Sea floor litter monitoring

International Bottom Trawl Survey 2017

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Wageningen University &
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Summary

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

GES is described by 11 descriptors, and marine litter is one of them. The Dutch monitoring program for this descriptor includes amongst others 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 by statutory task fish surveys using standardized GOV fishing net, as a part of the International Bottom Trawl Survey (IBTS).

This report presents the results of the seafloor litter monitoring during the IBTS survey of Quarter 1 2017. Seafloor litter data is collected annually during this survey since 2013, and the new data is presented in perspective of the data collected in previous years. This is done for the composition and the spatial distribution of the seafloor litter from the catch. This year the allocation of rectangles over the countries participating in the IBTS has changed, resulting in a different area covered by the Dutch survey, only partially overlapping with the area covered in earlier years.

In 2017 litter was caught in 91% of the hauls. The composition of this litter was similar compared to earlier years; more than 80% of the 350 items caught was plastic and these were mainly plastic sheets and various types of rope and fishing lines. The majority of these items was, like in previous years, small falling in the category <25 cm^2. The haul with the highest amount of litter items was close to the Dutch coast, in front of Katwijk, in this haul 33 separate items were recorded. While three of the five empty hauls were close to the UK coast. One of the empty hauls was a 15 min haul done as an experiment next to the full 30 min haul in which litter was caught. Again an indication that the litter catches are very variable in space.

Due to the spatial change in the allocation of the survey area, and the semi-random sampling in a grid cell it is difficult to compare the data between years. However, looking at the mean and median values these are on the lower side compared to earlier years, even though the two largest catches of litter were found this year. This is more likely related to the higher number of hauls in the cleaner middle part of the North Sea, than that it is a reflection of lower amounts of litter in North Sea.

1 Introduction

The European Marine Strategy Framework Directive (MSFD 2008/56/EC) dictates that EU Member States are obliged 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, one of these, Descriptor 10, is Marine Litter. To achieve GES in 2020 for this descriptor 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).

Marine litter is a threat to wildlife, hinders human activities, is unappealing and reduces the recreational value of our coasts (Fleet et al. 2009). Sources of marine litter vary and can be sea or land-based. Land-based sources include sewage outlets, recreational activities on the coast, illegal dumping and river outlets. Sea based sources of marine litter are shipping, fisheries including aquaculture, offshore installations and recreational sailing.

Various initiatives to reduce litter in the environment have been initiated or are currently discussed. For example, in 2013 the law on dumping of garbage by marine vessels has changed, from "all garbage may be dumped except" into "no garbage may be dumped except". And bans or taxes on plastic bags in supermarket. In the Netherlands, it is no longer allowed to give free plastic bags from the first of January 2016. Other examples are "Green deals" on Clean Beaches and on Fishery for a Clean Sea. The Green deal on Fishery include the "Fishing for litter", program by KIMO to bring bycatch litter to land to recycle or process it and studies to reduce loss from netting material.

Such measures are steps to achieve GES, but the MSFD also requires monitoring the achievements of these measures. This is interpreted as a requirement to monitoring 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 aspects: monitoring litter in the water column, washed ashore, in biota and deposited on the seafloor.

This report describes the methods used and data collected in 2017 for the Dutch part of the monitoring of litter deposited on the seafloor as commissioned by Rijkswaterstaat (RWS). The OSPAR commission has proposed to collect this type of data by using the catches of the International Bottom Trawl Survey (IBTS). In earlier work (van Hal & de Vries 2013, van der Sluis & van Hal 2014), it was shown that in the Dutch situation it was possible to collect data on seafloor litter from catches of this and other 'statutory task fish surveys' on board of the research vessel Tridens (e.g. IBTS and Beam Trawl Survey) 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).

The project carried out in 2013 (van Hal & de Vries 2013) was a successful pilot, after which it was decided that monitoring of seafloor litter would become a regular part of the Dutch IBTS. Therefore the international IBTS protocol on marine litter (ICES 2015) was included in the Dutch survey manual (van Damme et al. 2016), along with additional guidelines on how to classify specific litter items based on decisions made during the pilot (van Hal & de Vries 2013). Since 2013 the IBTS data on seafloor litter are stored and provided to RWS.
With the data collected in 2017, five years of data are available. Therefore RWS requested to put the 2017 data into context of the earlier years. This is done for litter composition, amount and spatial distribution.

2 Materials and Methods

2.1 IBTS 2017

The International Bottom Trawl Survey Q1 (IBTS Q1) is carried out annually in January and February. The survey in the first quarter of the year (Q1) is carried out by Scotland, Germany, Sweden, Norway, Denmark and The Netherlands (ICES 2015).
The survey design is such that the North Sea is divided by a grid, ICES rectangles, of 0.30° latitude and 1° longitude. Each of these rectangles is sampled twice. The rectangles are allocated to the participating countries such that the majority of the rectangles is sampled by two countries each carrying out one trawl haul. The distribution of the area between the countries has been the same for many years up to 2017. In 2017, the allocation changed as one of the countries had to reduce its effort and was no longer able to cover all the allocated rectangles. This change also affected the area covered by the Netherlands, this year a more compact area is covered, no longer going up north till Aberdeen and no longer covering the Channel and the southern English coast (**Figure 2-1**).

The sampling gear 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 is about 5 m above the seafloor, which is particularly convenient to sample pelagic fish species and those species which dwell just above the bottom. As the ground rope of the GOV only touches the bottom, flatfish, benthic organisms and bottom litter might go underneath it. This can be substantial. For example, for small flatfish (<25 cm) the part going underneath the ground rope is assumed to be 50% (Piet et al. 2009). Comparing GOV catches with beam trawl catches indicated that 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 thus definitely not representative (ICES 2003).
The horizontal opening of the net is determined by the pressure on the two doors (otter boards), 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 bottom creating a dust cloud, herding fish towards the actual net opening. The actual net opening (wingspread) varies as well with depth. 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. Trawling is only carried out during daylight hours.

Standard, The Netherlands uses the research vessel Tridens II for the IBTS. In 2015 and 2016, due to a refit of the Tridens, the English research vessel CEFAS Endeavour was hired. In 2017, the Tridens II was used again, with the Dutch GOV-net and otterboards and with a new SIMRAD net-geometry system attached to the doors.

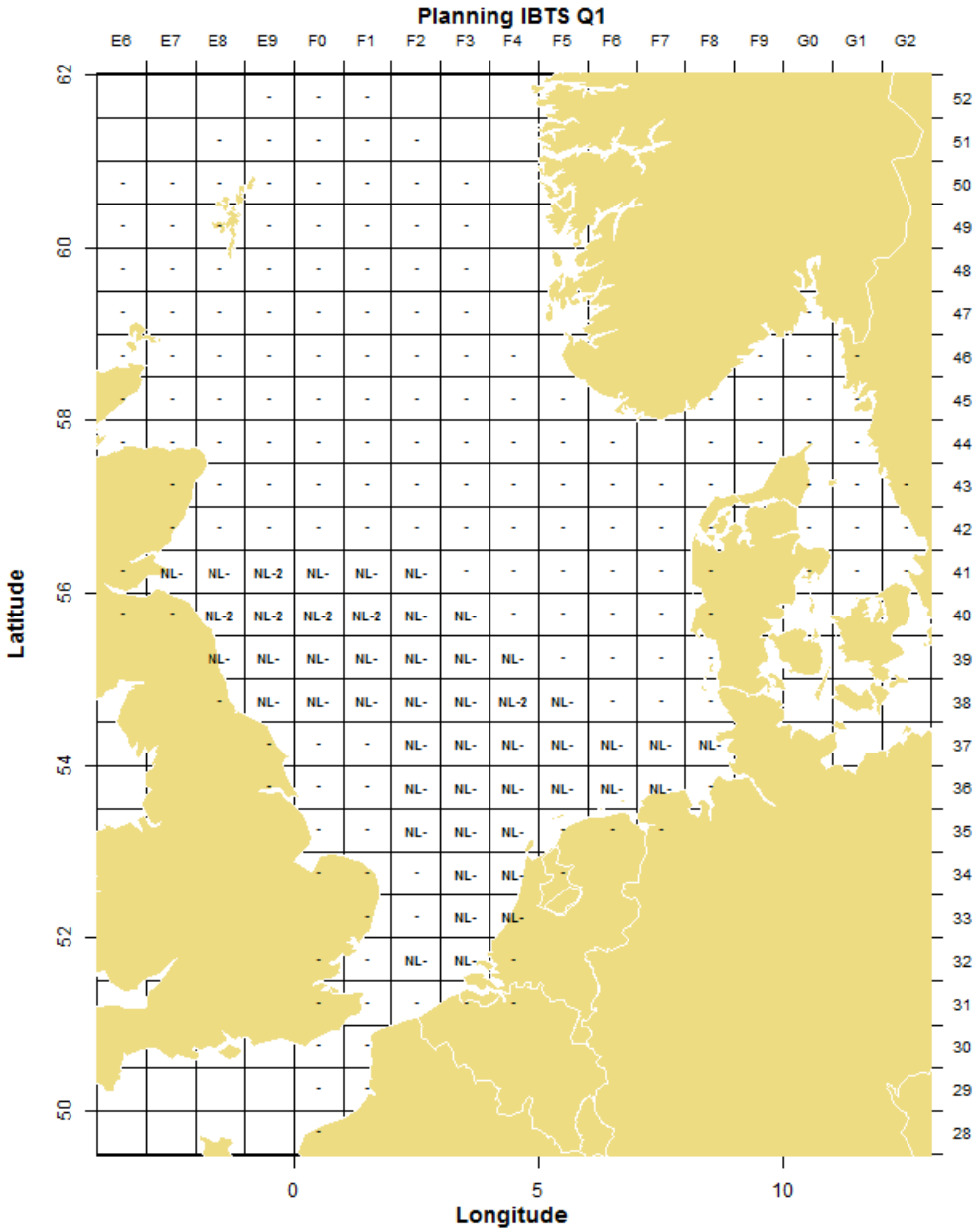

Figure 2-1: Planned ICES rectangles for Dutch GOV hauls during the IBTS 2017, rectangles with NL-2 are covered twice by the Netherlands.

2.2 Sampling litter

The manual of the IBTS states that litter has to be collected each haul and classified according to **Table 2-1**. There is no guidance on how detailed the catch should be sorted or on visual inspection of the net. Additional guidance should be provided by the concept CEMP/JAMP protocols (EIHA 15/5/14-E; EIHA 15/5/14 Add.1-E), however these still left a lot of room for interpretation at the time of the 2017 survey.

Photo 1: Marine litter with organisms attached

On the Tridens the complete net is hoisted on board, 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 (after removing attached organisms and debris) and the size is estimated. In case similar items were

found in a single trawl haul, these were recorded as a single category, weighed together and the number of individual items was registered (**Table 2-2** and Annex 1). This happened most often by category A7 (Synthetic rope). When organisms were attached (Photo 1) this was recorded as well. Occasionally an extended description of the litter item is given (Table 2-2). At the end all the litter in a haul was photographed (Annex 2).

Table 2-1: Classification of marine litter items and the related size categories (ICES 2015).

A: Plastic	B: Sanitary waste	C: Metals	Related size category
A1. Bottle	B1. diapers	C1. Cans (food)	A: <5*5 cm= 25 cm^2
A2. Sheet	B2. cotton buds	C2. Cans (beverage)	B: <10*10 cm= 100 cm^2
A3. Bag	B3. cigarette butts	C3. Fishing related	C: <20*20 cm= 400 cm^2
A4. Caps/ lids	B4. condoms	C4. Drums	D: <50*50 cm=2500 cm^2
A5. Fishing line (monofilamen	B5. syringes	C5. appliances	E: <100*100 cm= 10000 cm^2= 1 m^2
A6. Fishing line (entangled)	B6. sanitary towels/tampon	C6. car parts	F: >100*100 cm = 10000 cm^2= 1 m^2
A7. Synthetic rope	B7. other	C7. cables	
A8. Fishing net		C8. other	
A9. Cable ties			
A10. Strapping band			
A11. crates and containers			
A12. other			
D: Rubber	**E: Glass/ Ceramics**	**F: Natural products**	**G: Miscellaneous**
D1. Boots	E1. Jar	F1. Wood (processed)	G1. Clothing/ rags
D2. Balloons	E2. Bottle	F2. Rope	G2. Shoes
D3. bobbins (fishing)	E3. piece	F3. Paper/ cardboard	G3. other
D4. tyre	E4. other	F4. pallets	
D5. glove		F5. other	
D6. other			

Table 2-2: Registration sheet with example data. Recording litter type, size, weight and the number of items in the category. Where possible a description is given and sometimes attached organisms are recorded.

sample	date	Litter Type (A1; B2; C...)	Description (Label/ Brand)	Size category (A; B; C..)	Weight (g)	attached organisms (yes/no) Taxonomy Info	number of items (0= multiple material**,1 in most cases, >1 monofilament)
3000001	29/01/2015	G1	some stocking like piece of cloth	A	1		1
3000002	30/01/2015	A2	blue sheet	B	1	briozoa	1
3000002	30/01/2015	A7	string orange rope	A	1		1
3000003	30/01/2015	A2		D	52		1
3000003	30/01/2015	A2		E	637		1
3000003	30/01/2015	G1	ripped piece of cloth	A	20		1
3000003	30/01/2015	D5		A	5		1
3000003	30/01/2015	A7		A	40	hydrozoa	1
3000004	30/01/2015	A7		A	1		1
3000004	30/01/2015	A7		B	70		1
3000005	30/01/2015	A7	strings of blue and orange rope	A	1		3

** A 0 is reported when an item exists of multiple materials. The main material is than reported as 1, but other materials are registered but recorded as 0. For example: A bottle with a cap, is report as A1 number =1 and A4 number =0. In a similar way items existing of wood and metal etc. are recorded.

2.3 Calculations

Seafloor litter is presented as number of items per km^2. To calculate this the swept area is required. 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 (otter boards) 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 as the actual net opening. We assume that marine litter is not herded into the net by the doors and cables, therefore wingspread is considered the relevant measure for sea floor litter.

With the SIMRAD net geometry system we only record the doorspread, and wing spread needs to be calculated. In some cases doorspread was not recorded properly, in those cases doorspread is calculated as well. The formulas are based upon the data of multiple years in case of doorspread and based on the information gathered during the two years on the English vessel using their wingspread sensors.

The used formulas are:

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 was than calculated as:

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

These formulas are the same as in the report on the 2016 data, however differ from those used in earlier years. All data presented here in this report are calculated using these formulas, therefore the values of earlier years differ with what is in those years reports.

3 Results

The Dutch 2017 IBTS Q1 performed 55 valid trawl hauls. Two hauls were done on nearly the same location, the first haul took 30 minutes the second 15 minutes. This was part of a trawl duration experiment, where the standard 30 min hauls are compared with 15 min hauls, as proposed by the IBTSWG (ICES 2016). Furthermore, two hauls had a shorter duration of 20 minutes and a single haul had a shorter duration of 28 minutes.
In 50 of the hauls at least one litter item was found, meaning that 5 hauls contained no marine litter. In total 351 litter items (including the total number of lines/ropes counted which are reported as a single type) were registered.

3.1 Composition of the litter

Plastics are by far the most frequent category with 83.8% of the items caught (**Figure 3-1**). This is followed by Natural products (9.9%) and Miscellaneous (2.5%).

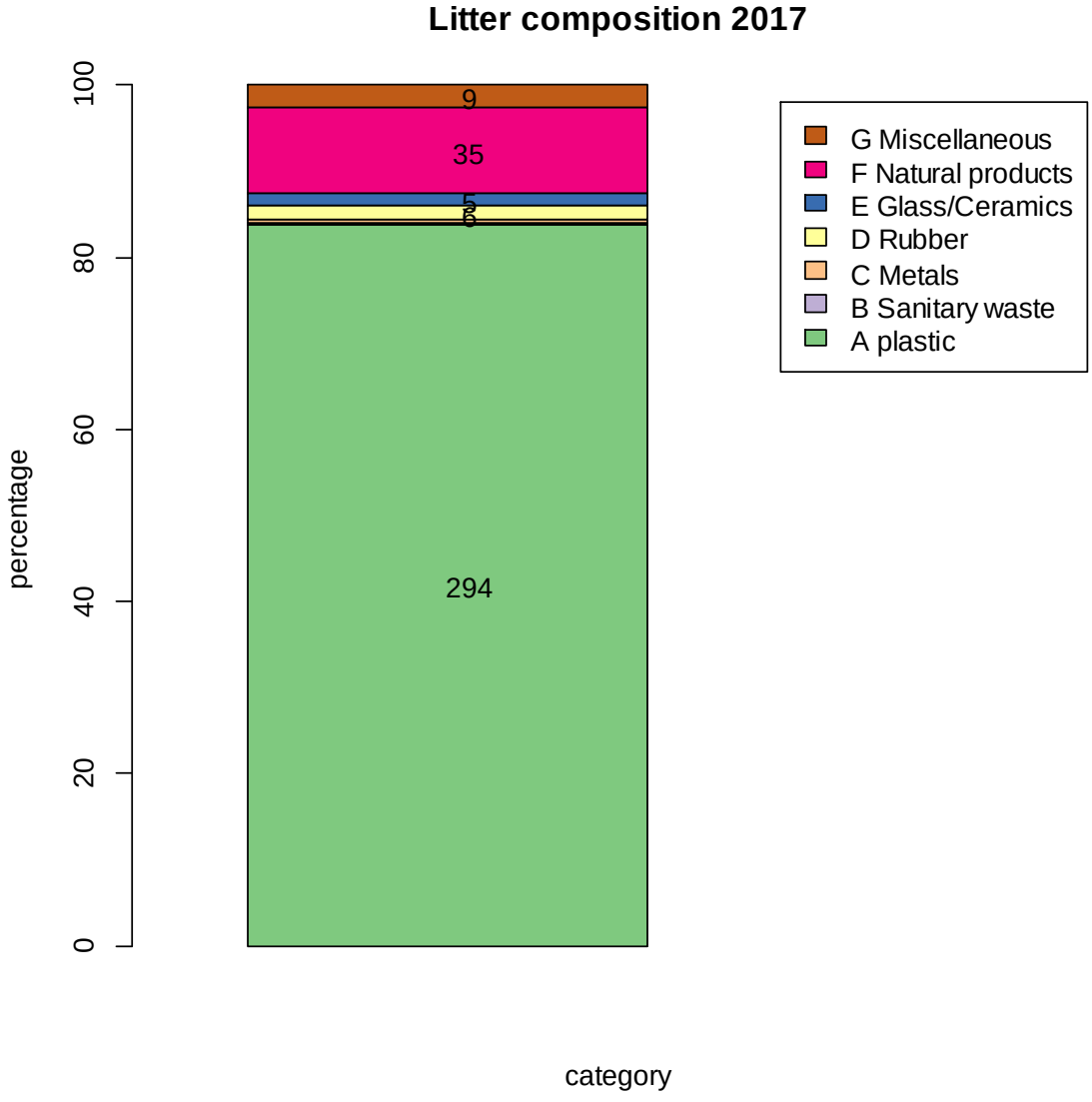

Figure 3-1: Composition of the seafloor litter in the catches of the Dutch IBTS Q1 2017. Values are the absolute number of items for the categories containing more than 1% of the total item count.

The largest category Plastic contains 12 subcategories. The most dominant category is A2 Sheet with 34.0%, followed by A5 Fishing line (monofilament) with 29.9% of the items (**Figure 3-2**).

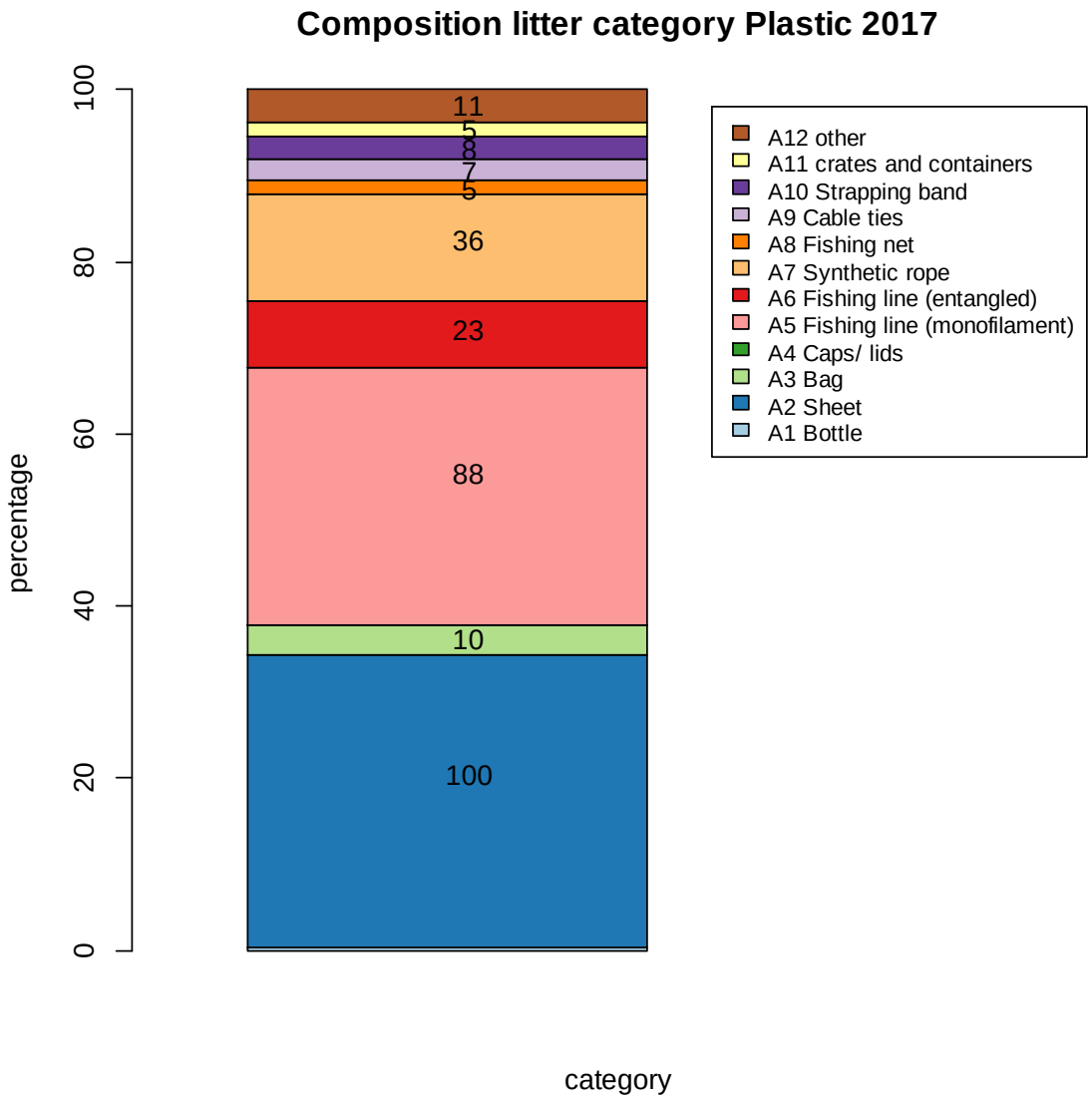

Figure 3-2: Composition of the seafloor litter category A Plastic in the catches of the Dutch IBTS Q1 2017. Values are the absolute number of items for the categories containing more than 1% of the items.

All items were given a size category based on an estimation of the surface. Most of the items (208), e.g. strings and pieces of rope, are classified as smaller than 5 * 5 cm (<25 cm^2). Not a single item was placed in the largest category (>10000cm^2) (**Figure 3-3**). The item placed in category E (2500-10000 cm^2) was a fishing net attached with many other monofilament lines and synthetic ropes.

Photo 2: Fish net, largest item caught in 2017

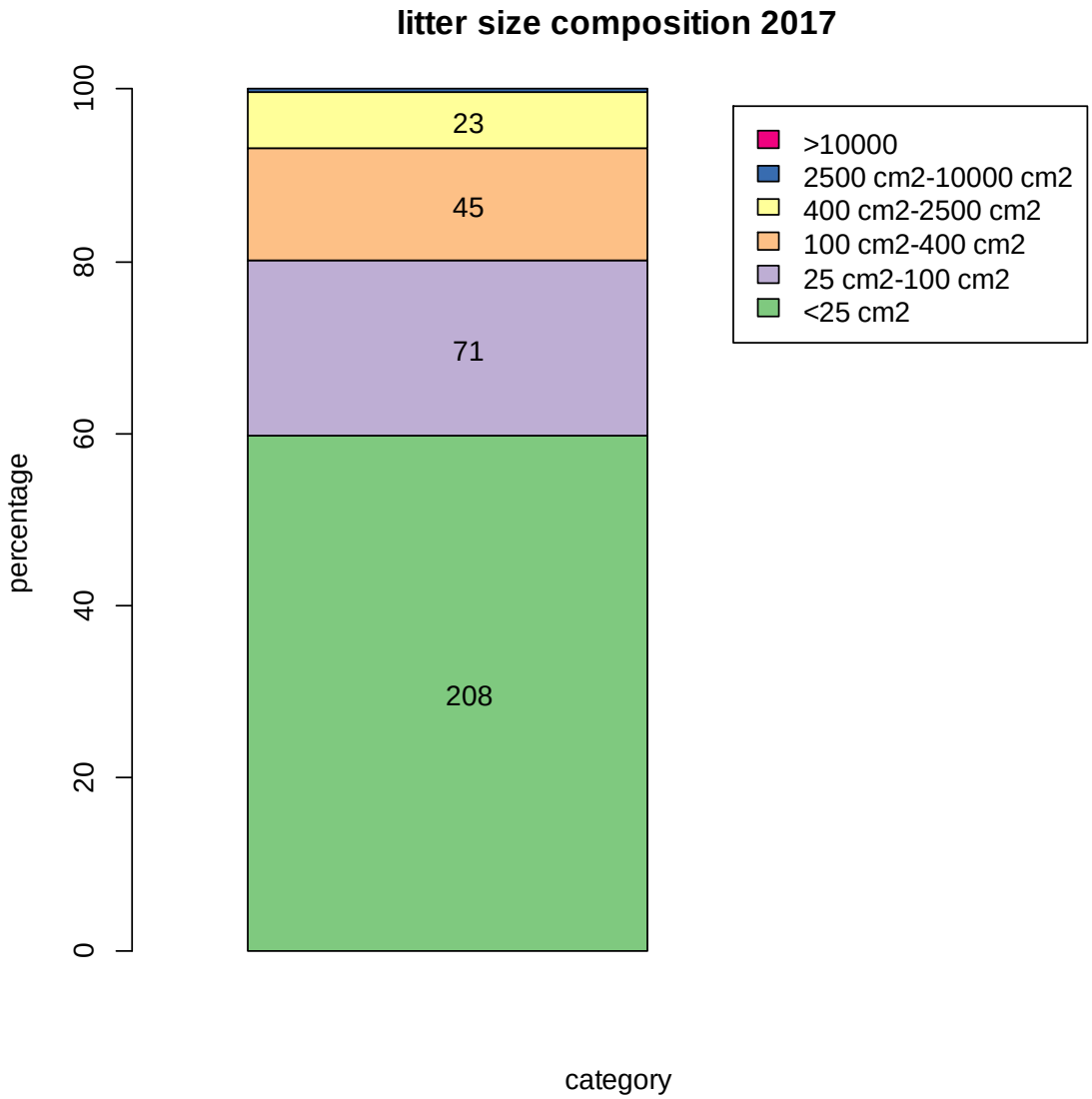

Figure 3-3: Size composition of the seafloor litter (categories A to G combined) in the catches of the IBTS Q1 2017. Values are the absolute number of items for the categories containing more than 1% of the items.

Weighing wasn't done consistently this year, as it was forgotten in a number of hauls. Therefore, only 266 of the 351 items were weighed. The heaviest item was the fish net in photo 2 with 16.6 kg. Followed by a fishing bobbin of 5.1 kg and a bundle of entangled dolly ropes of 1.5 kg. All other items were less than 500 g. Most items weigh only a couple of grams. So the distribution of the weight is skewed, seen in the difference between average weight (106.9 g) and the median weight (2.0 g) (**Table 3-1**).

Table 3-1: Summary data of the Dutch 2016 IBTS litter catches (categories A to G combined). For the items per trawl the duration of the trawl and the swept area varies.

	min	max	mean	median
Items per trawl	0	33	6.4	4
Surface trawled (km^2)	0.0383	0.09677	0.07161	0.07396
Items per km^2	0	610.6	98.0	62.1
Weight (g)	-	16600	106.9	2.0

3.2 Abundance and distribution of the litter

Information on the amount of litter can be provided for the locations of the GOV trawls only. Owing to the changed allocation of rectangles, the spatial coverage of the Dutch IBTS has 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 was collected, gives the impression that the amount of litter varies a lot between different habitats in 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 at small distances.

The distribution of litter based on the IBTS 2017 is presented in **Figure 3-4**. This shows the five hauls without litter items in the catch as the minimum catch. Three of these locations are located near the English coast, being the most western positions. The fourth is located in the rectangle northeast of 54.5°N and 5°E. The fifth position is the 15 min haul, directly next to the 30 min haul that had 3 litter items (39 items/km^2).

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). The maximum value of 700 items per km^2 is not reached this year. The maximum in 2017 is 611 items per km^2 which is found nearly on the beach of Katwijk, the Netherlands. The maximum value of 611 items per km^2 corresponds to 33 items reported from the catch. The median number of items is 62.1 items per km^2 corresponding to 4 items in the catch (**Table 3-1**).

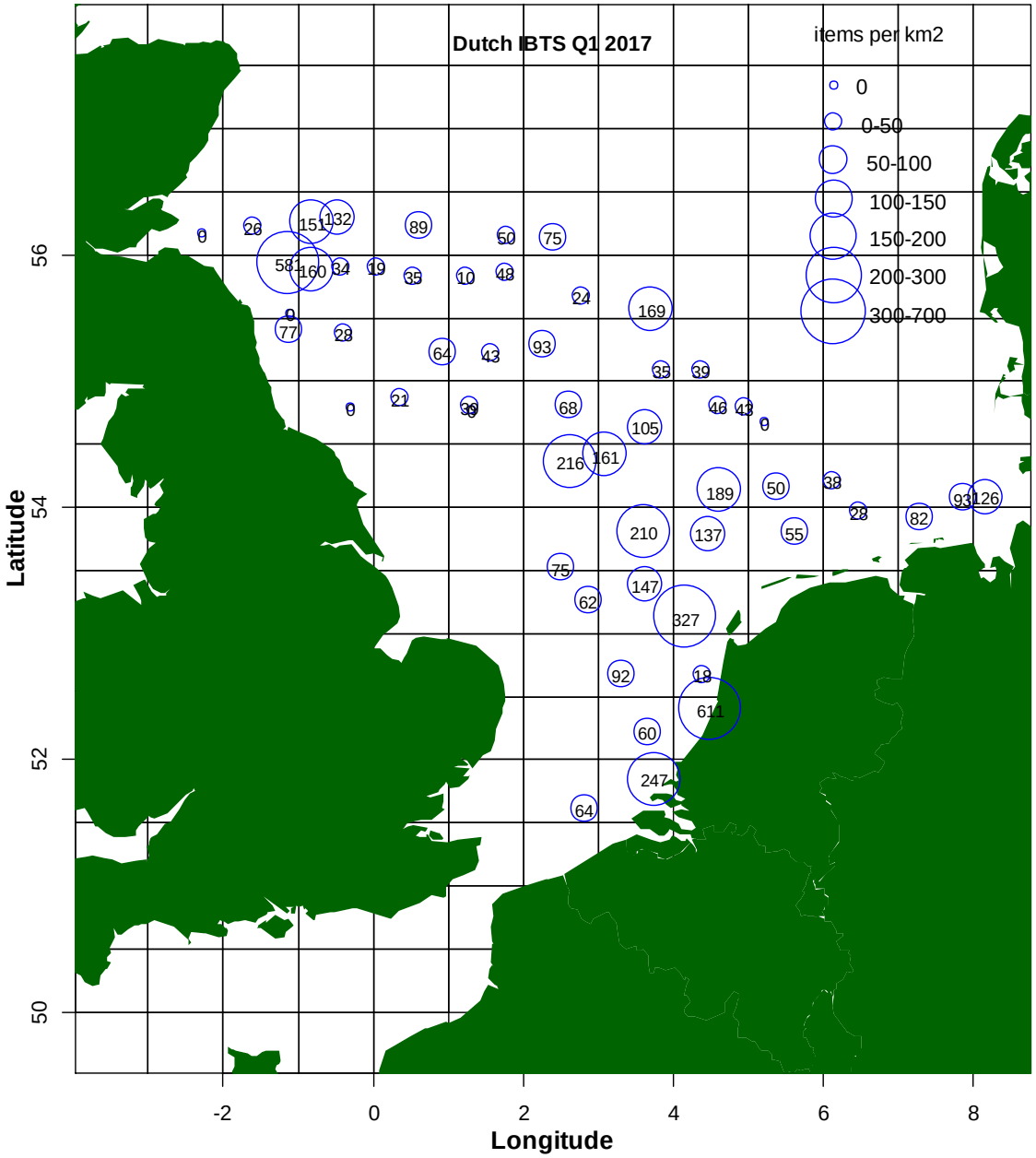

Figure 3-4: Density of litter items per haul per km^2 for the IBTS 2017. The numbers in the circle are the number of items per km^2. The numbers are the midpoints of the circles and correspond to the start position of the trawls, and thus determine the rectangle that is sampled. Empty rectangle have not been sampled by the Dutch IBTS, but are sampled by other countries participating in the survey.

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. In 2017 the largest plastic category was A2 Sheets which corresponds to 2013 and 2014. While in the previous years, 2016 and 2015, these were the A5 Fishing line (monofilament) or A7 Synthetic rope, respectively. The decision on A5, A6 or A7 but also on A2 or A3 Bag and what to place in A12 Others remains an arbitrary choice. Also registering and counting the number of individual pieces of rope/sheet correctly and in a consistent way is sometimes arbitrary. For example, if the decision is A6 it will be a single item, but when the decision is A5 it likely results in a number of items. Photo 3 clarifies the issue: the orange lines on the left side are considered A6 as various starting points can be seen, likewise the blue coil of rope in the middle is considered as A6, while the blue string on the right is considered as a single A5. So in the current classification it are three different items, while when they would have become entangled in the net it would likely have been a single A6

item. Or when the orange entanglement would have been entangled less it could have been a number of A5 items. If the orange entanglement would have been tighter together, it might even have been classified as A7 synthetic rope. As of this, it is unlikely that the small differences in plastic subcategories between years are actually representing changes in seafloor litter composition.

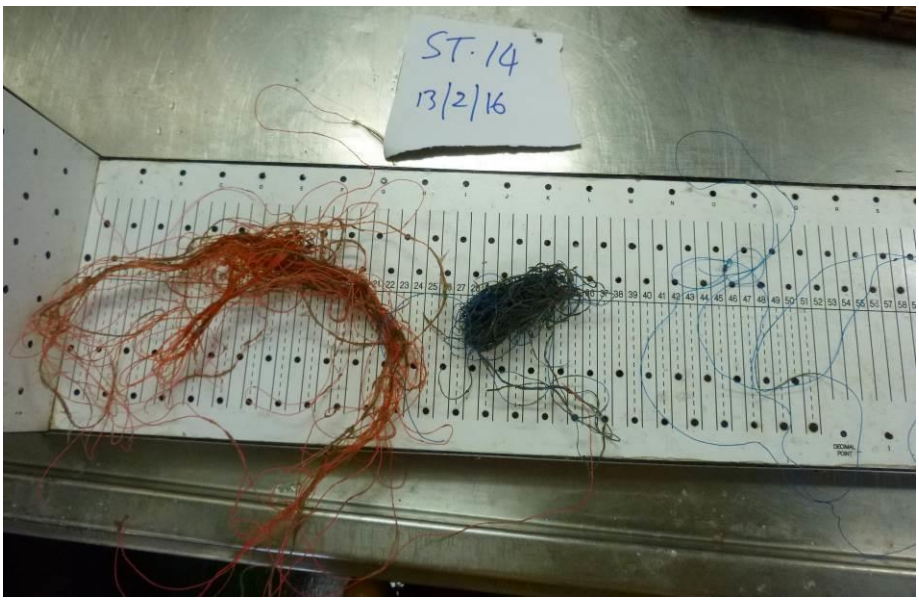

Photo 3: Litter items of haul 14 in 2016.

Overall the values in 2017 are comparable to those in previous years (**Table 3-2**, **Figure 3-5**), only 2013 had a clearly lower number of litter items. The spatial distribution is difficult to compare, especially using the maps presenting single hauls (**Figure 3-4**). Comparing the 2017 map with those of earlier years indicates that the distribution seems as random as in previous years. Following the survey design, that 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 3-6**; **Figure 3-7**). These maps are somewhat easier to compare, but do not provide a clear pattern of hotspot of litter over the year. Neither do they indicate clear differences between years.

Table 3-2: Comparison between Dutch IBTS litter results for the period 2013-2017. The values differ with those in the reports on 2015 and earlier as a different formula for calculating fished area was used.

2017	min	max	mean	median	stdev
items per trawl	0	33	6.4	4.0	6.45
items per km2	0	611	98.2	62.13	119.4
2016	min	max	mean	median	Stdev
items per trawl	0	21	7	6	5.00
items per km²	0	298.1	106.9	99.4	76.07
2015	min	max	mean	median	Stdev
items per trawl	0	23	8	7	5.7
items per km²	0	330.0	115.9	102.9	84.4
2014	min	max	mean	median	Stdev
items per trawl	0	21	6.5	5.0	4.9
items per km²	0	529.1	91.7	65.6	88.0
2013	min	max	mean	median	Stdev
items per trawl	0	11	4.1	4	2.4
items per km²	0	132.1	51.2	49.3	36.5

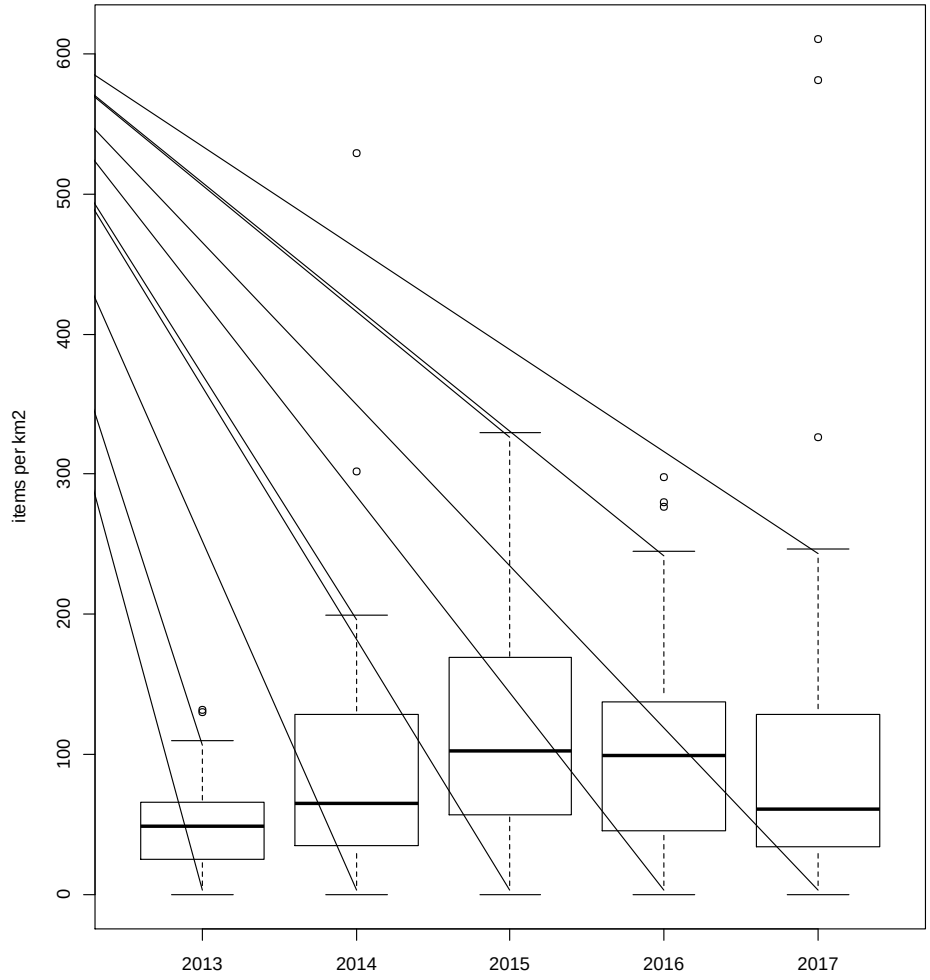

Figure 3-5: Boxplot of the items per km^2 for all the hauls in each year. The black horizontal line is the median. Note: the geographical coverage between years differs.

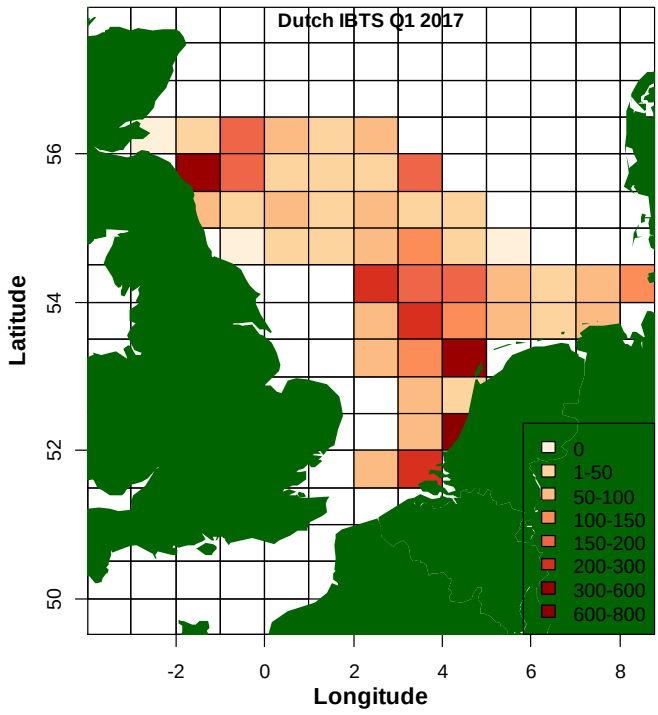

Figure 3-6: Density of litter items per km^2 for the IBTS 2017. The colour range is the same as in the maps below, except for the largest category. The white rectangles are not sampled by the Dutch survey.

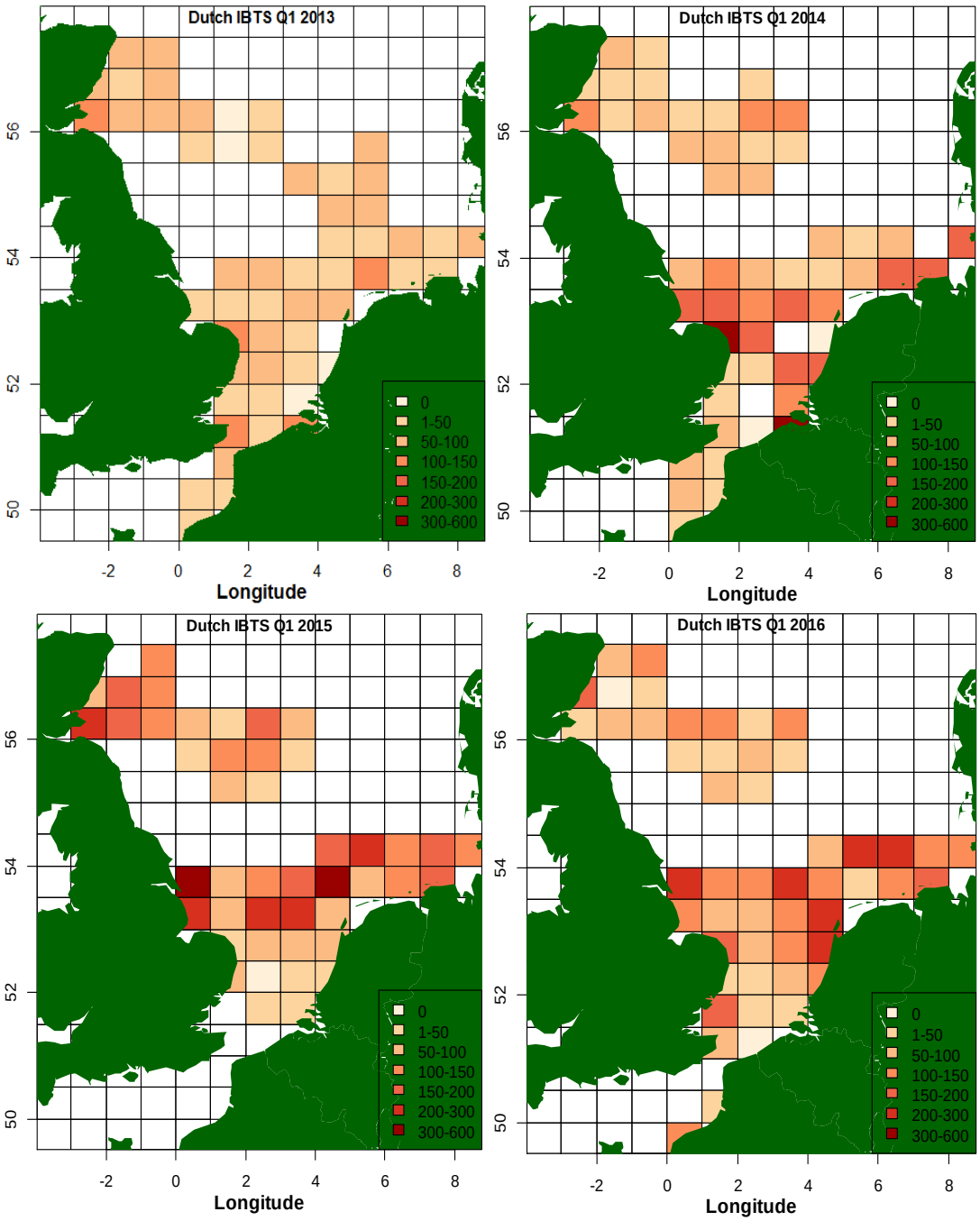

Figure 3-7: Density of litter items per km^2 for the IBTS 2013, 2014, 2015 and 2016. The colour range is the same in all maps.

4 Discussion and Conclusions

The results of 2017 are in line with those of previous years. The seafloor litter from the catches of the Dutch IBTS Q1 2017 contained mostly plastic items: 83.8% of the total number of litter items found was plastic. Also 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).

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, not designed for catching 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. The fact that these items are caught indicates that it is likely that there are more items in the trawl path. 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 not yet fully operational during the 2017 survey. It might be possible to use the multibeam during the trawl haul and record seafloor structures. 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 of the subcategory. 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 at the start of the 2017 survey these protocols were still in draft and the draft versions at that time did not provide clearer guidelines on the issue of counting items.

The definition of Good Environmental Status (GES) for marine litter ultimately is "no litter should be present in the marine environment". It is well known and presented here, that this is not reached and is unlikely to be reached within a short time frame. 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 it the way it is collected.

The other issue is that even if the international data is combined and the collection of litter is further standardised, it is questionable if 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.

4.1 Recommendations

- Create more consistency in the Dutch and international IBTS litter data, e.g. stricter guidelines in the manual including photographic examples. The last might also reduce the difference in interpretation between individual observers. In addition, an international training session within the North Sea is recommended once the CEMP guideline is available.
- Redo the types of analyses presented in this report on the combined international dataset.
- Developing a protocol to use the seafloor structure as additional metadata for the sea floor litter data.
- 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.

5 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

Report C054/17
Project Number: 4316100081

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

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Date: 4th of July, 2017

Approved: Drs. J. Asjes
Manager integration

Signature: 

Date: 4th of July, 2017

Annex 1 Data tables with sea floor litter monitoring data of Dutch IBTS Q1 2017.

Annex 1 table 1: Complete dataset of the Dutch IBTS Q1 2017: Sample = haulnumber; Number of items = sum of all litter items; Items km^2 = sum of all litter items divided by the fished surface (Bottom track * Wing spread).

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	33F4	3000001	52.40583	52.43817	4.50217	4.50933	10.2	3620	14.9	33	610.6
Tri2	NED	36F3	3000002	53.81433	53.81133	3.59417	3.64933	34	3637*	19.6	15	209.9
Tri2	NED	35F3	3000003	53.39017	53.37683	3.62267	3.57683	23.5	3383	16.1	8	147.2
Tri2	NED	35F2	3000004	53.2645	53.2855	2.85967	2.83267	27.6	2937	16.4	3	62.1
Tri2	NED	36F2	3000005	53.52733	53.519	2.49833	2.52483	34.6	1997	20.0	3	74.9
Tri2	NED	37F3	3000006	54.4175	54.41433	3.094	3.15367	35	3892	17.6	11	160.8
Tri2	NED	37F2	3000007	54.37	54.344	2.62167	2.66183	23.8	3908	13.0	11	215.8
Tri2	NED	38F2	3000008	54.8135	54.808	2.60233	2.5475	18.8	3591	16.4	4	67.8
Tri2	NED	38F3	3000009	54.64283	54.64867	3.62083	3.5655	40.4	3632	21.0	8	104.9
Tri2	NED	34F4	3000010	52.67867	52.67167	4.39533	4.33717	17.8	3984	13.8	1	18.2
Tri2	NED	40F3	3000011	55.56967	55.5965	3.71283	3.6835	31.6	3449	18.9	11	168.8
Tri2	NED	40F2	3000012	55.67267	55.675	2.77883	2.838	62.5	3753	21.9	2	24.3
Tri2	NED	41F2	3000013	56.14283	56.1135	2.39033	2.41383	69.5	3569	22.5	6	74.8
Tri2	NED	41F1	3000014	56.15133	56.1265	1.77083	1.80467	88.6	3480	23.0	4	49.9
Tri2	NED	40F1	3000015	55.86383	55.83167	1.7605	1.78133	82.8	3805	22.1	4	47.6
Tri2	NED	40F1	3000016	55.83417	55.79717	1.2315	1.252	79	4305	22.5	1	10.3
Tri2	NED	40F0	3000017	55.82983	55.80067	0.527	0.54983	81.8	3558	23.8	3	35.4
Tri2	NED	40F0	3000018	55.9055	55.88517	0.03783	0.03667	125.1	2262*	23.8	1	18.6
Tri2	NED	38E9	3000019	54.79367	54.76933	-0.30967	-0.28417	63.3	3190	21.3	0	0.0
Tri2	NED	38F0	3000020	54.86683	54.83533	0.35383	0.389	75.1	4163	23.2	2	20.7
Tri2	NED	38F1	3000021	54.80317	54.77083	1.2785	1.31167	33.5	4187	18.3	3	39.1
Tri2	NED	38F1	3000022	54.774	54.758	1.31067	1.32617	30.6	2027	18.9	0	0.0
Tri2	NED	39E9	3000024	55.38383	55.355	-0.39467	-0.38217	63.1	3314	21.5	2	28.0
Tri2	NED	39E8	3000025	55.40783	55.3775	-1.13183	-1.10283	63.1	3838*	23.6	7	77.2
Tri2	NED	40E8	3000026	55.5395	55.57217	-1.12067	-1.11783	100	3606	23.6	0	0.0
Tri2	NED	40E8	3000027	55.937	55.91883	-1.13317	-1.141	74	2095	21.3	26	581.4
Tri2	NED	41E7	3000028	56.17233	56.14083	-2.2855	-2.2925	56.1	3529	21.5	0	0.0
Tri2	NED	41E8	3000029	56.22417	56.19233	-1.599	-1.5895	55.8	3578	21.2	2	26.4
Tri2	NED	41E9	3000030	56.26	56.239	-0.8215	-0.875	65.5	4065	21.2	13	151.2
Tri2	NED	41E9	3000031	56.30017	56.26183	-0.4745	-0.469	62.5	4296	21.2	12	132.0
Tri2	NED	40E9	3000032	55.88367	55.87267	-0.80933	-0.74817	75	4031	23.2	15	160.2
Tri2	NED	40E9	3000033	55.90483	55.89533	-0.42617	-0.368	74.6	3778	23.6	3	33.6
Tri2	NED	41F0	3000034	56.23917	56.21067	0.60317	0.63267	178	3681	24.4	8	89.2
Tri2	NED	39F0	3000035	55.2365	55.26417	0.91967	0.91633	52.8	3075	20.2	4	64.4
Tri2	NED	39F1	3000036	55.22117	55.2295	1.57183	1.519	32.2	3614	19.5	3	42.7
Tri2	NED	39F2	3000037	55.2955	55.26783	2.2555	2.2365	32.5	3298	19.5	6	93.5
Tri2	NED	32F3	3000038	51.85217	51.86883	3.74917	3.77167	13.7	2439	16.6	10	246.6

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	36F4	3000039	53.79383	53.7925	4.46517	4.51567	37.1	3348	19.6	9	136.8
Tri2	NED	37F4	3000040	54.13617	54.12567	4.62183	4.67117	43.1	3440	20.0	13	188.7
Tri2	NED	37F5	3000041	54.17033	54.15767	5.37767	5.43417	36.1	3962	20.0	4	50.4
Tri2	NED	36F5	3000042	53.812	53.80867	5.61133	5.67117	26.8	3944	18.3	4	55.3
Tri2	NED	37F8	3000043	54.08817	54.1005	8.1495	8.10333	13.8	3336	19.0	8	126.0
Tri2	NED	37F7	3000044	54.08183	54.08217	7.8555	7.799	37.5	3673	20.6	7	92.6
Tri2	NED	36F7	3000045	53.929	53.93783	7.27233	7.31833	21.8	3192	19.1	5	82.1
Tri2	NED	36F6	3000046	53.96533	53.94283	6.473	6.51617	24.2	3799	18.7	2	28.1
Tri2	NED	37F6	3000047	54.214	54.2035	6.1185	6.17633	33	3970	20.0	3	37.7
Tri2	NED	39F3	3000048	55.0915	55.0565	3.85233	3.85167	42.2	3892	21.7	3	35.5
Tri2	NED	39F4	3000049	55.0885	55.11183	4.377	4.33633	44	3704	20.8	3	39.0
Tri2	NED	38F4	3000050	54.80567	54.806	4.59833	4.53583	41.3	3994	21.7	4	46.1
Tri2	NED	38F4	3000051	54.791	54.769	4.94567	4.90283	38.1	3698	19.1	3	42.5
Tri2	NED	38F5	3000052	54.679	54.64833	5.2135	5.1915	40.6	3717	21.5	0	0.0
Tri2	NED	33F3	3000053	52.22933	52.2075	3.65133	3.68917	24.4	3623	18.5	4	59.6
Tri2	NED	32F2	3000054	51.6175	51.588	2.80983	2.77433	36	4105	19.1	5	63.8
Tri2	NED	34F3	3000055	52.6825	52.64633	3.30667	3.30617	21.9	4026	18.9	7	92.0

Annex 1 table 2: Complete dataset of the Dutch IBTS Q1 2017. Sample= haulnumber; Litter type = subcategory;

Sample	**date**	**Litter Type**	**Size category**	**Weight (g)**	**number of items**
3400001	24-1-2017	A1	C	18	1
3400001	24-1-2017	A4			0
3400001	24-1-2017	A10	B	2	1
3400001	24-1-2017	A2	B	1	1
3400001	24-1-2017	G1	B		1
3400001	24-1-2017	A12	B	5	1
3400001	24-1-2017	A12	B	1	1
3400001	24-1-2017	A12	B	1	1
3400001	24-1-2017	A11	B	1	1
3400001	24-1-2017	A12	A	1	1
3400001	24-1-2017	A2	A	1	1
3400001	24-1-2017	G3	B	4	1
3400001	24-1-2017	A2	B	1	2
3400001	24-1-2017	A2	A	1	3
3400001	24-1-2017	F1	B	48	1
3400001	24-1-2017	A11	A	1	1
3400001	24-1-2017	A2	A	1	1
3400001	24-1-2017	C7	B	12	1
3400001	24-1-2017	A7	A	5	3
3400001	24-1-2017	A8	A	3	1
3400001	24-1-2017	A7	A	1	1
3400001	24-1-2017	F2	A	1	1
3400001	24-1-2017	A7	B	36	1
3400001	24-1-2017	A6	B	23	1
3400001	24-1-2017	A5	A	1	1
3400001	24-1-2017	A6	C		1
3400001	24-1-2017	A2	A	1	1
3400001	24-1-2017	A11	C	14	1

Sample	date	Litter Type	Size category	Weight (g)	number of items
3400001	24-1-2017	A8	C		1
3400002	25-1-2017	F1	C		1
3400002	25-1-2017	G1	D		1
3400002	25-1-2017	D6	D		1
3400002	25-1-2017	A2	D	20	1
3400002	25-1-2017	A2	C	18	1
3400002	25-1-2017	A2	B	3	1
3400002	25-1-2017	A6	B	6	1
3400002	25-1-2017	F2	B		1
3400002	25-1-2017	F2	A	34	1
3400002	25-1-2017	A2	C	3	1
3400002	25-1-2017	A6	B	7	1
3400002	25-1-2017	A2	C	3	1
3400002	25-1-2017	A5	A	1	1
3400002	25-1-2017	A2	B	1	1
3400002	25-1-2017	G1	B		1
3400003	25-1-2017	A2	D	10	1
3400003	25-1-2017	A2	D	10	1
3400003	25-1-2017	A2	B	3	1
3400003	25-1-2017	A6	B	50	1
3400003	25-1-2017	G1	C		1
3400003	25-1-2017	A5	A		3
3400004	25-1-2017	A2	B	11	1
3400004	25-1-2017	A7	B	10	1
3400004	25-1-2017	A2	B	1	1
3400005	25-1-2017	D3	B	36	1
3400005	25-1-2017	A5	A	1	1
3400005	25-1-2017	A2	B	1	1
3400006	26-1-2017	A5	A	1	3
3400006	26-1-2017	A5	A	1	2
3400006	26-1-2017	A5	A	1	2
3400006	26-1-2017	A6	B	19	1
3400006	26-1-2017	A2	C	5	1
3400006	26-1-2017	A2	B	2	1
3400006	26-1-2017	A2	B	2	1
3400007	26-1-2017	A5	A	2	1
3400007	26-1-2017	A5	A	1	1
3400007	26-1-2017	A5	A	1	1
3400007	26-1-2017	A5	A	1	1
3400007	26-1-2017	A5	A	1	1
3400007	26-1-2017	A2	D	55	1
3400007	26-1-2017	A7	A	7	1
3400007	26-1-2017	A2	A	1	3
3400007	26-1-2017	G1	D	68	1
3400008	26-1-2017	A2	C	63	1
3400008	26-1-2017	G1	C	27	1
3400008	26-1-2017	A2	B	3	1
3400008	26-1-2017	A2	A	1	1
3400009	26-1-2017	A7	A	3	1
3400009	26-1-2017	A5	A	1	3
3400009	26-1-2017	A5	A	1	1

Sample	date	Litter Type	Size category	Weight (g)	number of items
3400009	26-1-2017	A7	A	26	1
3400009	26-1-2017	A2	B	5	1
3400009	26-1-2017	A2	C	5	1
3400010	30-1-2017	A5	A	1	1
3400011	31-1-2017	A9	A	4	2
3400011	31-1-2017	A9	A	1	1
3400011	31-1-2017	A9	A	1	1
3400011	31-1-2017	A5	A	3	2
3400011	31-1-2017	F2	A	8	1
3400011	31-1-2017	A2	A	1	1
3400011	31-1-2017	A2	A	1	1
3400011	31-1-2017	A3	C	17	1
3400011	31-1-2017	A2	B	9	1
3400012	31-1-2017	A5	A		1
3400012	31-1-2017	A6	A		1
3400013	31-1-2017	A11		14	1
3400013	31-1-2017	A6	A	1	1
3400013	31-1-2017	A5	A	1	1
3400013	31-1-2017	A2	A	1	1
3400013	31-1-2017	A10		8	1
3400013	31-1-2017	A5		1	1
3400014	31-1-2017	A2	D	24	1
3400014	31-1-2017	A10	A	2	1
3400014	31-1-2017	A5	A	1	1
3400014	31-1-2017	A7	A	1	1
3400015	1/feb/17	A2	C	30	2
3400015	1/feb/17	A2	A	1	1
3400015	1/feb/17	A5	A	1	1
3400016	1/feb/17	A2	B	7	1
3400017	1/feb/17	A2	C	15	2
3400017	1/feb/17	A2	C	14	1
3400018	1/feb/17	A10	A	2	1
3400019	2/feb/17	EMPTY			
3400020	2/feb/17	A2	B	240	2
3400021	2/feb/17	A6	A		1
3400021	2/feb/17	A6	A		1
3400021	2/feb/17	A5	A		1
3400022	2/feb/17	EMPTY			
3400023	3/feb/17	A10	A	3	1
3400023	3/feb/17	A5	A	0	1
3400024	3/feb/17	A5	A	1	1
3400024	3/feb/17	A6	A	2	1
3400024	3/feb/17	A2	A	11	1
3400024	3/feb/17	A2	A	1	1
3400024	3/feb/17	A2	B	36	1
3400024	3/feb/17	A10	A	3	2
3400025	3/feb/17	EMPTY			
3400026	3/feb/17	A9	A	2	2
3400026	3/feb/17	A2	A	1	1
3400026	3/feb/17	A2	A	1	1
3400026	3/feb/17	A7	A	1	1

Sample	date	Litter Type	Size category	Weight (g)	number of items
3400026	3/feb/17	A7	A	1	1
3400026	3/feb/17	A7	A	6	2
3400026	3/feb/17	A12	A	1	1
3400026	3/feb/17	F2	B	64	3
3400026	3/feb/17	F2	B	10	1
3400026	3/feb/17	F2	A	14	8
3400026	3/feb/17	F2	A	14	4
3400026	3/feb/17	F2	A	1	1
3400027	6/feb/17	EMPTY			
3400028	6/feb/17	A12	B	2	1
3400028	6/feb/17	A2	A	0	1
3400029	6/feb/17	A11	C	150	1
3400029	6/feb/17	A6	B	164	1
3400029	6/feb/17	A2	A	1	3
3400029	6/feb/17	A2	B	2	1
3400029	6/feb/17	A2	B	1	1
3400029	6/feb/17	A2	A	1	1
3400029	6/feb/17	A7	B	15	1
3400029	6/feb/17	A7	A	2	1
3400029	6/feb/17	A7	A	1	1
3400029	6/feb/17	F2	A	4	1
3400029	6/feb/17	A12	B	41	1
3400030	6/feb/17	A6	C	168	1
3400030	6/feb/17	A7	A	2	1
3400030	6/feb/17	A7	A	4	1
3400030	6/feb/17	A5	A	1	1
3400030	6/feb/17	A7	A	25	1
3400030	6/feb/17	A12	A	1	1
3400030	6/feb/17	A2	B	2	1
3400030	6/feb/17	A7	A	3	1
3400030	6/feb/17	A6	A	12	1
3400030	6/feb/17	A3	C	22	1
3400030	6/feb/17	A6	C	170	1
3400030	6/feb/17	D3	C	5160	1
3400031	8/feb/17	A2	D	28	1
3400031	8/feb/17	A8	B	15	1
3400031	8/feb/17	A2	A	1	1
3400031	8/feb/17	A2	A	1	1
3400031	8/feb/17	A2	C	15	1
3400031	8/feb/17	A2	C	5	1
3400031	8/feb/17	A3	B	10	1
3400031	8/feb/17	A2	B	2	1
3400031	8/feb/17	A5	A	1	1
3400031	8/feb/17	A5	A	1	1
3400031	8/feb/17	A5	A	1	1
3400031	8/feb/17	A7	A	4	1
3400031	8/feb/17	A7	B		1
3400031	8/feb/17	D5	D	2	1
3400031	8/feb/17	B6	B	3	1
3400032	8/feb/17	A2	D	12	1
3400032	8/feb/17	A7	B	10	1

Sample	date	Litter Type	Size category	Weight (g)	number of items
3400032	8/feb/17	E2	C	246	1
3400033	8/feb/17	A2	A	1	1
3400033	8/feb/17	A2	D	20	1
3400033	8/feb/17	A7	A	14	1
3400033	8/feb/17	A3	D	266	5
3400034	9/feb/17	A6	B	31	1
3400034	9/feb/17	A2	B	4	1
3400034	9/feb/17	A5	A	56	1
3400034	9/feb/17	A8	B	26	1
3400035	9/feb/17	A2	A	3	1
3400035	9/feb/17	A7	B	17	1
3400035	9/feb/17	A6	A	20	1
3400036	9/feb/17	A2	C	24	1
3400036	9/feb/17	A2	B	3	1
3400036	9/feb/17	A7	B	10	1
3400036	9/feb/17	A6	B	34	1
3400036	9/feb/17	A2	C	20	1
3400036	9/feb/17	A7	A	3	1
3400037	13/feb/17	A5	A	1	1
3400037	13/feb/17	A5	A	1	1
3400037	13/feb/17	A5	A	1	1
3400037	13/feb/17	A5	A	1	1
3400037	13/feb/17	A2	B	1	1
3400037	13/feb/17	A2	A	1	1
3400037	13/feb/17	A2	A	1	1
3400037	13/feb/17	A2	A	1	1
3400037	13/feb/17	F2	A	1	1
3400037	13/feb/17	F2	A	1	1
3400038	14/feb/17	A2	B	1	1
3400038	14/feb/17	A6	C	1	1
3400038	14/feb/17	A5	A	1	4
3400038	14/feb/17	F2	A	3	3
3400039	14/feb/17	A2	C	24	3
3400039	14/feb/17	A8	B	5	1
3400039	14/feb/17	F1	A	36	3
3400039	14/feb/17	A10	A	30	1
3400039	14/feb/17	A5	A	1	1
3400039	14/feb/17	A5	A	1	1
3400039	14/feb/17	A2	A	1	1
3400039	14/feb/17	A2	A	1	1
3400039	14/feb/17	A3	C	26	1
3400040	14/feb/17	A5	A	1	1
3400040	14/feb/17	A5	A	1	1
3400040	14/feb/17	A5	A	1	1
3400040	14/feb/17	A5	A	1	1
3400041	14/feb/17	A5	A	1	1
3400041	14/feb/17	A5	A	1	1
3400041	14/feb/17	A2	B	1	1
3400041	14/feb/17	A7	A	2	1
3400042	15/feb/17	E2	C		1
3400042	15/feb/17	E2	B		1

Sample	date	Litter Type	Size category	Weight (g)	number of items
3400042	15/feb/17	E2	B		1
3400042	15/feb/17	E2	B		1
3400042	15/feb/17	A5	A		1
3400042	15/feb/17	D1	C		1
3400042	15/feb/17	A12	D	416	1
3400042	15/feb/17	A5	A	1	1
3400043	15/feb/17	A2	A	2	1
3400043	15/feb/17	A5	A	1	1
3400043	15/feb/17	A5	A	1	1
3400043	15/feb/17	A5	A	1	1
3400043	15/feb/17	A5	A	1	1
3400043	15/feb/17	A5	A	1	1
3400043	15/feb/17	A5	A	1	1
3400044	15/feb/17	A6	B	20	1
3400044	15/feb/17	D2	C	4	1
3400044	15/feb/17	A2	A	1	1
3400044	15/feb/17	A12	D	268	1
3400044	15/feb/17	A9	A	2	1
3400045	15/feb/17	A5	A	1	1
3400045	15/feb/17	G2	C	212	1
3400046	15/feb/17	A5	A	1	1
3400046	15/feb/17	A5	A	1	1
3400046	15/feb/17	A7	A	12	1
3400047	16/feb/17	A2	B	3	1
3400047	16/feb/17	A12	D	12	1
3400047	16/feb/17	F5	A	3	1
3400048	16/feb/17	A5	A	1	1
3400048	16/feb/17	A8	E	16600	1
3400048	16/feb/17	G3	C		1
3400049	16/feb/17	A2	C	18	1
3400049	16/feb/17	A2	C	16	1
3400049	16/feb/17	A6	D	1555	1
3400049	16/feb/17	A5	A	1	1
3400050	16/feb/17	A5	A	1	1
3400050	16/feb/17	A5	A	1	1
3400050	16/feb/17	A6	C	326	1
3400051	16/feb/17	EMPTY			
3400052	20/feb/17	A3	D	50	1
3400052	20/feb/17	A5	A	1	1
3400052	20/feb/17	A2	C	30	1
3400052	20/feb/17	A7	A	3	1
3400053	21/feb/17	A2	D	25	1
3400053	21/feb/17	A5	A	1	1
3400053	21/feb/17	A5	A	1	1
3400053	21/feb/17	A7	A	1	1
3400053	21/feb/17	F2	A	2	1
3400054	21/feb/17	A5	A	1	1
3400054	21/feb/17	A5	A	1	1
3400054	21/feb/17	A5	A	1	1
3400054	21/feb/17	A5	A	1	1
3400054	21/feb/17	A5	A	1	1

Sample	date	Litter Type	Size category	Weight (g)	number of items
3400054	21/feb/17	A2	B	2	1
3400054	21/feb/17	A2	C	30	1
3400055	21/feb/17	A2	A	1	4
3400055	21/feb/17	A7	A	1	1
3400055	21/feb/17	A7	A	3	1
3400055	21/feb/17	A7	A	20	1
3400055	21/feb/17	F1	C	465	1
3400055	21/feb/17	A2	A	1	1
3400055	21/feb/17	A5	A	1	9
3400055	21/feb/17	A5	A	1	2
3400055	21/feb/17	A2	A	2	1
3400055	21/feb/17	A7	A	1	1

Annex 2 Photos of seafloor litter in the Dutch IBTS Q1 2017

Photo P100606: Part of the litter of sample 3400001

Photo P100607: Part of the litter of sample 3400001

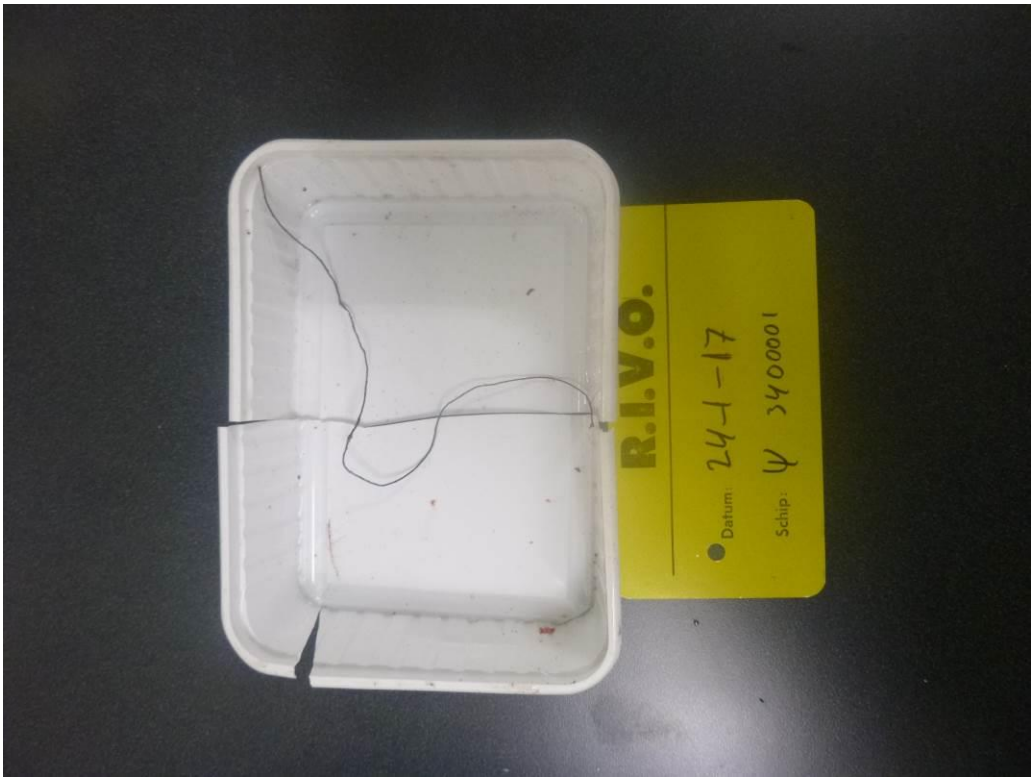

Photo P100609: Part of the litter of sample 3400001


Photo P1000610: All litter of sample 3400002

Photo P1000611: All litter of sample 3400003

Photo P1000612: All litter of sample 3400004

Photo P1000613: All litter of sample 3400005


Photo P1000614: All litter of sample 3400006

Photo P10000615: All litter of sample 3400007

Photo P10000616: All litter of sample 3400008

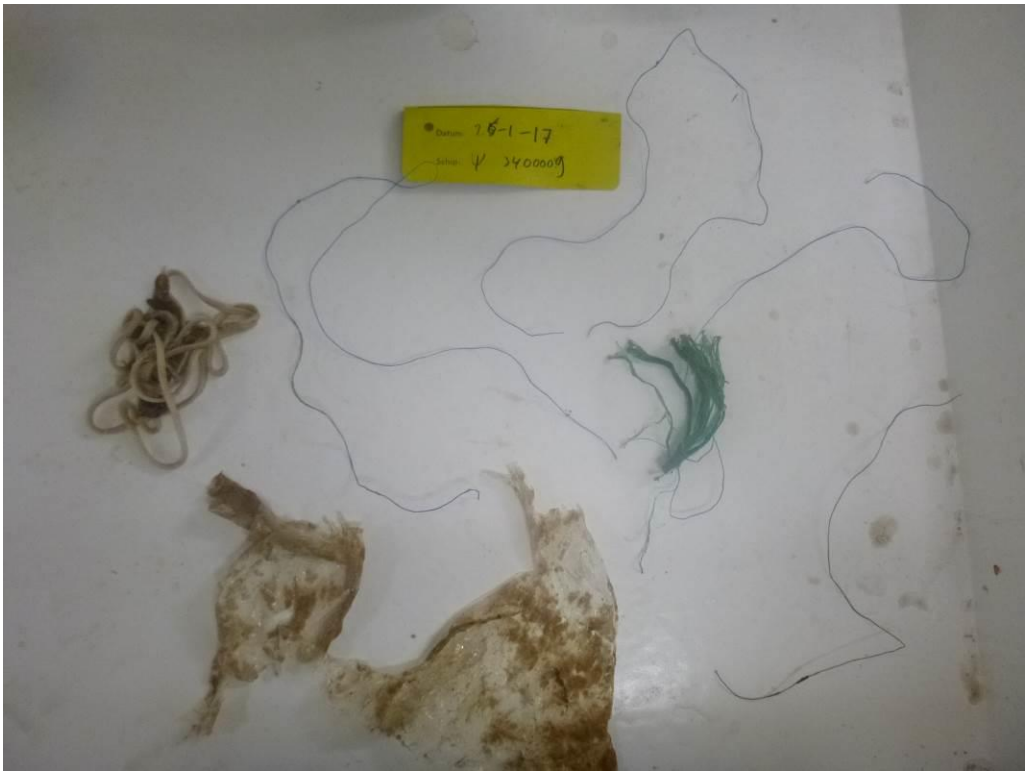

Photo P10000617: All litter of sample 3400009

Photo P10000618: All litter of sample 34000010

Photo P10000622: All litter of sample 3400011

Photo P10000624: All litter of sample 3400012

Photo P10000626: All litter of sample 3400013


Photo P10000627: All litter of sample 3400014

Photo P10000628: All litter of sample 3400015

Photo P10000629: All litter of sample 3400016

Photo P10000633: All litter of sample 3400017

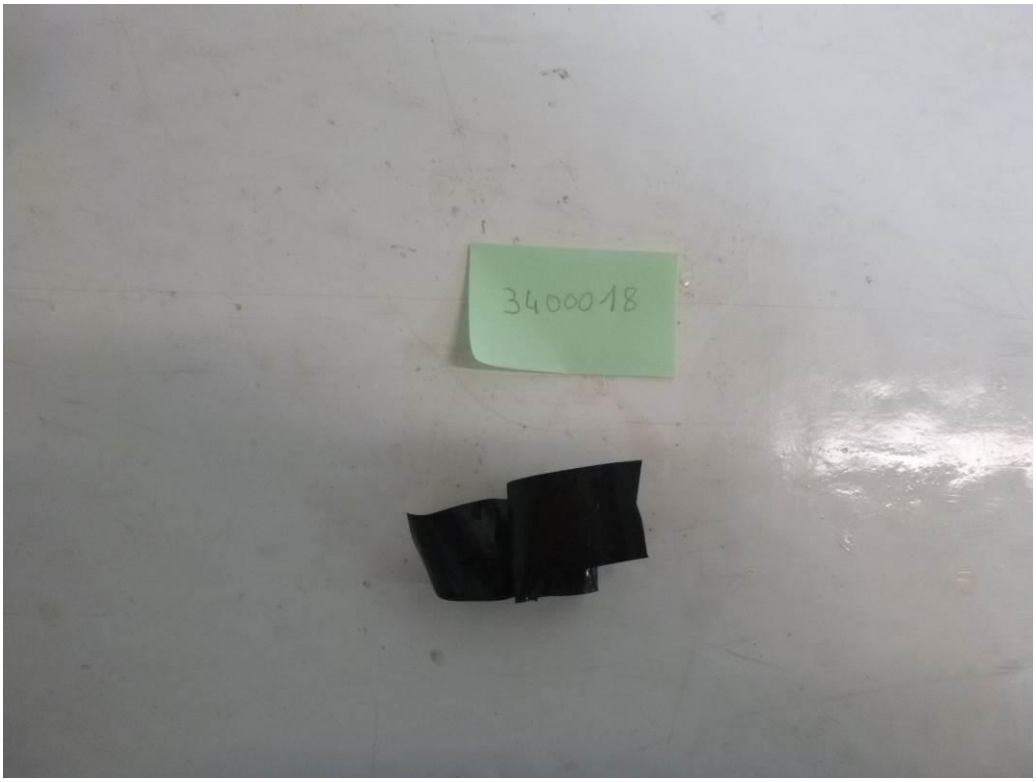

Photo P10000634: All litter of sample 3400018

Photo P10000635: All litter of sample 3400020

Photo P10000636: All litter of sample 3000021

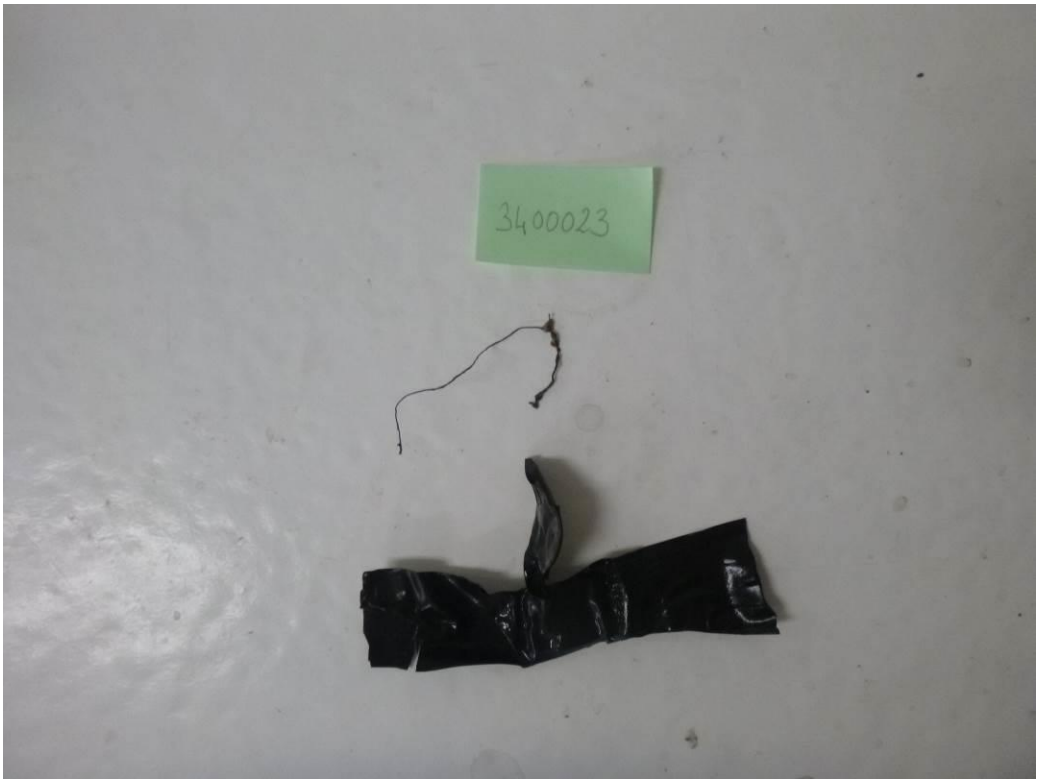

Photo P10000637: All litter of sample 3400023


Photo P10000638: All litter of sample 3400024

Photo P10000641: All litter of sample 3400026

Photo P10000647: All litter of sample 3400028

Photo P10000648: All litter of sample 3400029

Photo P10000649: All litter of sample 3400030

Photo P10000650: All litter of sample 3400031

Photo P10000651: All litter of sample 3400032

Photo P10000652: All litter of sample 3400033

Photo P10000653: All litter of sample 3400034

Photo P10000654: All litter of sample 3400035

Photo P10000656: All litter of sample 4000036

Photo P10000658: All small litter of sample 3000037

Photo P10000659: All small litter of sample 3000038

Photo P10000660: All litter of sample 3400039

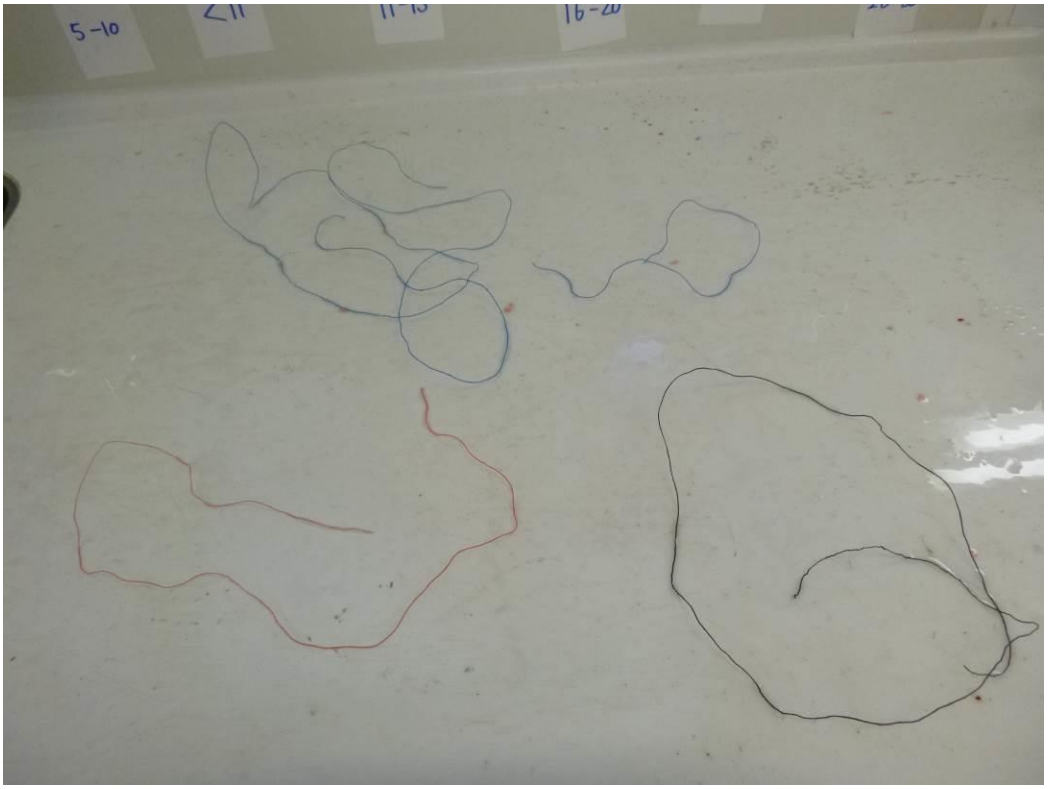

Photo P10000661: All litter of sample 3400040

Photo P10000663: All litter of sample 3400041

Photo P10000664: All litter of sample 3400042

Photo P10000667: All litter of sample 3400043

Photo P10000668: All litter of sample 3400044

Photo P10000669: All litter of sample 3400045

Photo P10000670: All litter of sample 3400046

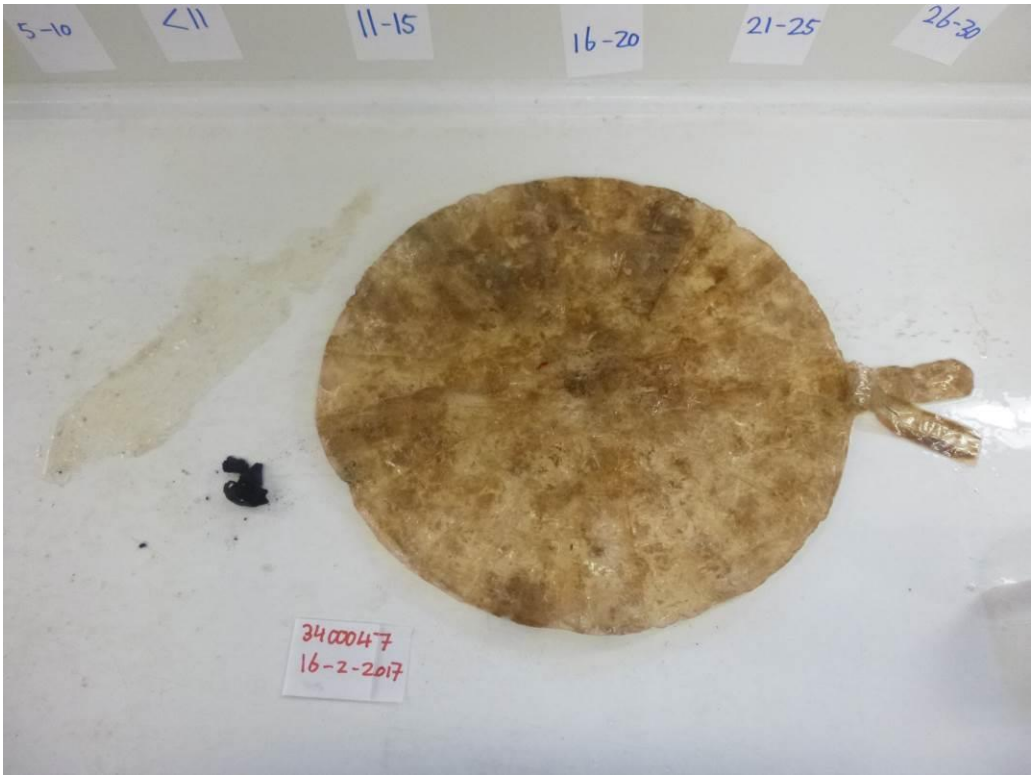

Photo P10000671: All litter of sample 3400047

Photo P10000673: All litter of sample 3000048

Photo P10000674: All litter of sample 3400049

Photo P10000676: All litter of sample 3400050

Photo P10000677: All litter of sample 3400052

Photo P10000678: All litter of sample 3400053

Photo P10000679: All litter of sample 3400054

Photo P10000680: All litter of sample 3400055

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The Wageningen Marine Research vision
'To explore the potential of marine nature to improve the quality of life'

The Wageningen Marine Research mission
- 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

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