. WGISUR, IBTSWG, WKMAL) (ICES 2015).

A successful pilot study for collecting and recording seafloor litter on board was carried out during the Dutch International Bottom Trawl Survey (IBTS) in 2013 (van Hal & de Vries 2013). This pilot only looked at the practical implications on board. The practical method was by no means optimised to nor represents a statistical representative approach. Following the pilot, it was decided that monitoring of seafloor litter would become a regular part of the Dutch IBTS. As a result of this, international IBTS protocol on marine litter (ICES 2015) was included in the Dutch survey manual (van Damme et al. 2017), along with additional guidelines on how to classify specific litter items based on decisions made during the pilot (van Hal & de Vries 2013). Since then, a number of guidelines have been published, the last of which was in 2017 (CEMP Guidelines on Litter on the Seafloor). However, it should be noted that these guidelines still leave much room for interpretation and as such, the sampling this year was carried out as in previous years.

Since 2013, the IBTS data on seafloor litter have been stored and provided to RWS. Including the data collected in 2018, a total of six years of data are available. As a result, RWS has requested to put the 2018 data into context with earlier years.

Aims and Objectives:

This report will present the seafloor litter data collected during the Dutch International Bottom Trawl Survey during Quarter 1 of 2018. The objectives of this report are to:

- Provide insight into the abundance and composition of seafloor litter in part of the North Sea.
- Assess the spatial distribution of seafloor litter in part of the North Sea.
- Compare these findings to those of previous years (2013-2017).

2 Materials and Methods

2.1 IBTS 2018

The International Bottom Trawl Survey Q1 (IBTS Q1) is carried out annually in January and February, and is performed by Scotland, Germany, Sweden, Norway, Denmark and The Netherlands (ICES 2015).
The survey design is such that the North Sea is divided into grids (ICES rectangles) of 0.30° latitude and 1° longitude, which are distributed amongst the participating countries. Each rectangle needs to be sampled twice over the course of the IBTS but the allocation of rectangles among countries means that the majority of the rectangles is sampled once by two different countries. For many years, the distribution of areas covered by each country remained unchanged. However, in 2017 one of the countries had to reduce its effort and was no longer able to cover all its allocated rectangles resulting in a redistribution of rectangles among the participating countries. This change affected the area covered by the Netherlands: it became more compact, no longer reaching as far north to Aberdeen nor as far south as the Channel and the southern English coast. The area remained mostly unchanged for the 2018 survey, with the exception of an additional rectangle taken from the German survey (**Figure 2-1**).

The sampling gear used for the IBTS is the "Grand Ouverture Verticale" (GOV), a (semi-pelagic) bottom trawl. The mesh size of the net is 100 mm and 10 mm in the codend. The headline of the net lies about 5 m above the seafloor, which is particularly convenient for sampling pelagic fish species and species that dwell just above the bottom. However, as the ground rope of the GOV only touches the bottom, flatfish, benthic organisms and seafloor litter may well go underneath it, and the proportion can be substantial. For example, the proportion of small flatfish (<25 cm) going underneath the ground rope is assumed to be 50% (Piet et al. 2009). Due to the weak ground contact of the GOV, small flatfishes, other small bottom dwelling species and epibenthos are caught by the GOV in an effectively random manner (<5% compared to a beam trawl), and are thus not representative of what is actually on the seafloor (ICES 2003). This may well be the case for seafloor litter as well.
The horizontal opening of the net is determined by the pressure on the two doors (otterboards), one on each side of the net. The horizontal opening of the net varies with depth. The width between the doors (doorspread) is therefore measured continuously during each haul. The doors are connected to the net by a 10 m back strop and a 50 m sweep. This sweep moves over the seafloor creating a dust cloud, herding fish towards the actual net opening. The actual net opening (wingspread) varies with depth as well. The wingspread is considered relevant for seafloor litter as it is not expected that seafloor litter is herded towards the net by the dust cloud created by the sweeps.

The standard haul duration is 30 minutes, with a fishing speed of 4 knots and trawling is only carried out during daylight hours.

The Netherlands uses the research vessel Tridens II for the IBTS each year. In 2015 and 2016, due to a refit of the Tridens, the English research vessel CEFAS Endeavour was hired. Since the refit of the Tridens, the Dutch GOV-net and otterboards, as well as a new SIMRAD net-geometry system attached to the doors have been used.

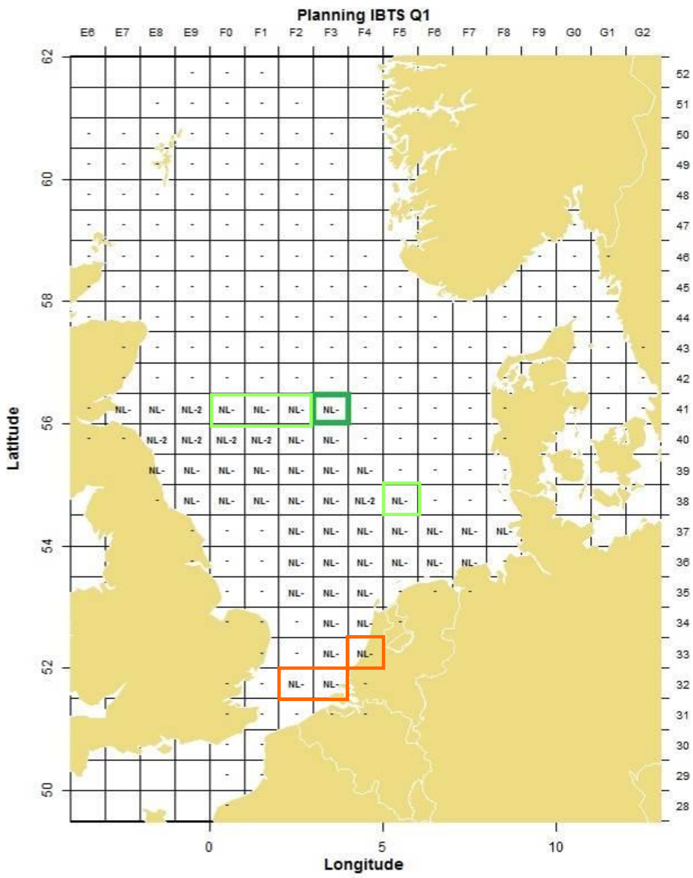

Figure 2-1. Planned ICES rectangles for Dutch GOV hauls during the 2018 IBTS. *Rectangles marked NL-2 are those covered twice by the Netherlands. The dashes in the adjacent rectangles are those covered by other participating countries. The dark green square represents the additional rectangle added to the 2018 Dutch IBTS. The light green rectangles were covered twice and the orange rectangles were not covered, which was a deviation of the plan.*

2.2 Sampling litter

The IBTS manual states that litter has to be collected each haul and classified according to **Table 2-1**. Additional guidelines are available, most recently of which is the CEMP Guidelines on Litter on the Seafloor. However, it should be stressed that these guidelines still leave too much room for interpretation. For instance, there is no guidance on how detailed the catch should be sorted or on visual inspection of the net. As a result, sampling was carried out in much alike the same way since the pilot in 2013.

Photo 1*. Example of marine litter with organisms attached to it (in this case anemone, barnacles and dogfish eggs)*

On the Tridens the complete net is hoisted on board and only a part of the ground rope is left hanging over the side. The net is inspected and cleaned as far as possible after each trawl haul. Litter items in the net and in the catch are collected. Each litter item is classified, weighed, the size is estimated and photographed (**Annex 2**). In case similar items are found in a single trawl haul, these are recorded as a single category, weighed together and the number of individual items is registered (**Annex 1, Table 2**). This year, this occurred most often with category A7 (Synthetic rope). When organisms are attached (**Photo 1**) this is recorded as well. Moreover, a more detailed description of the litter item is given to facilitate analysis post-survey (**Annex 1, table 2**).

Table 2-1. Classification of marine litter items *(ICES 2015). The table presents six categories of litter (A-F) and their respective subcategories, as well as size categories (A-F) used in the categorisation of seafloor litter items caught during the IBTS.*

A: Plastic	**B: Metals**		**Related size category**
A1. Bottle	B1. Cans (food)		A: <5*5 cm= 25 cm^2
A2. Sheet	B2. Cans (beverage)		B: <10*10 cm= 100 cm^2
A3. Bag	B3. Fishing related		C: <20*20 cm= 400 cm^2
A4. Caps/ lids	B4. Drums		D: <50*50 cm= 2500 cm^2
A5. Fishing line (monofilament)	B5. Appliances		E: <100*100 cm= 10000 cm^2= 1 m^2
A6. Fishing line (entangled)	B6. Car parts		F: >100*100 cm = 10000 cm2= 1 m^2
A7. Synthetic rope	B7. Cables		
A8. Fishing net	B8. Other		
A9. Cable ties			
A10. Strapping band			
A11. crates and containers			
A12. diapers			
A13. sanitary towel/tampon			
A14. other			
C: Rubber	**D: Glass/ Ceramics**	**E: Natural products**	**F: Miscellaneous**
C1. Boots	D1. Jar	E1. Wood (processed)	F1. Clothing/ rags
C2. Balloons	D2. Bottle	E2. Rope	F2. Shoes
C3. Bobbins (fishing)	D3. Piece	E3. Paper/ cardboard	F3. Other
C4. Tyre	D4. Other	E4. Pallets	
C5. Glove		E5. Other	
C6. Other			

2.3 Area surveyed

Seafloor litter is presented as number of items per km^2. This requires the area surveyed, e.g. the swept area. The swept area of the GOV is variable, and depends on the depth and the amount of fishing line used. For fish, two swept areas are calculated: one based on doorspread and the other on wingspread. The doorspread is the area between the doors (otterboards) of the gear, which is relevant for fish that are herded into the net. The wingspread is the area between the wings, which is considered the actual net opening. We assume that marine litter is not herded into the net by the doors and cables, and thus wingspread is considered the relevant measure for seafloor litter.

The SIMRAD net geometry system records the doorspread only, and as such wingspread needs to be calculated. In some cases doorspread is not recorded properly, and in these cases doorspread is calculated as well. The formulae are based upon (1) the data of multiple years for the doorspread and (2) the information gathered during the two years on the English vessel using their wingspread sensors.

The used formulae are as follow:

Doorspread= 14.2*LOG(Depth)+16.72*LOG(Warp_length)+18.49
Wingspread= Doorspread*0.18870+5.87280

The number of litter items per km^2 is then calculated as:

Number of litter items per km^2 = Items/(Wingspread*Distance trawled).

It should be noted that these formulae are the same as those used in the 2016 and 2017 reports, but differ from those used in earlier years. As a result of this, values from reports prior to 2016 differ from what is presented in the 2016, 2017 and present reports. However, all data from these years were recalculated using the new formulae, thus allowing for comparison between years.

2.4 Litter analysis

The litter data are presented as figures showing the composition of the litter by categories A-F (**Table 2-1**), and for the major category (Plastic), by subcategories A1-A14. Furthermore, the composition of the litter is also presented by size categories A-F.
This is followed by figures on the spatial distribution in both absolute numbers and numbers per km^2. The numbers of items and number of items per km^2 are summarised by the minimum, maximum, mean and median values. The median is presented together with the median absolute deviation (MAD), representing the median of the absolute deviations from the data's median.

3 Results

The Dutch IBTS 2018 Q1 performed 56 valid trawl hauls. 55 of the hauls lasted the standard 30 minutes, with only one lasting 27 minutes (haul no. 3400035). At sea, a number of rectangles were swapped with the foreign colleagues. The rectangles 41F0, 41F1, 41F2 and 38F5 were covered twice (taking over German and French stations), 33F4, 32F2 and 32F3 were not covered (are covered by the French colleagues).

At least one litter item was found in 45 of the hauls meaning that 11 hauls contained no marine litter. In total 162 litter items were registered.

3.1 Composition of the litter

General litter composition

Plastic is by far the most frequent category of seafloor litter with 138 (85.2%) of the 162 items caught (**Figure 3-1**). This is followed by Natural Products (14 items; 8.6%) and Miscellaneous (6 items; 3.7%). Categories B (Metals) and D (Glass/ceramics) were not recorded this year.

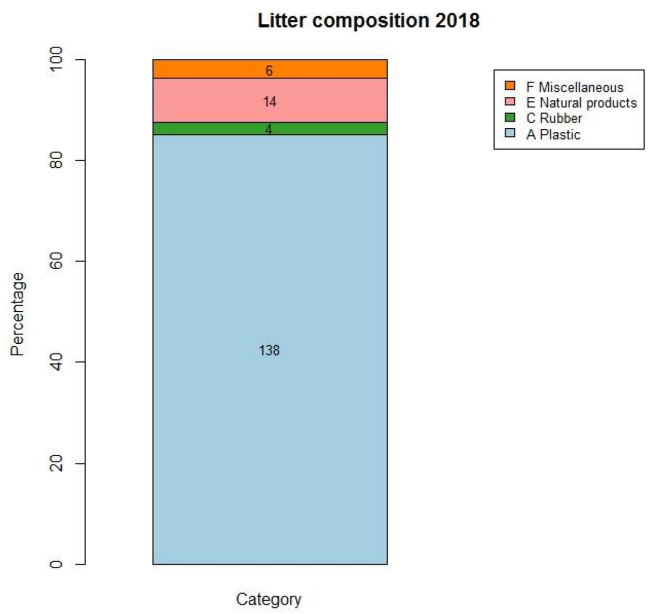

Figure 3-1. Composition of the seafloor litter in the catches of the Dutch IBTS Q1 2018. *Values within the graph are the absolute number of items for the categories containing more than 1% of the total items counted. Plastic represents the largest category with 138 items (85.2%) of the 162 litter items caught.*

Plastic composition

The largest category, Plastic, contains 14 subcategories (**Table 2-1**). The most dominant subcategory is A7 (Synthetic rope) representing 77 (55.8%) of the 138 plastic items caught, followed by subcategory A2 (Sheet) with 34 items (24.6%). The other items are markedly lower in contribution (**Figure 3-2**).

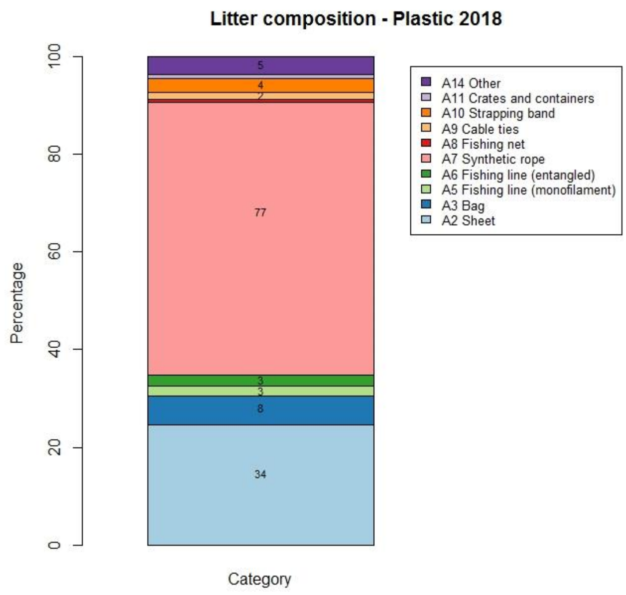

Figure 3-2. Composition of the seafloor litter category A Plastic in the catches of the Dutch IBTS Q1 2018. *Values within the graph are the absolute number of items for the subcategories containing more than 1% of the items counted. Most plastic items caught are synthetic ropes (subcategory A7), with 77 items (55.8%) of the 138 plastic items caught, followed by plastic sheets (subcategory A2) with 34 items (24.6%).*

Size composition

All litter items are assigned a size category based on an estimation of the surface. Most of the items (117; 72.2%) are classified as size category A (<25 cm^2). The number of items decreases as the size category increases: 26 items (16%) in category B; 13 items (8%) in category C; and 6 items (4%) in category D. No item is assigned to the largest two categories (E: 2500cm^2 - 10000cm^2 and F: >10000cm^2) (**Figure 3-3**). The number of items decreases as the size category increases. No item was classified in either of the two largest categories.

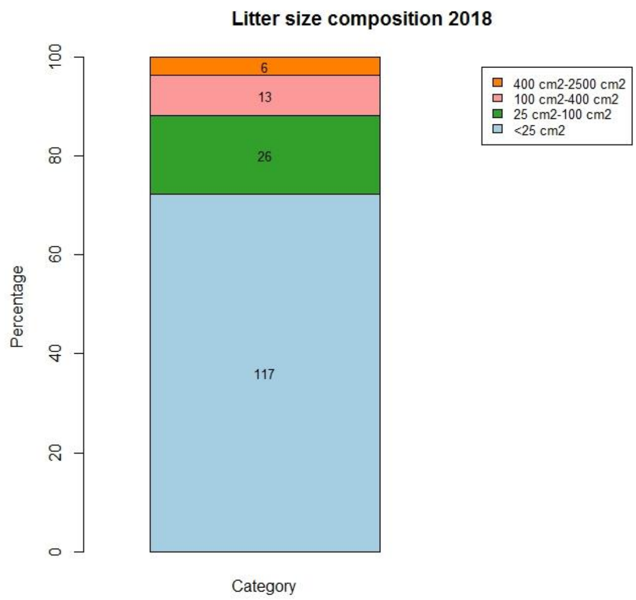

Figure 3-3. Size composition of the seafloor litter in the catches of the IBTS Q1 2018. *Values within the graph are the absolute number of items for the categories containing more than 1% of the items. Most items (117) are <25cm^2.*

Weighing was done consistently this year, however many items weighed less than 1 gram (e.g. single synthetic rope) for which no weight is recorded. The heaviest item was a rope weighing 8 kg **(Photo 2**), followed by entangled fishing lines of 2.3 kg, 1.55 kg and 1.15 kg. All other items were less than 1 kg. Thus, the distribution of the weight is skewed, as seen in the difference between average weight (241.2 g) and the median weight (5.0 g) (**Table 3-1**).

Photo 2. *Largest litter item caught during the Dutch IBTS 2018: entangled rope caught during haul 3400040 (8th February)*

Table 3-1*. *Summary data of the Dutch 2018 IBTS litter catches. *Each parameter is presented with its minimum, maximum, mean, median and median absolute deviation values.*

	min	max	mean	median	MAD
Items per trawl	0	20	2.89	2.00	1.48
Surface trawled (km^2)	0.00354	0.10370	0.07301	0.07166	0.01
Items per km^2	0	253.2	40.3	30.9	32.15
Weight (g)	-	8000	241	5.00	5.93

3.2 Abundance and distribution of the litter

Information on the abundance and distribution of seafloor litter can be provided for the locations of the GOV trawls only. Owing to the redistribution of rectangles in 2017, the spatial coverage of the Dutch IBTS changed compared to earlier years. Besides that, the exact locations of the trawl hauls also vary between years, as the fishing positions are chosen semi-randomly within an ICES rectangle. This creates variation in the actual depth and seafloor structure of the trawl hauls between years. A one-to-one comparison of the trawl hauls between years is therefore complicated. Personal experience of the years in which litter data were collected gives the impression that the amount of litter varies a lot between different habitats within the same rectangle. The impression is that areas with lots of structure, e.g. Sabellaria reefs or kelp areas, tend to have more litter items than sandy areas. As a result catches of litter can vary a lot even over small distances.

The spatial distribution of litter caught during the IBTS 2018 is presented in **Figure 3-4**. This shows the 11 hauls without litter items in the catch as the minimum catch. Ten of the 11 empty hauls were located in the northern part of the area surveyed (close to the UK coast), while one was at the southern end, between the UK and the Netherlands.

The ranges presented by the bubbles in the plots are the same as those used in the earlier reports (van der Sluis & van Hal 2014, van Hal 2015, 2017a, b). The maximum value of 700 items per km^2 was not reached this year. The maximum in 2018 is 253 items per km^2 which is located close to the German coast and corresponds to 20 items reported from the catch. The median number of items is 30.9 items per km^2 corresponding to 2 items in the catch (Table 3-1).

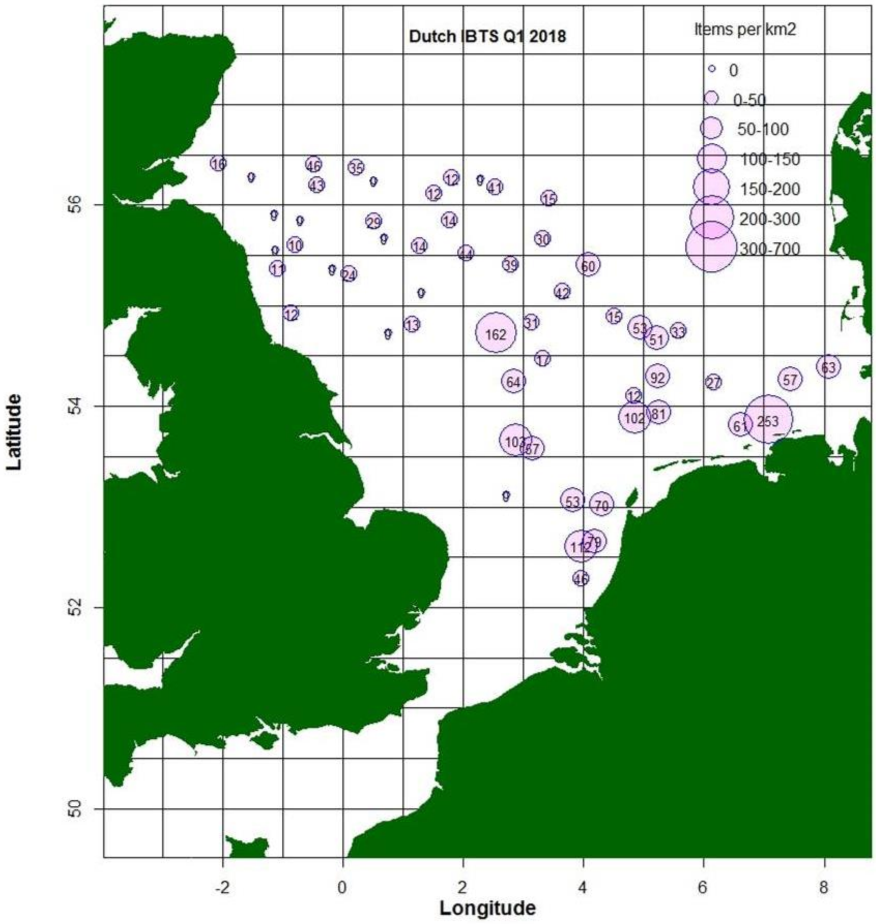

Figure 3-4. Density of litter items per haul per km2 for the Dutch IBTS 2018. *The numbers in the circles represent the number of litter items per km2, as well as the start position of the trawls and thus determine the rectangle sampled. The largest catch can be seen just off the German coast (253 items per km2). Most of the minimum catches are located in the northern part of the survey, close of the UK coast.*

3.3 Comparison with earlier years

In all years the seafloor litter was dominated by plastics, with 83-88% of the total number of items caught. The largest plastic category this year was A7 (Synthetic rope), which was the same as in 2015. In other years (2013, 2014 and 2017) A2 (Sheets) represented the largest category. In 2016 this was A5 Fishing line (Monofilament). The decision on whether to place items in some categories remains an arbitrary choice (more of which in the discussion). This also extends to registering and counting the number of individual pieces of rope/sheet correctly and in a consistent way. Overall, the values in 2018 are some of the lowest since recording began in 2013. Although 2013 had the lowest maximum values for both items per trawl and items per km^2, the median for both are higher than those of 2018 (**Table 3-2, Figure 3-5**). The spatial distribution is difficult to compare, especially using the maps presenting single hauls (**Figure 3-4**). Comparing the 2018 map with those of earlier years indicates that the distribution seems as random as in previous years. Following the survey design in which a haul is representative for the whole ICES rectangle, or if multiple hauls are done the average is a representation of that rectangle, spatial maps were created (**Figure 3-5, Figure 3-6**). These maps are somewhat easier to compare, but do not provide a clear pattern of hotspots of litter over the years. Neither do they indicate clear differences between years.

Table 3-2. Comparison between Dutch IBTS litter results for the period 2013-2018*. The minimum and maximum. mean, median and median absolute deviation values for Items per trawl and Items per km^2 are presented for comparison for years 2013-2018. The values differ from those in the 2013, 2014 and 2015 reports as a different formula for calculating fished area was used for those reports. However, they have been recalculated to enable comparison across the years.*

2018	min	max	mean	median	Stdev	MAD
Items per trawl	0	20	2.90	2.00	3.40	1.48
Items per km^2	0	253.2	40.3	30.9	44.8	32.15
2017	min	max	mean	median	Stdev	MAD
Items per trawl	0	33	6.40	4.00	6.46	4.45
Items per km^2	0	610.6	98.2	62.1	119.4	50.57
2016	min	max	mean	median	Stdev	MAD
Items per trawl	0	21	7.00	6.00	5.00	4.45
Items per km^2	0	298.1	106.9	99.4	76.1	74.4
2015	min	max	mean	median	Stdev	MAD
Items per trawl	0	23	8.00	7.00	5.73	5.93
items per km^2	0	330.0	115.9	102.9	83.5	78.0
2014	min	max	mean	median	Stdev	MAD
Items per trawl	0	21	6.39	5.00	4.88	4.45
Items per km^2	0	529.1	91.7	65.6	88.0	57.8
2013	min	Max	mean	median	Stdev	MAD
Items per trawl	0	11	4.02	4.00	2.42	2.97
Items per km^2	0	132.1*	51.2	49.3	32.0	30.6

* Individual ropes were not counted. If multiple (dolly) ropes were present these were most of the time registered as a single item.

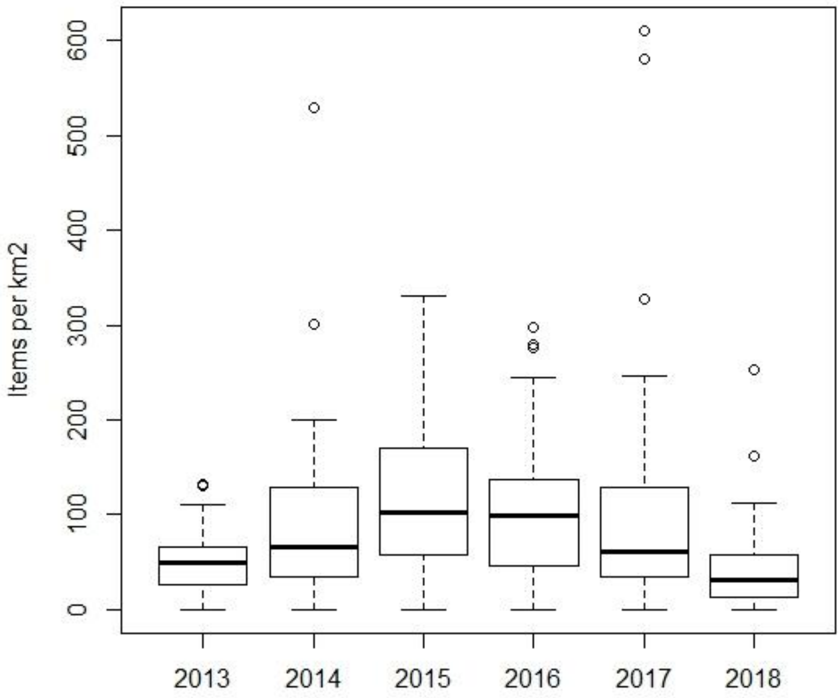

Figure 3-5**.** ***Boxplot of the Items per km² for all the hauls in each year (2013-2018)****. The black horizontal line represents the median. Overall, the values in 2018 are some of the lowest since recording began in 2013. Although 2013 had the lowest maximum values for both items per trawl and items per km², the median for both are higher than those of 2018. NB: the geographical coverage differs between years.*

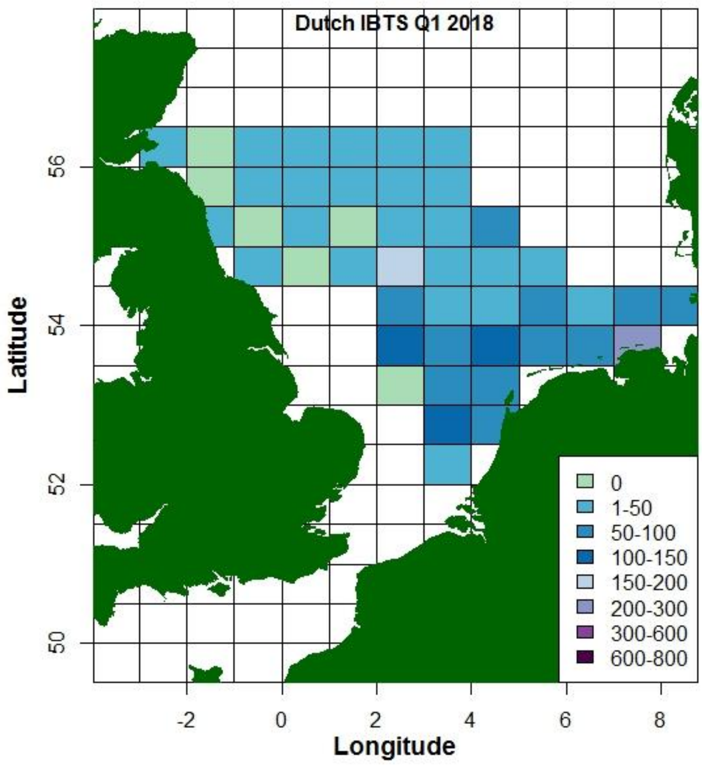

Figure 3-6. Density of litter items per km² for the IBTS Q1 2018*. The highest density in 2018 (253 items per km²) was observed near the German coast. Hauls in which no litter was caught were mostly located in the northern part of the Dutch survey, towards the English coast. The majority of hauls had 50-100 items per km². For rectangles in which two hauls were carried out, the average of the density of litter items per haul per km² is used. The white rectangles are not sampled by the Dutch survey.*

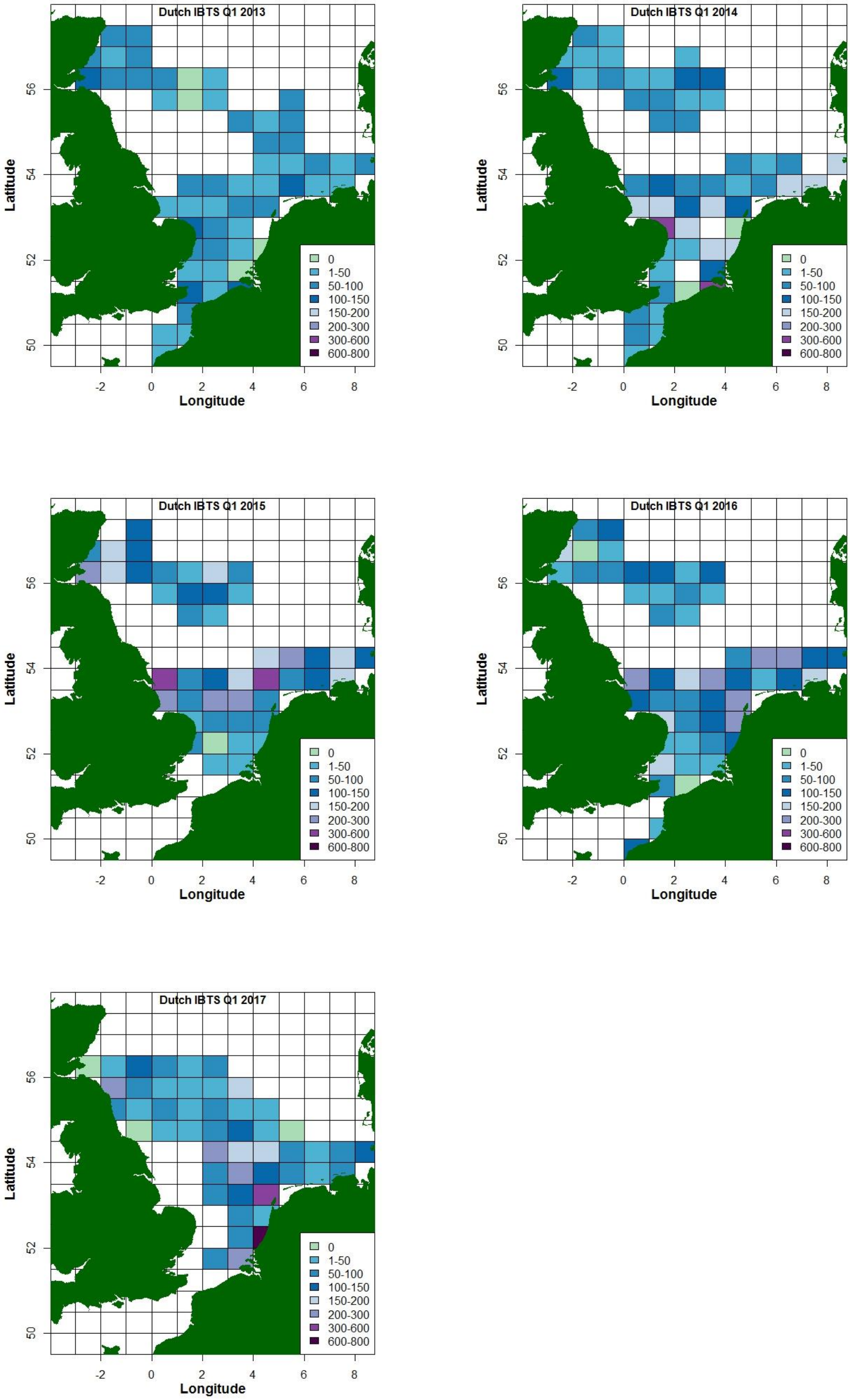

***Figure 3-7. Density of litter items per km² for the IBTS 2013, 2014, 2015, 2016 and 2017**. The colour range is the same in all maps to allow for comparison across the years. For rectangles in which two hauls were carried out, the average of the density of litter items per haul per km² is used.*

4 Discussion and Conclusions

The abundance and composition of seafloor litter in 2018 are in line with those of previous years. The seafloor litter from the catches of the Dutch IBTS Q1 2018 contained mostly plastic items: 85.2% of the total number of litter items found was plastic. Moreover, the composition of the litter itself is comparable among the years, consisting mainly of plastic sheets and various types of ropes/lines. The differences in composition found between years are most likely related to inconsistencies in recordings rather than an actual change in the types of litter. The composition is biased towards items with a larger catchability. Once pushed up into the water column by the gear, items that tend to float (e.g. lighter plastics) are more likely to be retained in the cod-end, whereas heavier items (metals, glass etc.) are more likely to drop through the larger meshes before reaching the cod-end (van der Sluis & van Hal 2014, Moriarty et al. 2016).
Differences in values between years may be attributed to inconsistencies in the categorisation of items. The decision on whether to place an item in one category over another remains a point of major discussion. This is particularly true for subcategories A5, A6 and A7. For instance, a number of synthetic ropes were collected this year. If these were single “filaments” (**Photo 3**), then the decision was made to place them under A7 (synthetic rope) and count them individually. However, these were usually entangled (**Photo 4**) and thus this posed the question of whether they should be placed under A6 (fishing line (entangled)) or under A7. Indeed, it is common consensus amongst researchers on the Tridens that these pieces of rope have their origins in dolly ropes, and therefore should not be considered “fishing line” in sensu stricto. Such items then raised a further question: should they be counted as 1 item or not?

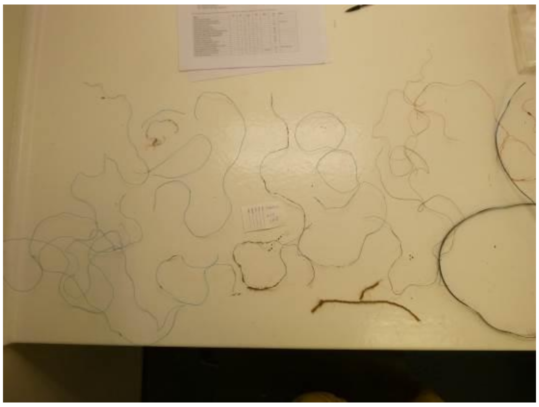

Photo 3. *Example of single filaments considered to fall under category A7 (synthetic rope), as they are not strictly speaking “fishing line” and thus should not be categorised as A5 (Fishing line (monofilament))*

Photo 4. *Example of entangled filaments considered to fall under category A7 (synthetic rope), as they are not strictly speaking “fishing line” and thus should not be categorised as A6 (Fishing line (entangled))*

This same thought process extends to other issues, such as the weighing of items. Should items be left to dry before weighing? Should organisms attached to items (as seen in **Photo 1**) be removed before weighing? Seeing as current guidelines do not provide this type of detailed information, the choice of which category to place items and how to record items remains arbitrary. Indeed, this seems to be a point of debate not only amongst those involved in the Dutch IBTS, but amongst colleagues from other countries participating in the IBTS. It is clear that there is a discrepancy in the methodology for collecting litter both between years in the Dutch IBTS and between countries. This highlights the need for sensible and straightforward guidelines for persons collecting and recording seafloor litter on board. Until the establishment and successful implementation of such guidelines, the use of data from all IBTS to determine, for instance, trends in seafloor litter, remains somewhat problematic. The development of guidelines is one of the terms of reference of the ICES Working Group of Marine Litter (WGML), which met for the first time end of April 2018. Both authors of this report participated during WGML, and have strongly advocated for more straightforward guidelines. Major steps have been made during WGML for this (ICES, 2018 in prep.).

Spatially, the amount of litter differs between the years. This is most likely a chance effect and related to differences in actual fishing location, rather than to actual differences in the amount of litter present in the North Sea. All the scientists involved in the IBTS agree that the GOV, which is not designed to catch litter, has only a small probability of catching a litter item when it is present in the trawl path. The probability varies with litter type and the size of the item. The majority of the items is small (**Figure 3-3**), even smaller than most fish for which a catchability of less than 5% is assumed, e.g. being caught randomly rather that representative (ICES 2003, Fraser et al. 2007, Piet et al. 2009). Therefore, the probability of catching these small litter items is assumed to be minute and random. Thus, the fact that these items are caught indicates that it is likely that there are many more items in the trawl path and that current values are a large underestimation of the actual litter present. Consequently, the degree of litter pollution on the seafloor is probably much larger than presented in this report. Additional work on this is shown in **Annex 3**, which compares litter catches of the IBTS with those of a Beam Trawl.

The actual fishing locations are semi-randomly chosen within a rectangle, and differ between years and with that the depth and seafloor structure which are sampled differ. Based on personal observation of the catches, it is hypothesised that the amount of litter items is determined by type of seafloor structures in the trawl path. This is likely related to the amount retained by the seafloor structures, but also the effect of habitat on the catchability of the litter items. The difference on small local scale is exemplified by the zero catch next to one of the largest catches in the Dutch coastal zone in 2014. Unfortunately, a description of habitat is not recorded (e.g. by side-scan sonar or multibeam) but it could be approximated on the basis of the fish catches or existing habitat or sediment maps. As it is not recorded it can't currently be incorporated in the analysis and the effect of sampling different habitats between years cannot be disentangled from the differences in the amount of litter present. However, the refitted Tridens has a multibeam with bathymetry option, which was positively tested during a part of the 2018 survey. This indicated that it might be possible to use the multibeam during the trawl haul and record seafloor structures without interfering with the net sensors. However, this will require a lot of additional work and analyses after the survey.

Currently, the combination of low number of trawl hauls, low number of items found per sampling station, the low probability of catching an item when it is present in the trawl path and the spatial differences in the survey between years, make it difficult to draw conclusions on the absolute amounts of litter found and to use these data in trend analysis.
An improved analysis can be carried out when the data in this report are combined with the international IBTS data, although at this moment the international data are probably inconsistent due to the lack of standardisation in the collection process, as also stated by Moriarty et al. (2016). While analysing the international data for the OSPAR assessment in 2017, it became clear that not all the countries reporting data for the North Sea actually count each litter item. Some of the countries only record the subcategory as present, rather than the number of items under that subcategory. Further analyses of these discrepancies in the international data were done during WGML 2018 (ICES, 2018 in prep.). Combining the North Sea data at this moment to create density maps is therefore not possible. The expectation was that the CEMP/JAMP protocols would provide stricter guidelines making the data collection between countries more consistent. However, as described above, these protocols still do not provide clearer guidelines on the issue of counting items.

The definition of Good Environmental Status (GES) for marine litter ultimately is that "no litter should be present in the marine environment". It is well known (Maes et al. 2018, Urban-Malinga et al. 2018) and presented here, that this is not reached and is unlikely to be reached within a short timeframe. The measures currently taken are to reduce the amount of litter in the environment and the indicators proposed for the MSFD should be able to detect a reduction in litter related to these measures.
Using only the Dutch IBTS data will not be sufficient to detect such a change over a six year period. The number of sampling stations is too low and the spatial distribution not consistent enough. This is acknowledged as the proposed OSPAR indicator combines all the international IBTS data on marine litter. The development of the database to store all the international data centrally is completed. This

database is developed by the ICES data centre and is linked to the existing DATRAS database (http://datras.ices.dk). The international data is thus available and could be combined, however as stated the current data in that database for the North Sea is not consistent in the way it is collected.

The other issue is that even if the international data are combined and the collection of litter is further standardised, it is questionable whether it will be possible to use the IBTS catches to detect changes in the amount of litter in the environment as a large number of sampling stations is required to detect a 10 to 30% change (Maes et al. 2014). This is further complicated considering the randomness with which the GOV gear samples small fish and epibenthos (ICES 2003) and most likely marine litter. This catchability problem is an issue requiring further investigation when continuing work on this indicator. Besides this, other methods for detecting changes in the amount of litter in the environment are like to be more prosperous. A dedicated survey, possibly on hotspot where litter is likely to be gathered by the dominant currents, might be more likely to provide the requested answers.

5 Recommendations

- Develop a dedicated survey method
- Create more consistency in the Dutch and international IBTS litter data, e.g. stricter guidelines in the manual including photographic examples. The latter might also reduce the difference in interpretation between individual observers. In addition, an international training session within the North Sea is recommended now that the CEMP guideline is available.
- Redo the types of analyses presented in this report on the combined international dataset.
- Develop a protocol to use the seafloor structure as additional metadata for the sea floor litter data and combine the data with distribution and transport models.
- Analyse the relation between litter occurrence, seafloor structure and other spatial variables to find out to what extend litter occurs differently in different habitats.
- Analyse the catch efficiency for seafloor litter of the GOV.
- Further investigate the differences in seafloor litter catch efficiency of the GOV and beam trawl gears, and to further establish/corroborate a correction factor for this. So that the data of both surveys could be combined increasing the amount of information available.

6 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

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Justification

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The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Marcel J.C. Rozemeijer
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Date: 24 July 2018

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Annex 1 Data tables with sea floor litter monitoring data of Dutch IBTS Q1 2018

Annex 1 table 1. Complete trawl list of the Dutch IBTS Q1 2018, in which the total number of items (Number of items) and the density (Items km^2) per haul are reported. *Sample represents the haul number; latitude_s and longitude_s represent the coordinates at the start of each haul; latitude_h and longitude_h represent the coordinates at the end of each haul; Items km^2 is sum of all litter items divided by the fished surface (Bottom track * Wingspread).*

Ship	Country	ICES rectangle	sample	latitude_s	latitude_h	longitude_s	longitude_h	Water depth	BOTTOM TRACK	WING SPREAD	Number of items	Items km^2
Tri2	NED	34F4	3400001	52.659	52.68783	4.184	4.19267	20.8	3263	19.4592	5	78.7459
Tri2	NED	35F4	3400002	53.02083	53.05183	4.30217	4.31333	27.6	3645	19.6479	5	69.81622
Tri2	NED	36F6	3400003	53.81317	53.80633	6.61167	6.664	15.2	3493	18.7044	4	61.223425
Tri2	NED	36F7	3400004	53.865	53.87717	7.07583	7.1365	18.7	4181	18.8931	20	253.190033
Tri2	NED	37F7	3400005	54.26983	54.27717	7.43833	7.50483	36.2	4403	19.8366	5	57.247178
Tri2	NED	37F8	3400006	54.39217	54.371	8.08467	8.047	14.8	3460	18.327	4	63.08012
Tri2	NED	37F6	3400007	54.23967	54.25483	6.15817	6.208	34.6	3645	20.0253	2	27.400181
Tri2	NED	37F5	3400008	54.298	54.31617	5.236	5.28317	39.2	3673	20.7801	7	91.7127
Tri2	NED	36F5	3400009	53.93633	53.96317	5.24933	5.294	35	4186	20.5914	7	81.210641
Tri2	NED	36F4	3400010	53.89367	53.92067	4.85267	4.90167	36.8	4387	20.0253	9	102.446198
Tri2	NED	37F4	3400011	54.10633	54.12917	4.839	4.88633	40.7	4021	20.5914	1	12.077584
Tri2	NED	33F3	3400012	52.28817	52.32933	3.96517	3.958	20.4	4656	18.5157	4	46.398814
Tri2	NED	34F3	3400013	52.60517	52.64317	3.9675	3.968	23.7	4239	18.8931	9	112.376595
Tri2	NED	38F2	3400014	54.72633	54.71617	2.5545	2.61067	16.1	3754	18.1383	11	161.548093
Tri2	NED	38F3	3400015	54.83417	54.85883	3.12767	3.19267	30.7	3128	20.4027	2	31.338313
Tri2	NED	39F3	3400016	55.13933	55.15783	3.6405	3.6855	35.9	3568	20.0253	3	41.987245
Tri2	NED	39F2	3400017	55.40967	55.42883	2.78367	2.837	36.5	4015	19.0818	3	39.157627
Tri2	NED	39F0	3400018	55.31183	55.30383	0.10083	0.156	74.7	3605	22.6671	2	24.475342
Tri2	NED	39E9	3400019	55.367	55.3665	-0.17267	-0.17017	69.9	NA	21.1575	NA	NA
Tri2	NED	41E7	3400020	56.41633	56.39	-2.07517	-2.086	46.2	3063	20.214	1	16.151049
Tri2	NED	41E8	3400021	56.286	56.2575	-1.52367	-1.49083	48.7	3735	21.1575	0	0
Tri2	NED	41E9	3400022	56.40417	56.37617	-0.482	-0.4815	71	3100	20.9688	3	46.151517
Tri2	NED	41E9	3400023	56.20483	56.1765	-0.44	-0.42167	61.8	3333	21.1575	3	42.542361
Tri2	NED	40E9	3400024	55.85383	55.85217	-0.70783	-0.64533	68.6	3888	22.101	0	0
Tri2	NED	40E9	3400025	55.60833	55.56717	-0.802	-0.80167	97	4577	22.6671	1	9.638804
Tri2	NED	38E9	3400026	54.92333	54.90483	-0.87267	-0.823	64.6	3805	22.2897	1	11.790741
Tri2	NED	39E8	3400027	55.37133	55.404	-1.0965	-1.12817	91.6	4168	5.8728	1	10.509808
Tri2	NED	40E8	3400028	55.55583	55.596	-1.1185	-1.118	94.8	4433	5.8728	0	0
Tri2	NED	40E8	3400029	55.9115	55.9475	-1.14433	-1.12417	81.2	4186	5.8728	0	0
Tri2	NED	41F0	3400030	56.37883	56.3815	0.2165	0.27783	85.2	3783	5.8728	3	34.975023
Tri2	NED	41F0	3400031	56.242	56.21567	0.508	0.5355	84.5	3375	21.1575	0	0
Tri2	NED	40F0	3400032	55.836	55.811	0.51967	0.5455	86.5	3219	21.1575	2	29.365992
Tri2	NED	40F0	3400033	55.6725	55.642	0.68817	0.69033	63	3396	19.8366	0	0
Tri2	NED	40F1	3400034	55.5955	55.61533	1.27	1.31083	77.4	3402	20.9688	1	14.018196
Tri2	NED	40F1	3400035	55.85083	55.8225	1.77067	1.78767	82	3301	21.7236	1	13.945134

Tri2	NED	41F1	3400036	56.12167	56.139	1.50533	1.55683	79.6	3758	21.7236	1	12.249304
Tri2	NED	41F1	3400037	56.27117	56.27267	1.80717	1.86583	82.1	3629	22.101	1	12.468124
Tri2	NED	41F2	3400038	56.25883	56.23	2.29	2.26933	76.3	3448	21.7236	0	0
Tri2	NED	41F2	3400039	56.18167	56.158	2.5235	2.4865	74.5	3447	21.3462	3	40.771754
Tri2	NED	38F5	3400040	54.75033	54.741	5.5825	5.629	38.8	3187	19.0818	2	32.887328
Tri2	NED	38F5	3400041	54.67633	54.65967	5.21933	5.17817	41.6	3253	17.9496	3	51.378618
Tri2	NED	38F4	3400042	54.78567	54.76917	4.94133	4.902	39.9	3182	17.7609	3	53.08308
Tri2	NED	38F4	3400043	54.8975	54.88067	4.5115	4.55883	41.2	3559	18.8931	1	14.87198
Tri2	NED	35F3	3400044	53.0665	53.1025	3.81917	3.8175	22.7	4034	18.7044	4	53.012748
Tri2	NED	38F0	3400045	54.72767	54.7685	0.7545	0.7555	75.8	4528	22.101	0	0
Tri2	NED	38F1	3400046	54.8175	54.85283	1.15317	1.156	42.5	3969	19.4592	1	12.947738
Tri2	NED	39F1	3400047	55.13583	55.15967	1.30483	1.3245	49.5	2949	18.8931	0	0
Tri2	NED	40F2	3400048	55.52083	55.54533	2.05283	2.08617	68.5	3476	19.8366	3	43.508514
Tri2	NED	41F3	3400049	56.06933	56.09633	3.42233	3.40267	68.1	3289	19.6479	1	15.47462
Tri2	NED	35F2	3400050	53.11667	53.15633	2.72033	2.69833	29.3	4685	20.0253	0	0
Tri2	NED	40F3	3400051	55.66883	55.6505	3.32567	3.37133	39.9	3511	18.7044	2	30.454774
Tri2	NED	39F4	3400052	55.40383	55.4085	4.08467	4.14183	31.9	3654	18.327	4	59.731039
Tri2	NED	37F3	3400053	54.47233	54.44417	3.32667	3.32617	38.6	3135	18.327	1	17.404882
Tri2	NED	37F2	3400054	54.2505	54.24467	2.84767	2.79733	45.6	3358	18.7044	4	63.68476
Tri2	NED	36F2	3400055	53.66133	53.636	2.88033	2.88183	33.5	2800	17.3835	5	102.724669
Tri2	NED	36F3	3400056	53.5855	53.564	3.14433	3.17233	32.5	3007	17.5722	3	56.775594

Annex 1 table 2. Complete litter list of the Dutch IBTS Q1 2018. For every haul, each litter item is categorised per type and size category. *Sample represents the haul number; Litter type and Size category are the subcategory and size class, respectively, assigned to each litter item as per Table 2-1. Additional information such as description, weight (g) if applicable, and the presence/absence of attached organisms are also recorded.*

Sample	Date	Litter Type (A1; B2; C…)	Description (Label/ Brand)	Size category (A; B; C..)	Weight (g)	Attached organisms (yes/no)	Number of items
3400001	22/1/2018	F1	Navy NY baseball cap	C	150.00	Y	1
3400001	22/1/2018	A7	Orange synthetic rope	B	24.00	N	1
3400001	22/1/2018	A9	Black cable tie	A	2.00	N	1
3400001	22/1/2018	A2	Candy wrapper	A		N	1
3400001	22/1/2018	A14	Black tape	A		N	1
3400002	22/1/2018	A7	Blue synthetic rope	B	3.00	N	1
3400002	22/1/2018	A2	Clear, colourless sheet	A		Y	1
3400002	22/1/2018	A7	Blue synthetic rope	A		N	1
3400002	22/1/2018	A7	Orange synthetic rope	A		N	2
3400003	23/1/2018	E2	Rope	A		N	3
3400003	23/1/2018	E2	Rope	A		Y	1
3400004	23/1/2018	A10	Blue strapping band	A	4.50	Y	1
3400004	23/1/2018	A2	Clear, colourless sheet	B	2.00	N	1
3400004	23/1/2018	A7	Orange synthetic rope	A	1.00	N	1
3400004	23/1/2018	A7	Blue synthetic rope	A		Y	10
3400004	23/1/2018	A7	Black synthetic rope	A		Y	1
3400004	23/1/2018	A7	Brown synthetic rope	A		Y	2
3400004	23/1/2018	A7	Orange synthetic rope	A		Y	2
3400004	23/1/2018	E2	Rope	A		Y	2

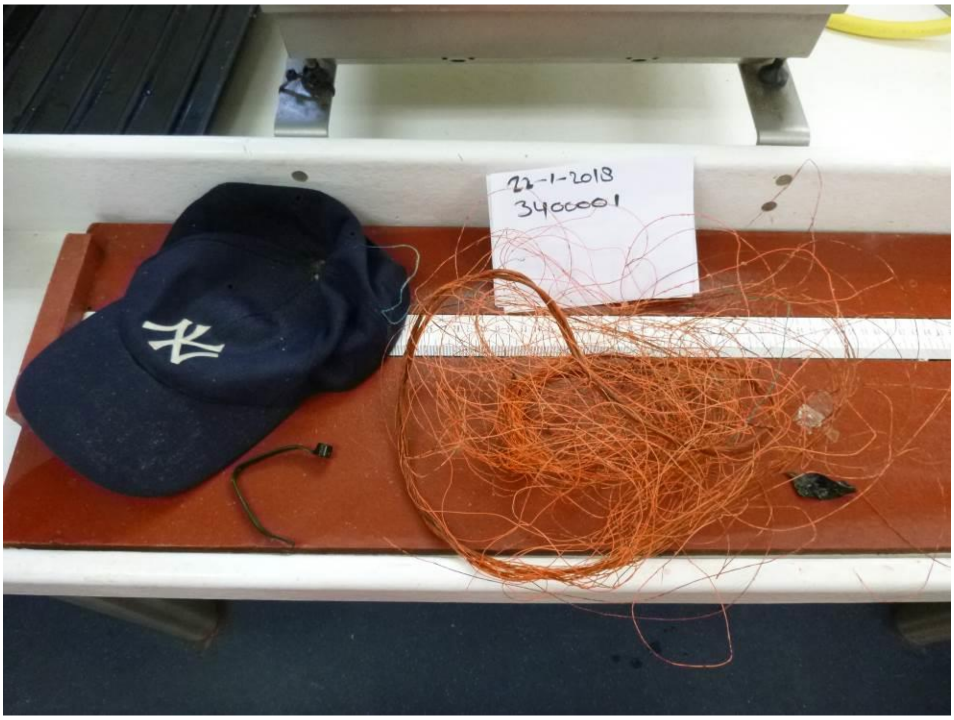
3400005	23/1/2018	E2	Rope	A	7.00	N	1
3400005	23/1/2018	A2	Clear, colourless sheet	C	4.00	Y	1
3400005	23/1/2018	A7	Blue synthetic rope	A		N	1
3400005	23/1/2018	A7	Black synthetic rope	A		N	1
3400005	23/1/2018	A7	Orange synthetic rope	A		N	1
3400006	23/1/2018	E2	Rope	A	8	N	1
3400006	23/1/2018	A7	Blue synthetic rope	A		N	2
3400006	23/1/2018	A7	Black synthetic rope	A		N	1
3400007	24/1/2018	A7	Orange synthetic rope	A		N	1
3400007	24/1/2018	A2	Clear, colourless sheet with "informatiq"	A		N	1
3400008	25/1/2018	A14	Orange (fruit) packaging	C	752	Y	1
3400008	25/1/2018	A7	Entangled synthetic rope (orange; black; blue)	B	338	Y	1
3400008	25/1/2018	A2	Clear, colourless sheet	B	167	Y	1
3400008	25/1/2018	A2	Clear, colourless sheet	B	5	Y	1
3400008	25/1/2018	A2	Clear, colourless sheet	A	5	Y	1
3400008	25/1/2018	E2	Rope	A	3	N	1
3400008	25/1/2018	A10	Strapping band	A	2	Y	1
3400009	25/1/2018	A2	Clear, colourless sheet	B	5	Y	1
3400009	25/1/2018	A2	Milkybar packaging	B	3	N	1
3400009	25/1/2018	A10	Black strapping band	A	3	Y	1
3400009	25/1/2018	A7	Blue synthetic rope	A		N	1
3400009	25/1/2018	A2	Danone packaging	A		N	1
3400009	25/1/2018	A2	Clear, colourless sheet	A		N	1
3400009	25/1/2018	C2	Grey metallic balloon piece	A		N	1
3400010	25/1/2018	A2	Clear, colourless sheet	D	380	Y	2
3400010	25/1/2018	A2	Blue sheet	A	19	N	1
3400010	25/1/2018	A7	Synthetic rope	A	3	Y	1
3400010	25/1/2018	A7	Blue synthetic rope	A		N	2
3400010	25/1/2018	E3	Green paper	A		N	1
3400010	25/1/2018	A7	Orange synthetic rope	A		N	2
3400011	25/1/2018	A7	Entangled synthetic rope (blue; orange; turquoise; black; orange)	B	48	Y	1
3400012	29/1/2018	A7	Blue synthetic rope	A		N	1
3400012	29/1/2018	A2	Clear, colourless sheet	A		Y	1
3400012	29/1/2018	A5	Gillnet	A		N	1
3400012	29/1/2018	A7	Brown synthetic rope	A		N	1
3400013	29/1/2018	A3	White (part of bag)	C	4	N	1
3400013	29/1/2018	A2	Candy wrapper	A	1	N	1
3400013	29/1/2018	A2	White sheet	A	1	Y	2
3400013	29/1/2018	A7	Blue synthetic rope	A	1	N	2
3400013	29/1/2018	A7	Green synthetic rope	A	1	N	1
3400013	29/1/2018	A7	Orange synthetic rope	A	1	N	1
3400013	29/1/2018	A5	White monofilament	A		N	1
3400014	30/1/2018	F3	Cigarette filter	A	1	N	1
3400014	30/1/2018	A2	Clear, colourless sheet	A		Y	1
3400014	30/1/2018	A7	Blue synthetic rope	A		N	5
3400014	30/1/2018	A7	Orange synthetic rope	A		N	3
3400014	30/1/2018	A7	Black synthetic rope	A		N	1

3400015	30/1/2018	A7	Blue synthetic rope	A		N	1
3400015	30/1/2018	A7	Orange synthetic rope	A		N	1
3400016	30/1/2018	A2	Clear, colourless sheet	B	5	Y	2
3400016	30/1/2018	A7	Orange synthetic rope	A		N	1
3400017	30/1/2018	A7	Entangled rope (orange)	C	280	Y	1
3400017	30/1/2018	A7	Blue synthetic rope	A		N	1
3400017	30/1/2018	A7	Orange synthetic rope	A		N	1
3400018	31/1/2018	C2	Pink balloon	A		N	1
3400018	31/1/2018	A7	Blue synthetic rope	A		N	1
3400019	31/1/2018	EMPTY					
3400020	1/2/2018	A2	Yellow sheet	A	19	N	1
3400021	1/2/2018	EMPTY					
3400022	1/2/2018	A2	Blue sheet	B	3	N	1
3400022	2/2/2018	A7	Blue synthetic rope	A		Y	1
3400022	2/2/2018	A7	Orange synthetic rope	A		Y	1
3400023	2/2/2018	A8	Fishing net+rope	C	1550	Y	1
3400023	2/2/2018	F1	Sock	B	53	N	1
3400023	2/2/2018	C6	Green fragments	B	20	N	1
3400024	2/2/2018	EMPTY					
3400025	2/2/2018	C5	Orange rubber glove	B	69	N	1
3400026	3/2/2018	A2	Blue sheet	A	1	N	1
3400027	5/2/2018	A3	Black sheet (binliner)	C	119	N	1
3400028	5/2/2018	EMPTY					
3400029	5/2/2018	EMPTY					
3400030	6/2/2018	F1	Black glove	B	154	N	1
3400030	6/2/2018	A2	Clear, colourless sheet	C	59	N	1
3400030	6/2/2018	A2	Blue sheet	A		N	1
3400031	6/2/2018	EMPTY					
3400032	6/2/2018	A3	White sheet (probably from a bag)	A	2	N	2
3400033	6/2/2018	EMPTY					
3400034	6/2/2018	A6	White gillnet; very entangled	B	99	Y	1
3400035	7/2/2018	A7	Orange synthetic rope	A		N	1
3400036	7/2/2018	A7	White intertwined rope	A	1	N	1
3400037	7/2/2018	A7	Green synthetic rope	B	45	N	1
3400038	7/2/2018	EMPTY					
3400039	7/2/2018	F1	Piece from fleece jacket inc. zipper	B	220	Y	1
3400039	7/2/2018	A11	Jerry can	C	179	Y	1
3400039	7/2/2018	A3	Black bin liner	D	27	N	1
3400040	8/2/2018	A7	Entangled rope	D	8000	N	1
3400040	8/2/2018	A7	Blue synthetic rope	A		Y	1
3400041	8/2/2018	E2	3 large ropes tied together	D	1150	Y	1
3400041	8/2/2018	A6	Entangled rope & fishing line	C	420	Y	1
3400041	8/2/2018	A3	Clear bag	C	33	Y	1
3400042	8/2/2018	A3	White sheet (probably from a bag)	B		N	1
3400042	8/2/2018	A14	Yellow fragments	A		N	2
3400043	8/2/2018	F3	Blue/green canvas entity	C	800	N	1
3400044	12/2/2018	A7	White synthetic rope	A	8	Y	2

3400044	12/2/2018	A2	Clear, colourless sheet	B	5	N	1
3400044	12/2/2018	A7	Green synthetic rope	A		N	1
3400045	13/2/2018	EMPTY					
3400046	13/2/2018	A7	Light blue synthetic tope	A		N	1
3400047	13/2/2018	EMPTY					
3400048	13/2/2018	A7	Entangled rope	A	3	Y	1
3400048	13/2/2018	A7	White synthetic rope	A	2	N	2
3400049	14/2/2018	A3	Black sheet (binliner)	B	2	N	1
3400050	19/2/2018	EMPTY					
3400051	20/2/2018	A6	Entangled fishing line	D	2300	Y	1
3400051	20/2/2018	A2	Boy Bawang Cornick (candy wrapper)	B	2	N	1
3400052	20/2/2018	E1	Wood	A	19	N	1
3400052	20/2/2018	A7	Orange synthetic rope	A	1	N	1
3400052	20/2/2018	A2	Clear, colourless sheet	A	1	N	1
3400052	20/2/2018	A7	Synthetic rope	A	1	N	1
3400053	21/2/2018	E1	Wood fragments	B	118	Y	1
3400054	21/2/2018	A14	Green fragment	A		N	1
3400054	21/2/2018	A5	Monofilament	A		N	1
3400054	21/2/2018	E2	Rope	A	10	N	1
3400054	22/2/2018	A10	Strapping band	C	805	N	1
3400055	22/2/2018	A2	Clear, colourless sheet	B	16	Y	1
3400055	22/2/2018	A2	Sheet	B	9	Y	1
3400055	22/2/2018	A2	White sheet (strip)	A	3	Y	1
3400055	22/2/2018	A9	Black cable tie	A	5	N	1
3400055	22/2/2018	A7	Blue synthetic rope	A	1	N	1
3400056	22/2/2018	A2	Clear, colourless sheet	A	1	Y	1
3400056	22/2/2018	A7	Synthetic rope	A	1	n	1
3400056	22/2/2018	A7	White synthetic rope	A	1	n	1

Annex 2 Photos of seafloor litter in the Dutch IBTS Q1 2018

Photos are captioned as follows:
Haul number: General description (subcategory) [from left to right and top to bottom]

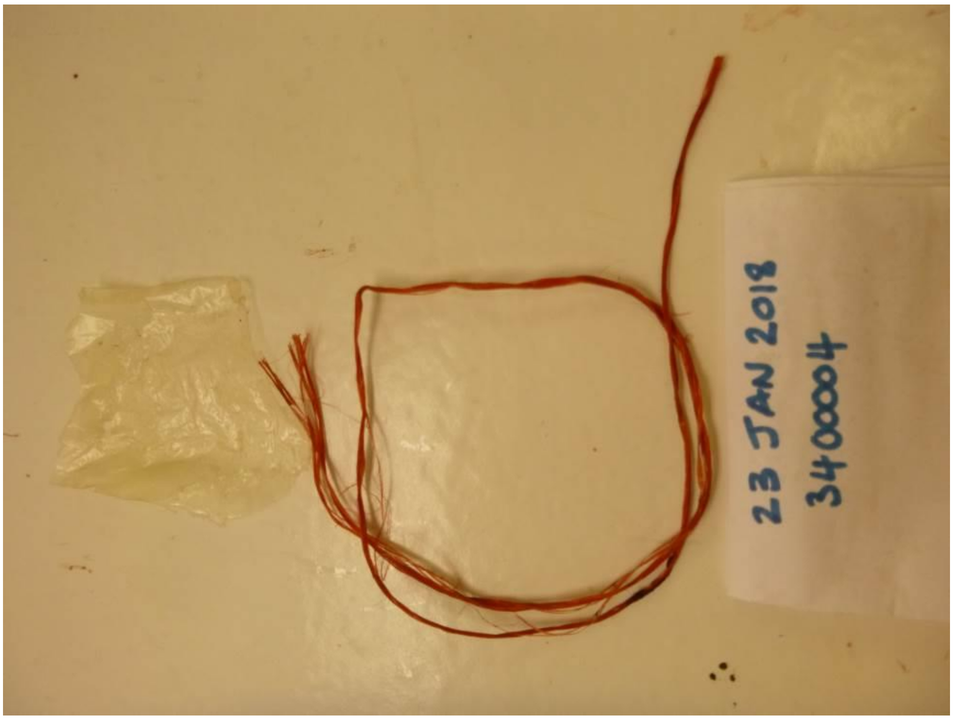


Haul 3400001: baseball cap (F1), cable tie (A9), synthetic rope (A7),
candy wrapper (A2) and plastic tape (A14)

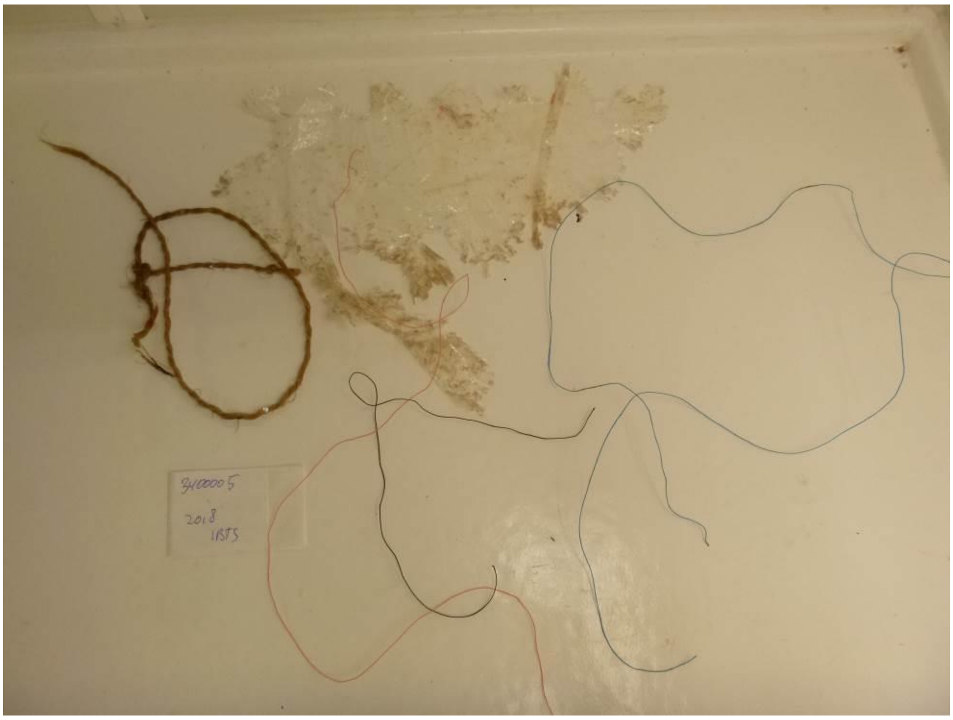
Haul 3400002: synthetic rope x2 (A7) and plastic sheet (with bryozoa) (A2)

Haul 3400003: Rope (E2)

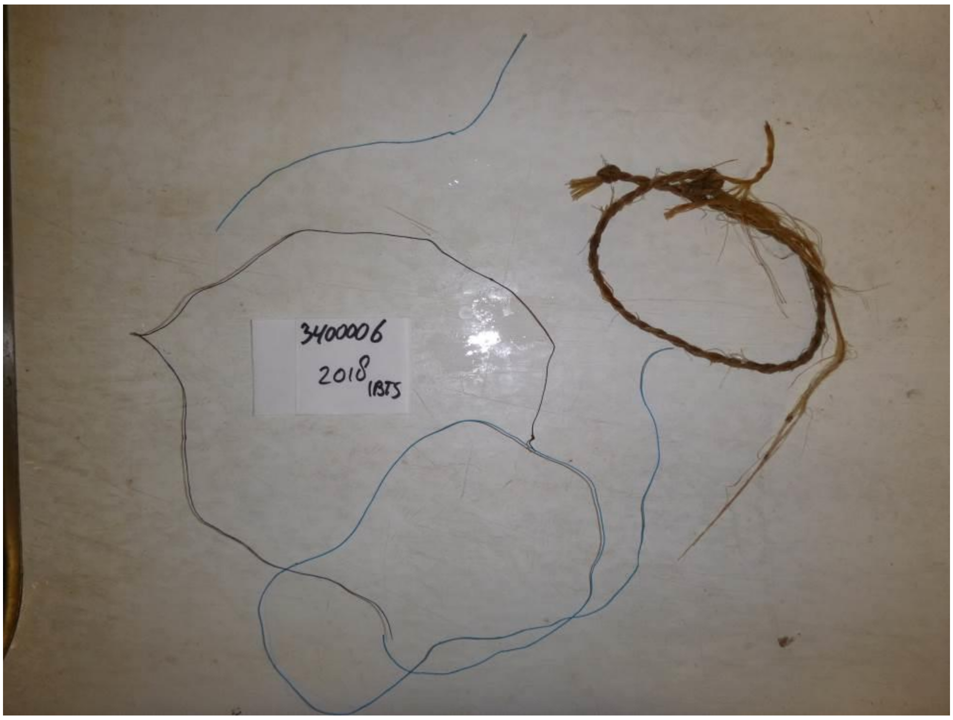
Haul 3400004: Selection of synthetic ropes (A7), rope (E2), strapping band (A10)



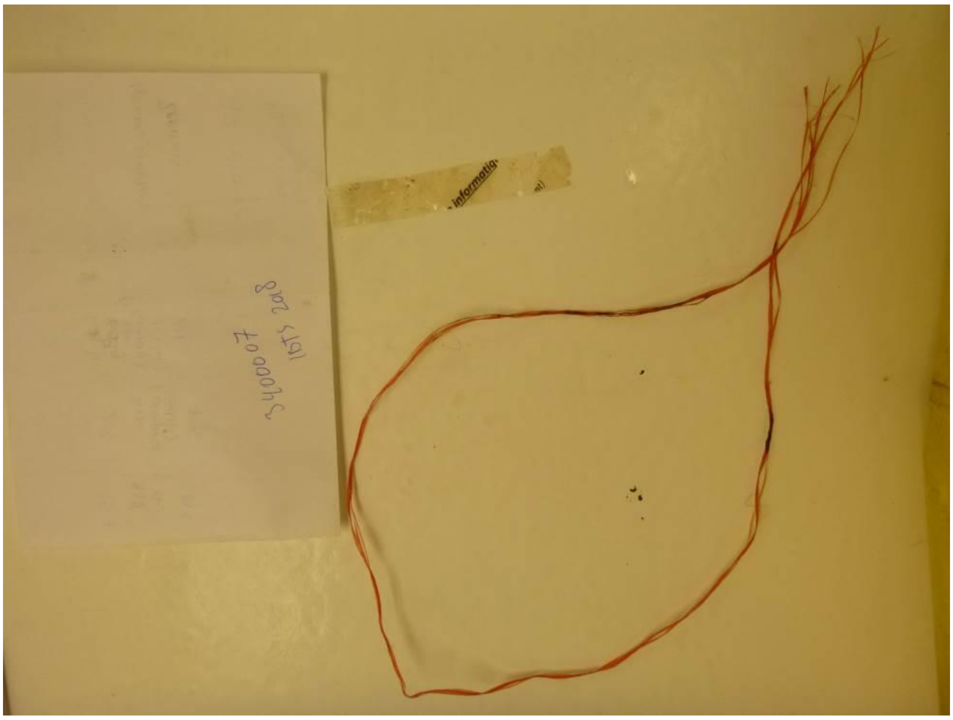
Haul 3400004: plastic sheet (A2) and synthetic rope (A7)



Haul 3400005: rope (E2), plastic sheet (A2) and synthetic rope x3 (A7)

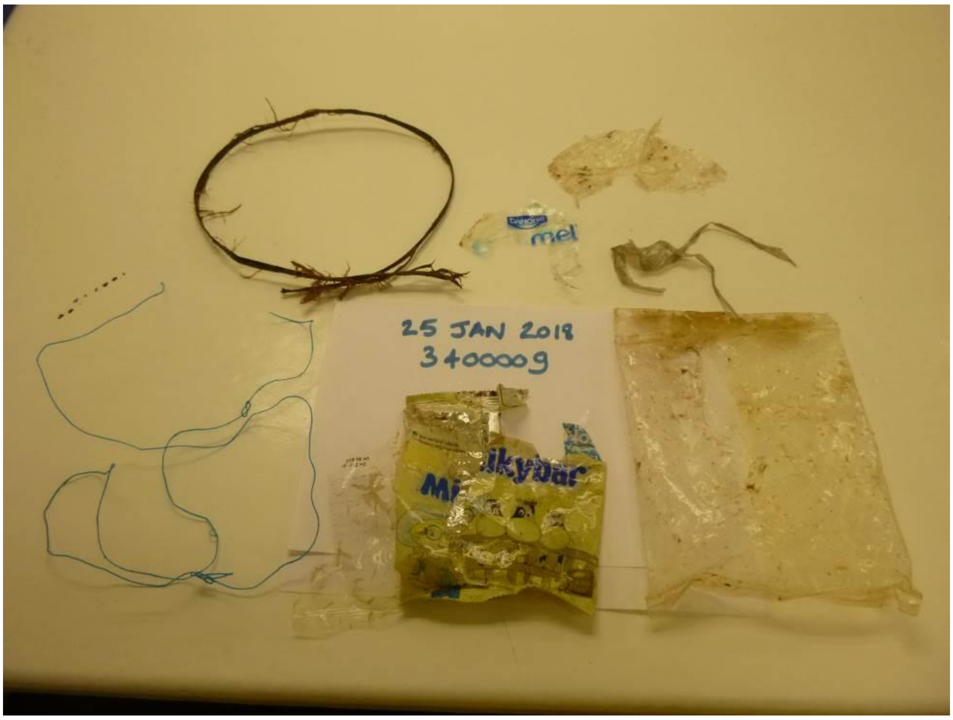


Haul 3400006: synthetic rope x3 (A7) and rope (E2)

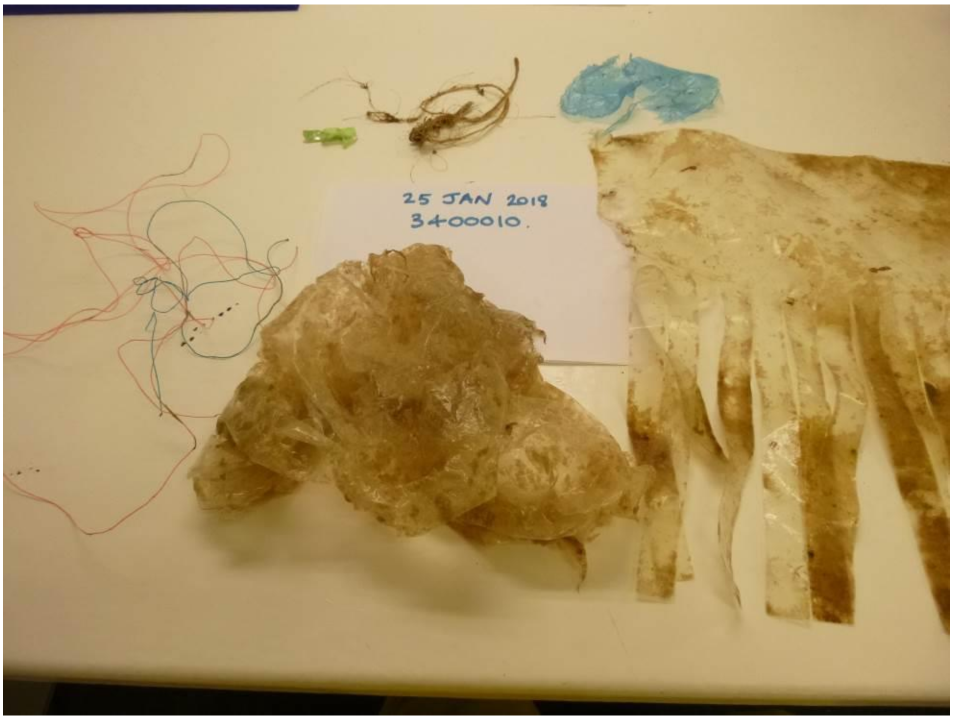


Haul 3400007: plastic sheet (A2) and synthetic rope (A7)

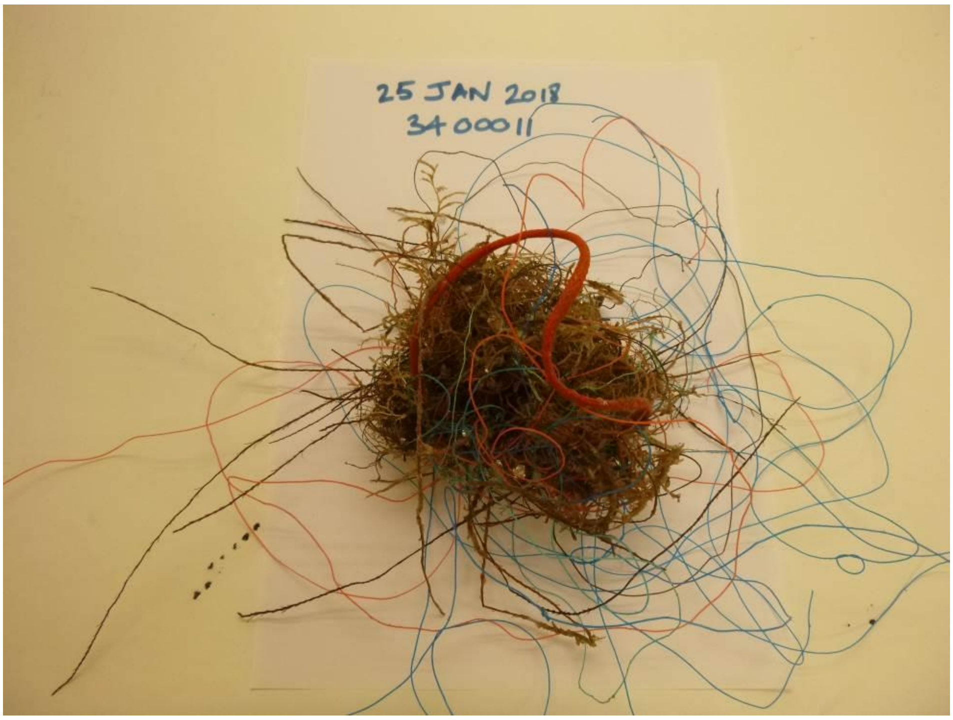
Haul 3400008: plastic sheet (A2), rope (E2), strapping band (A10), fruit packaging (A14), plastic sheet (A2) and entangled rope (A7)



Haul 3400009: synthetic rope (A7), strapping band (A10), Milkybar packaging (A2), Danone packaging (A2), plastic sheet x2 (A2) and balloon (C2)

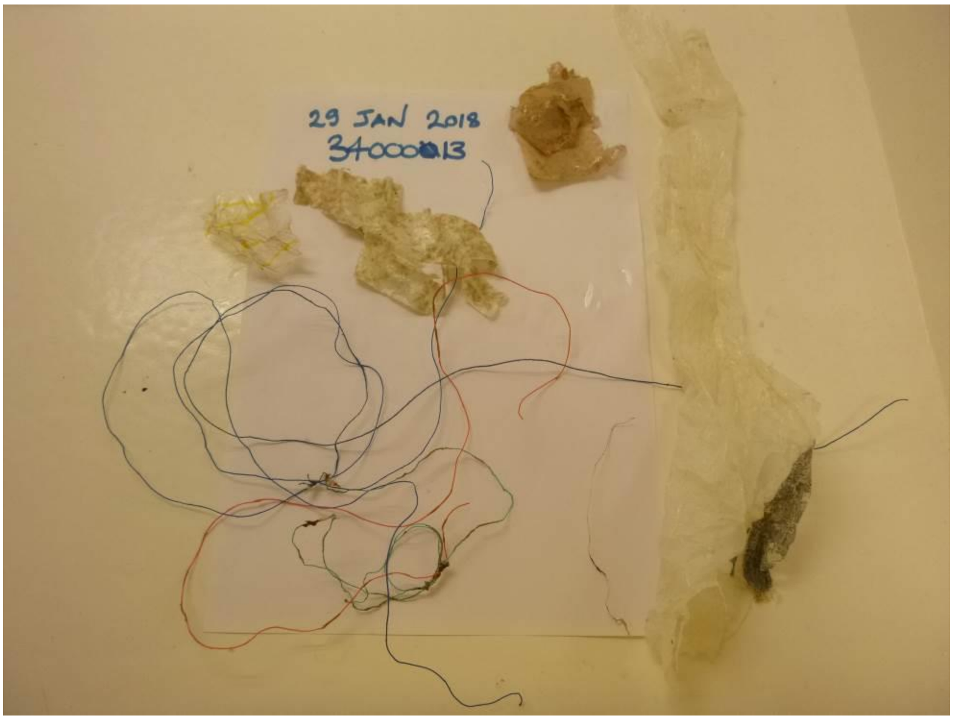


Haul 3400010: synthetic ropes x5 (A7), green paper (E3), plastic sheet x3 (A2)



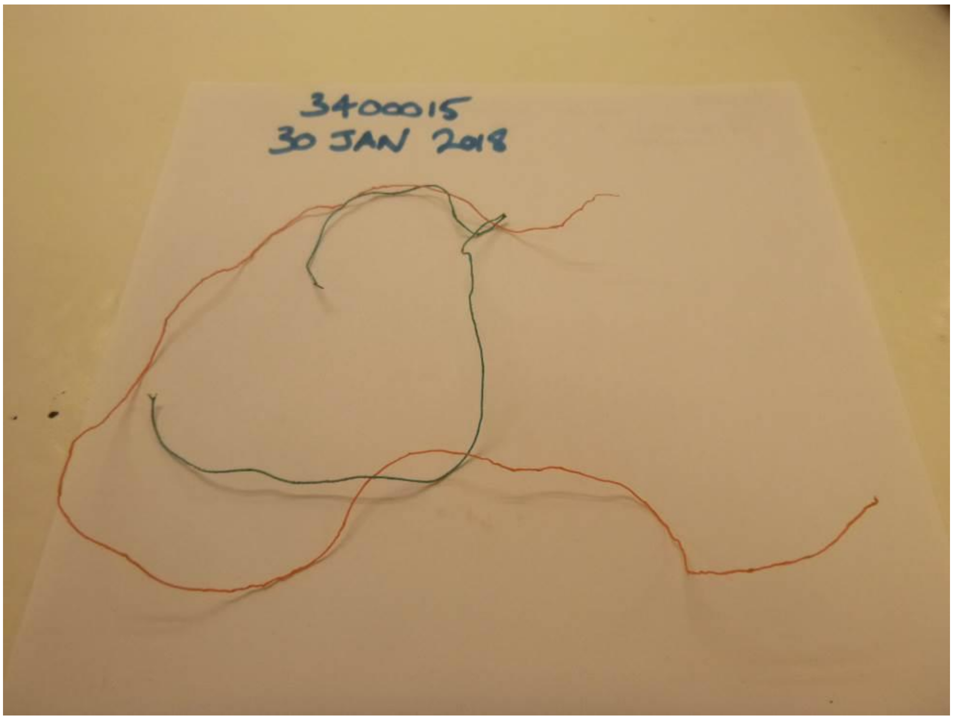
Haul 3400011: entangled synthetic rope (A7)

Haul 3400012: synthetic rope x2 (A7), plastic sheet (A2) and gillnet (A5)

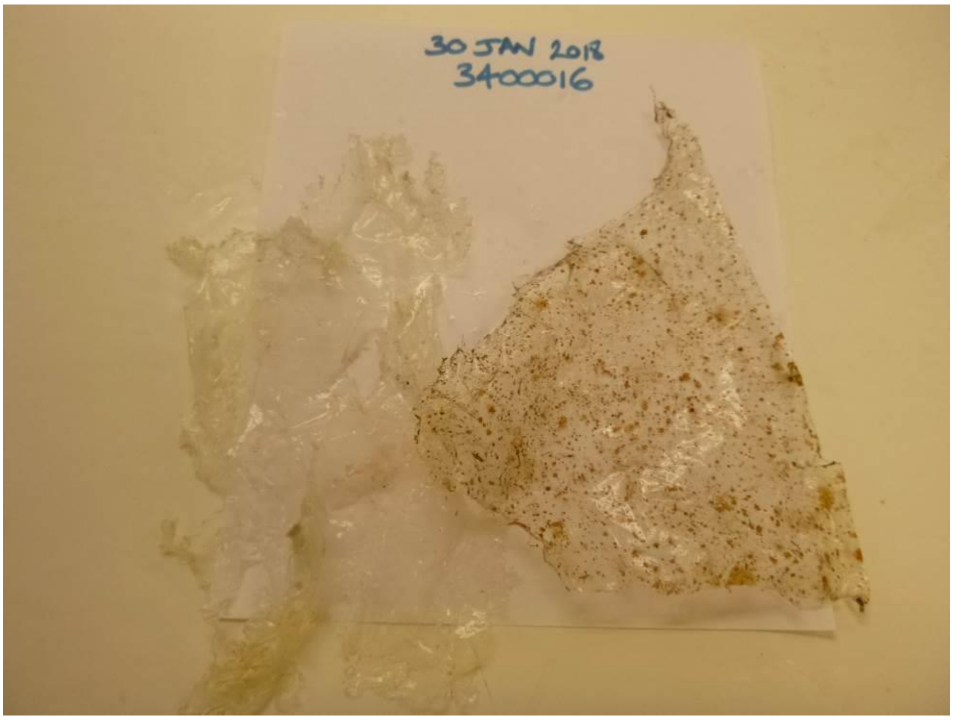


Haul 3400013: synthetic rope (A7), candy wrapper (A2), plastic sheet x2 (A2), monofilament (A5) and part of plastic bag (A3)

Haul 3400014: synthetic ropes (A7), plastic sheet (A2) and cigarette filter (F3)

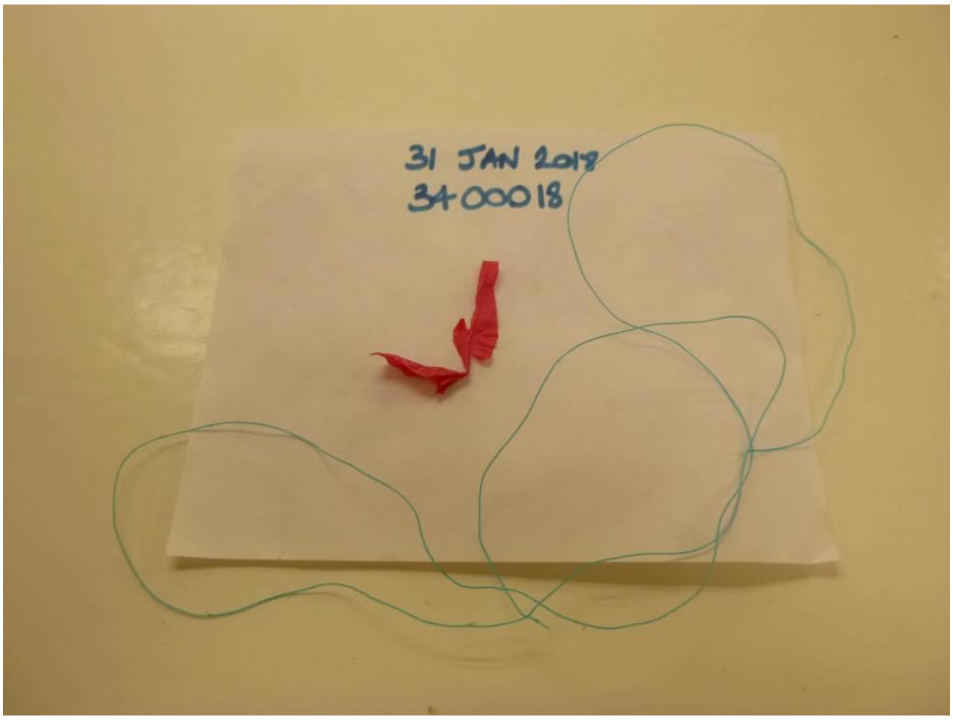


Haul 3400015: synthetic rope x2 (A7)

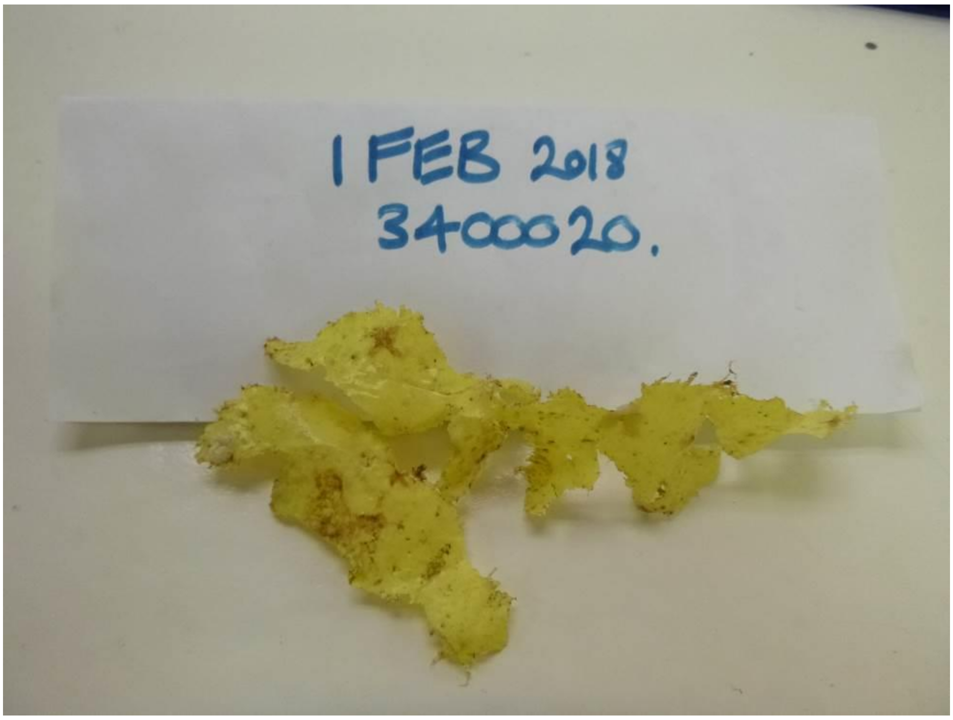


Haul 3400016: plastic sheet x2 (A7)

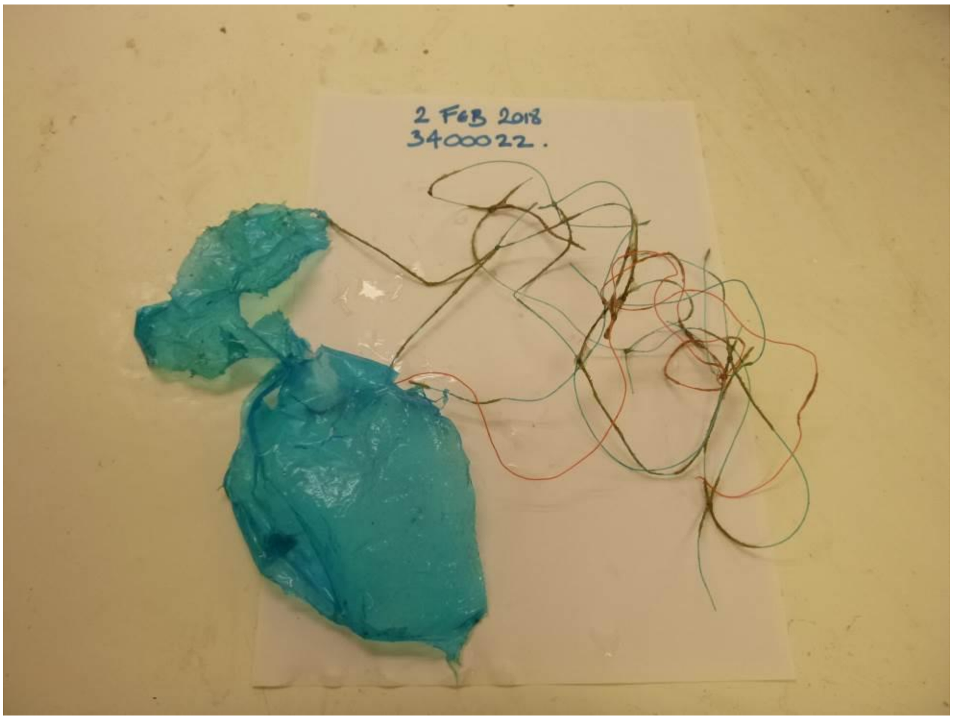
Haul 3400017: synthetic and entangle rope (all A7)



Haul 3400018: synthetic rope (A7) and pink balloon (C2)



Haul 3400020: plastic sheet (A2)



Haul 3400022: plastic sheet (A2) and synthetic ropes (A7)

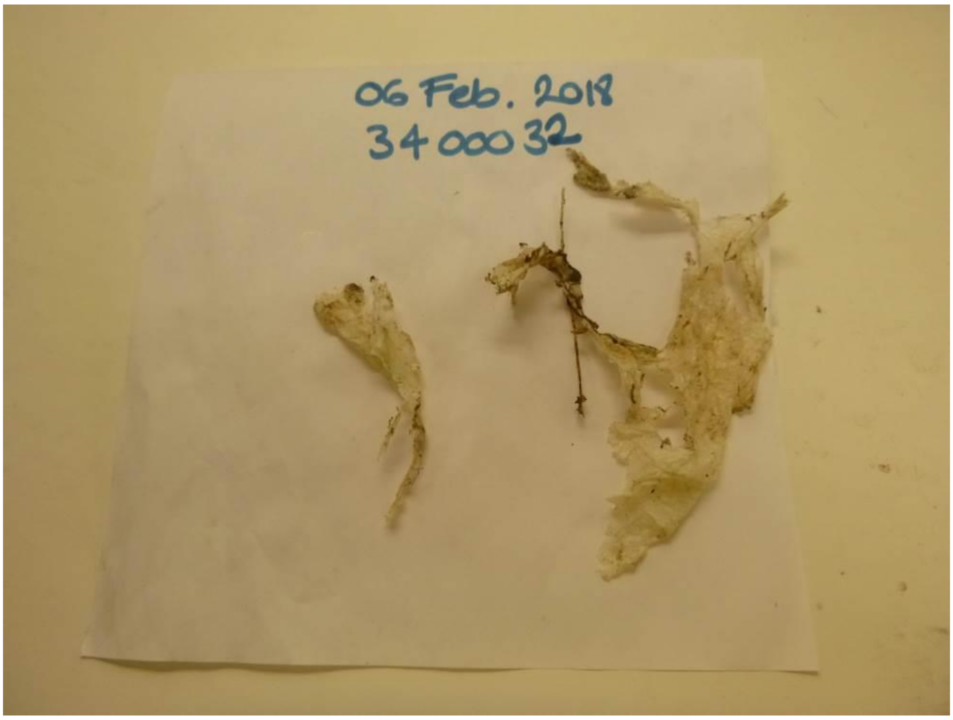
Haul 3400023: fishing net (A8), rubber fragments (C6) and sock (F1)

Haul 3400025: rubber glove (C5)

Haul 3400026: plastic sheet (A2)

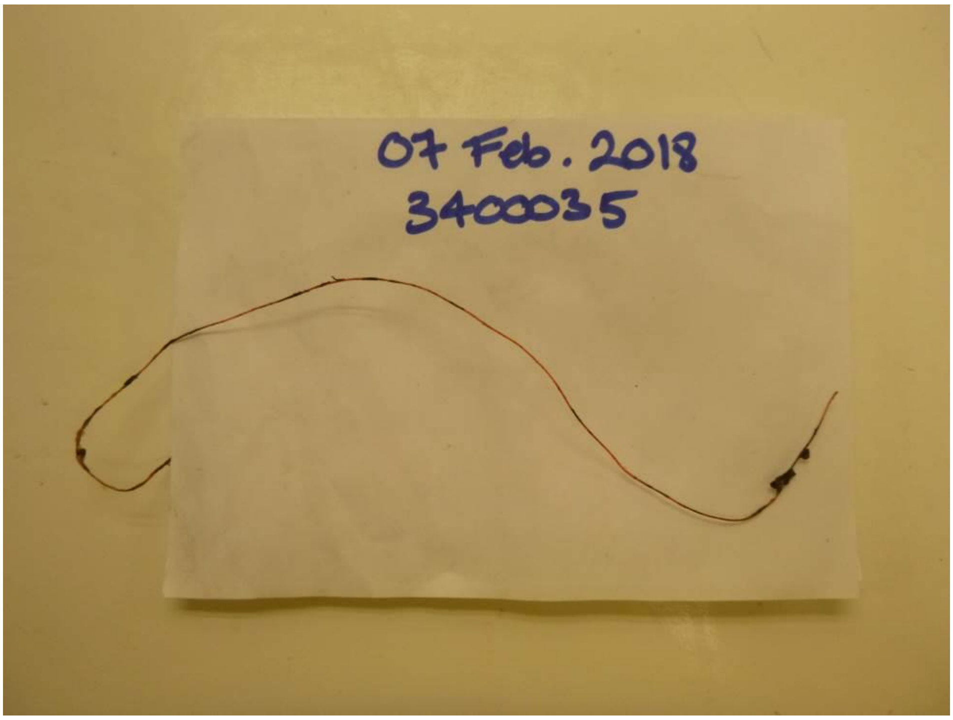
Haul 3400027: black sheet as part of binliner (A3)

Haul 3400030: glove (F1) and plastic sheet x2 (A7)



Haul 3400032: sheet probably from plastic bag (A3)

Haul 3400034: entangled gillnet (A6)



Haul 3400035: synthetic rope (A7)

Haul 3400036: synthetic rope (A2)

Haul 3400037: synthetic rope (A7)


Haul 3400039: binliner (A3), jerry can (A11) and part of fleece jacket (F1)


Haul 3400040: entangled rope (A7)

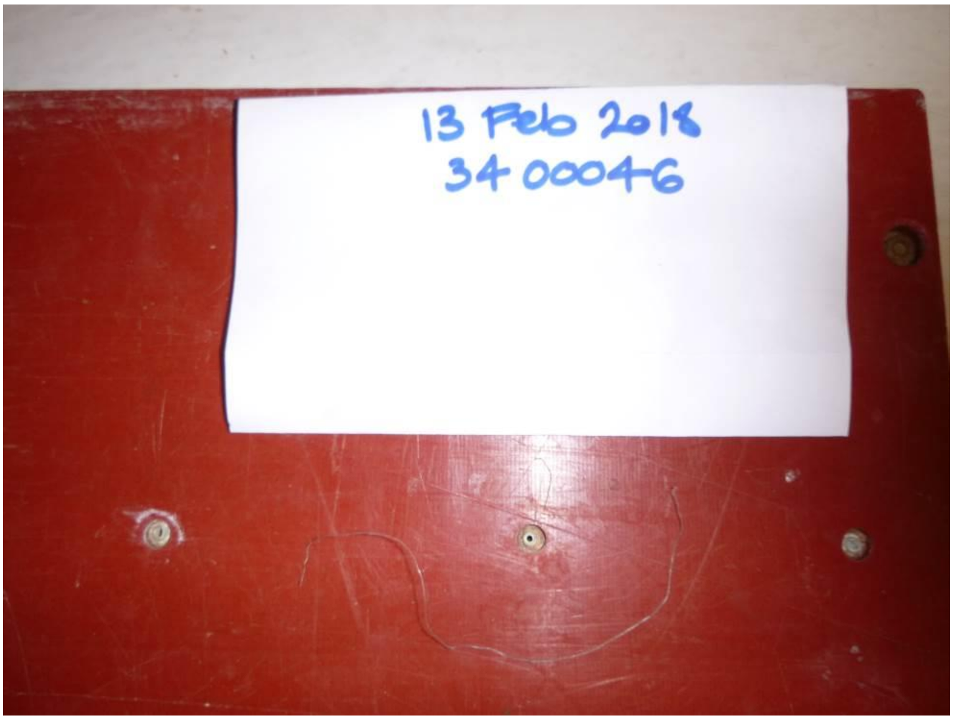
Haul 3400040: synthetic rope (A7)

Haul 3400041: ropes (E2), plastic sheet (A2) and entangled rope and fishing line (A6)

Haul 3400042: white sheet probably from bag (A3) and plastic fragments (A14)

Haul 3400043: canvas entity (F3)

Haul 3400044: synthetic rope (A7) and plastic sheet (A2)

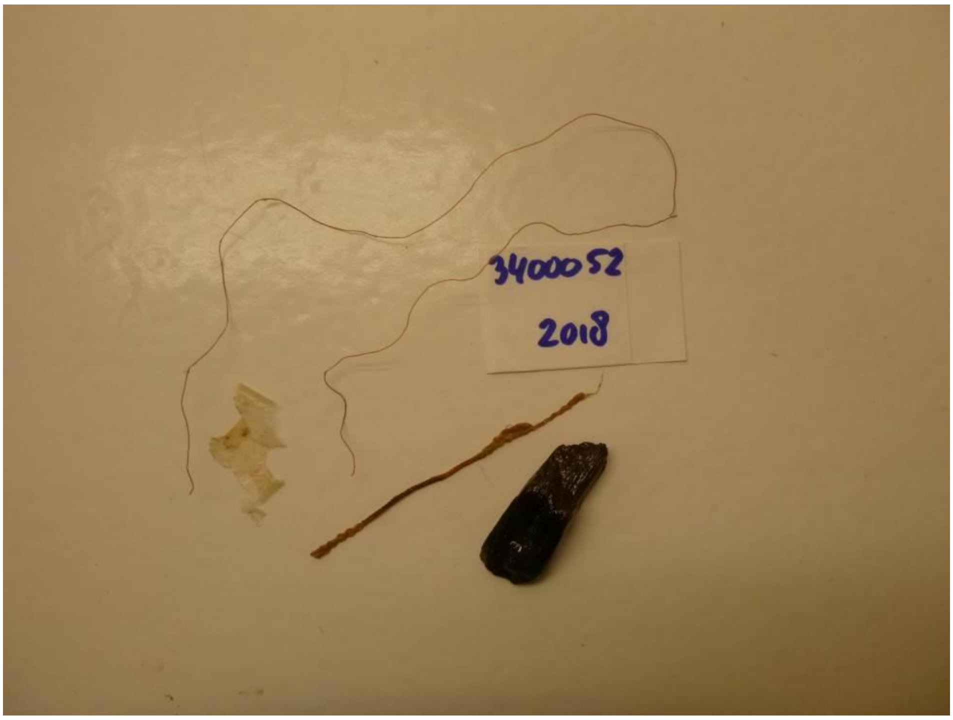


Haul 3400046: synthetic rope (A7)

Haul 3400048: synthetic ropes (all A7)

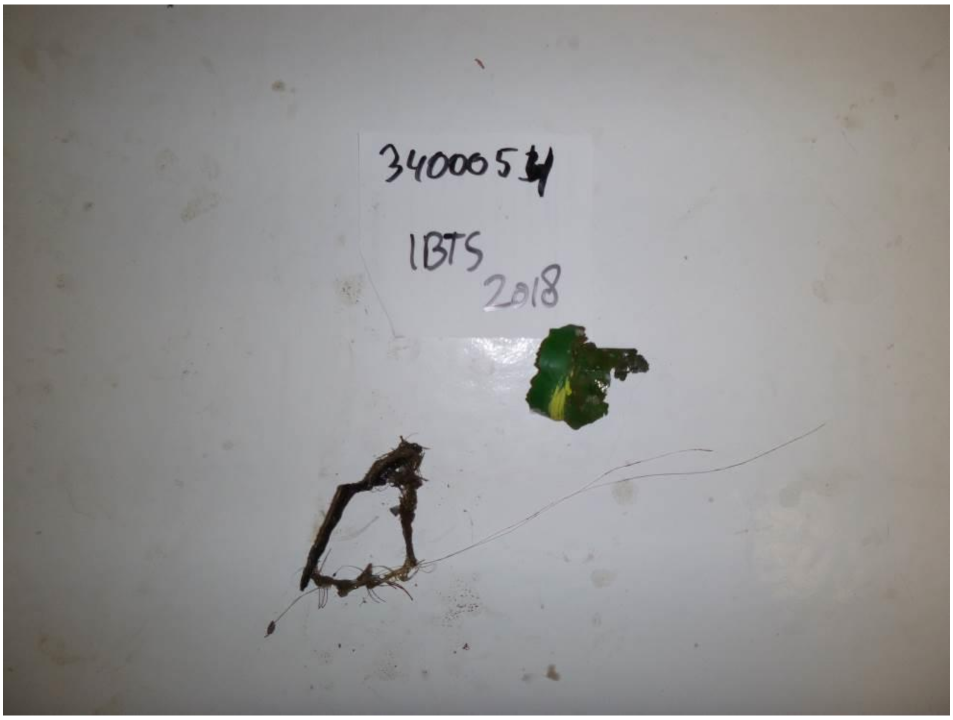
Haul 3400049: binliner (A3)

Haul 3400051: candy wrapper (A2) and entangled fishing line (A6)



Haul 3400052: synthetic rope x2 (A7), plastic sheet (A2) and wood (E1)

Haul 3400053: wood fragments (E1)



Haul 3400054: fishing line (monofilament) (A5) and plastic fragment (A14)

Haul 3400054: strapping band (A10) and rope (E2)

Haul 3400055: cable tie (A9), plastic sheet x3 (A2) and synthetic rope (A7)

Haul 3400056: plastic sheet (A2) and synthetic rope x2 (A7)

Annex 3 Comparison with Beam Trawl catches

In the main body of the report, issues are raised concerning the catchability of litter by the GOV used during the IBTS. The chance of catching litter items present on the seafloor is expected to be low, even to be random (<5% of the items is caught). This is a notable issue to consider when interpreting the amounts of litter caught by, and reported for the IBTS, as these are clearly a large underestimation of the actual amounts present on the seafloor. If the assumption that litter is caught randomly is indeed true, the IBTS can only be used as an indication of the presence of litter items, not as an indicator for presence-absence, nor as an indicator for the amounts of litter present.
A gear with both better bottom contact and higher catches of seafloor litter than the GOV is the beam trawl (Van der Sluis & van Hal, 2014). However, the beam trawl also has catchability issues and as such there is an issue with the underestimation of the actual amounts as well. A beam trawl of 8 m with a 40 mm codend mesh size is used during the Dutch Beam Trawl Survey [DBTS], a statutory survey in the North Sea that takes place in the third quarter of every year. During the DBTS, litter items are recorded following a similar methodology to that of the IBTS in the first quarter. Thus methodologically, the amounts could be compared. However, seasonal influences, spatial extent and habitat differences (the beam trawl can be used in other habitats than the GOV) hamper the straightforward comparison of the seafloor litter quantities in both surveys. **Table 1** presents the main differences between the IBTS and DBTS. Despite the aforementioned issues, the beam trawl catches of the 2016 survey are presented as an initial comparison to the catches from the GOV.

Annex 3 table 1. *Main differences between IBTS and DBTS*

	IBTS	**DBTS**
Location	North Sea	North Sea
Time of year	Q1	Q3
Duration of survey	5 weeks	4 weeks
Gear	Grande Ouverture Verticale	Beam Trawl
Gear info	"Semi pelagic" bottom trawl	Beam Trawl
Net width	Variable 15-20m	8m
Codend mesh size	10mm	40mm

The most noticeable difference is the composition of the litter caught by the two gears. Plastic accounts for 83-88% of the seafloor litter caught by the GOV, compared to just 54% of the litter caught during the 2016 DBTS (**Figure 1**). A much larger proportion of the litter in the DBTS is classified as Miscellaneous compared to the IBTS. This indicates that litter types are distributed differently on or in the seafloor. The beam trawl scrapes the top layer of the seafloor and catches items actually buried in this top layer, while the GOV touches the bottom and solely catches the items on top off or slightly floating above the seafloor.
The difference in the amount of litter caught is the other noticeable difference, due mostly related to the type of gear, although the above-mentioned effects should not be neglected. Comparing the absolute values per haul is not particularly relevant as the amount of seafloor covered is higher in the IBTS than in the DBTS. Therefore only the number of items per km^2 is of interest. Here, the larger catches of the DBTS become clear, with average catches of 296.3 items per km^2 (**Table 3**) compared to 40.3 to 115.9 items per km^2 in the IBTS (**table 3-1**). Indeed, the average catch of the DBTS is higher than the maximum catch of the IBTS in 2018.
The presence-absence of litter items indicates that DBTS has a higher chance of catching a litter item (or fishes in areas with more often litter presence). In 2016, only one of the 73 DBTS hauls contained no litter item, compared to 11 out of 54 hauls of the IBTS in 2018.
The background of the comparison between these two gears is to calculate a conversion factor to raise the amount of litter in the IBTS to "real" amounts of litter in the North Sea. A conversion factor could also enable the amalgamation of datasets of these two gears in a single analysis, thus increasing the number of data points and strengthening the analysis. **Table 2** presents the advantages for and disadvantages of a conversion factor.

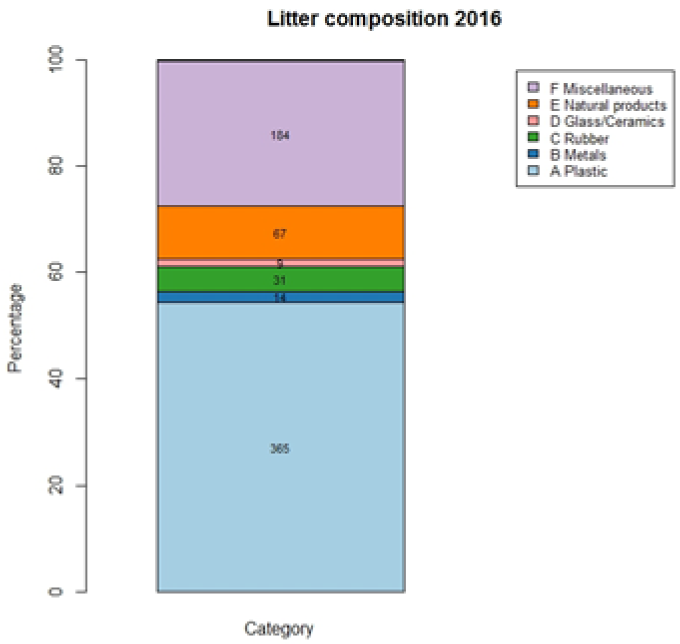
Annex 3 table 2. *A summary of the advantages for and disadvantages of a conversion factor*

Advantages	Disadvantages
- Raising the amounts of litter in the IBTS brings the values closer to actual amounts present on the sea floor - More realistic amounts are better for raising awareness - Allows for the expansion of the dataset by combining information of the two surveys, with the intention of improving statistical power	- The calculation of a conversion factor is hampered because the gears are not used at the same time, in the same spatial area and in the same habitats - A single conversion factor can't be calculated because the catchability for the various litter types varies for the two gears (larger proportion of plastic in the IBTS) and probably even for items within the same subcategory - Raising the amounts of litter in the IBTS will not give the "real" amounts of litter in the North Sea as the DBTS has its own catchability issues - Raising the amounts of litter in the IBTS will not raise the zero catches of the IBTS, while the presence-absence data of the DBTS indicate that the zeros in the IBTS are unlike to be all areas without litter - Raising the IBTS data will not affect the trend analyses based on these data only (except that the zeros will have a different influence as these are not raised)

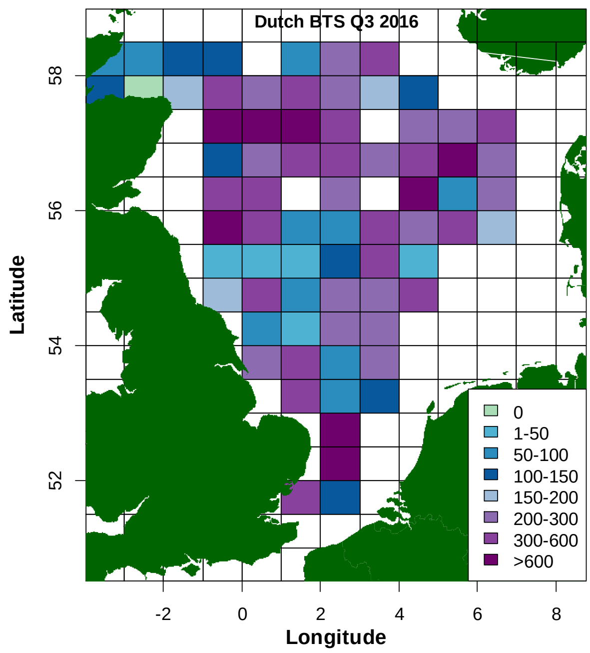
The advantages indicate that we are not advocating for using the conversion factor. However, there are statistical techniques that could be used to combine these different datasets in a single analysis. WGML (ICES 2018) has been considering these techniques. However, these require that there are no collinear factors. However, that is a problem for the two Dutch datasets, as different areas, habitats covered and time are all collinear with the difference in gears. Therefore, WGML has reviewed the international data and there is overlap between the International IBTS Q3 and the DBTS at least with respect to area and time, although habitats might still differ. WGML hasn't carried out combined analyses as of yet, as there were still a large number of data issues to be solved. This type of combined analysis is one of the terms of reference for WGML in the years to come.

Annex 3 table 3. Summary data of the Dutch 2016 BTS litter catches. *Each parameter is presented with its minimum, maximum, mean, median and median absolute deviation values*

DBTS 2016	min	max	mean	median
Items per trawl	0	36	9.1	7
Items per km^2	0	1286.8	296.3	247.2



Annex 3 figure 1. Composition of the seafloor litter in the catches of the Dutch BTS Q3 2016. *Values within the graph are the absolute number of items for the categories containing more than 1% of the total items counted. Plastic represents the largest category with 365 items (54.4 %) of the 670 litter items caught.*



Annex 3 figure 2. Density of litter items per km² for the DBTS Q3 2016*. The highest density in 2016 (1286 items per km²) was observed east of the Scottish coast (Aberdeen), situated in the middle of the three purple rectangles. The only rectangle in which no litter was caught was located in the Moray Firth. For rectangles in which two hauls were carried out, the average of the density of litter items per haul per km² was used. The white rectangles were not sampled by the Dutch survey.*

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'To explore the potential of marine nature to improve the quality of life'

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- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.
- Wageningen Marine Research is an independent, leading scientific research institute

Wageningen Marine Research is part of the international knowledge organisation Wageningen UR (University & Research centre). Within Wageningen UR, nine specialised research institutes of the Stichting Wageningen Research Foundation have joined forces with Wageningen University to help answer the most important questions in the domain of healthy food and living environment.