Sea floor litter monitoring

International Bottom Trawl Survey 2016

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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 2016. 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.

The composition of the litter collected in 2016 is similar compared to earlier years; plastic and specifically rope/lines are the most dominant litter items found. The survey was again carried out on board the UK vessel CEFAS Endeavour, and the standard Dutch IBTS area including the Channel area was covered. Even though, due to a survey design based on random sampling within ICES rectangles, comparison in spatial distribution of litter as well as in estimates of the amount of litter between years is difficult. The spatial distribution of the litter seems random with small and large catches close to each other. It might be a result of small probability of actually catching litter items with a GOV trawl not designed for this purpose, or by differences in seafloor structure. It is possible to register additional habitat information and use this information in the data analysis

After four years of litter sampling as part of the IBTS, inconsistencies in categorising the litter items are still found between national observers. In 2015 and 2016, close cooperation with CEFAS staff showed that these inconsistencies also exist between countries. The inconsistencies exist for a small number of subcategories, for which there is some arbitrary in how to divide items between them.

Analysing the Dutch IBTS data by itself indicates a number of limitations, e.g. the spatial differences owing to a semi-randomized survey design between years, which could be overcome by combining the international data of the IBTS. This data can be found in the database developed and accessible via the ICES datacentre and combining the data is done within OSPAR.

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 2016 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 2012).

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 2012) was included in the Dutch survey manual (van Damme et al. 2016, WMR-manual), 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 2016, four years of data are available. Therefore RWS requested to put the 2016 data into context of the earlier years. This is done for litter composition, amount and spatial distribution.

2 Materials and Methods

2.1 IBTS 2016

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.
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 distributed over the participating countries such that each rectangle is sampled by two countries each carrying out one trawl haul. The Netherlands normally covers the Southern North Sea, the English Channel, the German Bight and a northern part in front of the Scottish 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 substantially. 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. The gear used was the standard Dutch GOV-net, but rigged with the English otterboards and the English Scanmar units for measuring the geometry of the net. The Scanmar units were also mounted on the wings of the net, providing wingspread. On the Endeavour the whole net is hoisted on deck and the cod-end is lifted from deck to be emptied in a hopper on deck from where sorting of the catch takes place. On the Tridens a part of the ground rope is left hanging on the side of the deck, and the cod-end is emptied in the hopper below decks. This requires no lifting of the full net. For catching litter and sorting the litter this has likely had no effect.

The scientific crew on board of the Endeavour existed of 4 IBTS experts from Wageningen Marine Research completed with 2 IBTS experts from CEFAS. The last two are Scientist in Charge (SIC) on regular English surveys amongst which the IBTS Q3 and a number of beam trawl surveys and both have carried out these surveys for many years. The UK has initiated the collection of seafloor litter and has collected litter for many years (Maes et al. 2014). Both CEFAS experts were familiar with the methods in the IBTS manual and any additions provided by Thomas Maes (Lead in developing the OSPAR international seafloor litter assessment) to collect litter on English fish surveys.

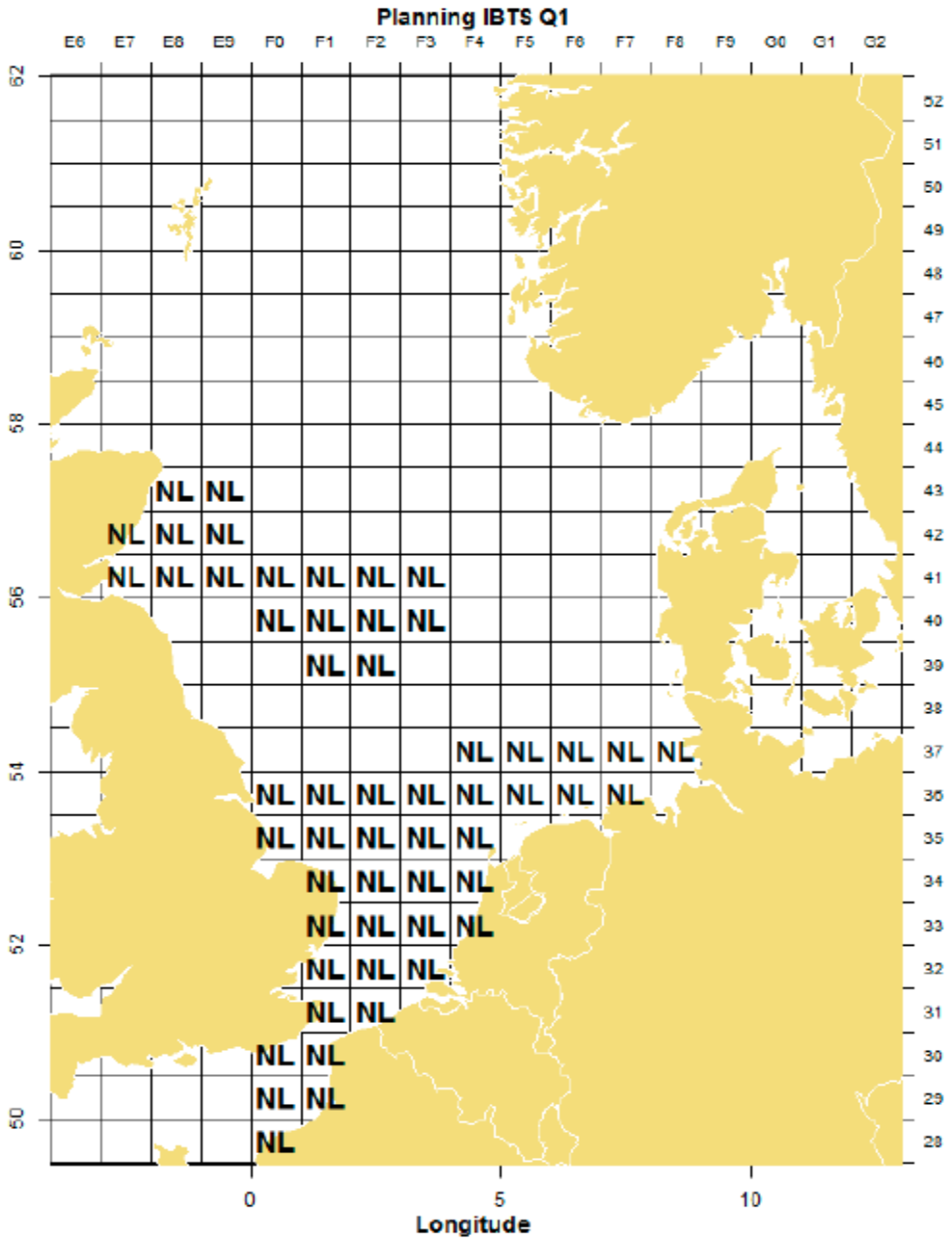

Figure 2-1: Planned ICES rectangles for Dutch GOV hauls during the IBTS 2016.

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 is provided by the concept CEMP/JAMP protocols (EIHA 15/5/14-E; EIHA 15/5/14 Add.1-E), however this still leaves a lot of room for interpretation.

Photo 1: Marine litter with organisms attached

On the Endeavour the complete net is hoisted on board and 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 has sometimes been 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, 2012).

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 on 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.
Like in 2015, we could use the wing sensors of CEFAS and wingspread is actually measured. However, the wing sensors became very unstable during the survey, therefore only of 21 tows information on wingspread was recorded. The missing wingspreads are calculated, which is the common practice when the Dutch vessel is used, as:

Wingspread= doorspread*0.18870+5.87280

In some cases doorspread was not recorded properly, in those cases doorspread is calculated as well:

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

The number of litter items per km^2 was than calculated as:

items/(wing spread*distance trawled).

These formulas differ from those used in the reports of previous years. Owing to measuring two years of wing spread using CEFAS equipment, it was possible to fit the wing spread function to our own data rather than using a function based on the information of other international vessels. For comparisons with previous years the data calculated in previous years are recalculated with the new functions.

3 Results

The Dutch 2016 IBTS Q1 performed 53 trawl hauls. Two of these hauls were marked as invalid for the use in the fish assessments. In one haul the net was stuck after 1 min of the tow, a torn net without catch was recovered. The second haul was fully fished however when hauled a part of the belly and wings of the net were torn. This is expected to have limited effect on the catches of litter and therefore this haul is considered as valid for the litter. Thus for litter 52 valid hauls were available. In 50 of the hauls at least one litter item was found, meaning that only 2 hauls contained no marine litter. In total 364 (including the total number of lines/ropes counted which are reported as a single type) litter items were registered.

3.1 Composition of the litter

Plastics are by far the most frequent category with 85.4% of the items caught (**Figure 3-1**). This is followed by Miscellaneous (5.7%) and Natural products (4.7%).

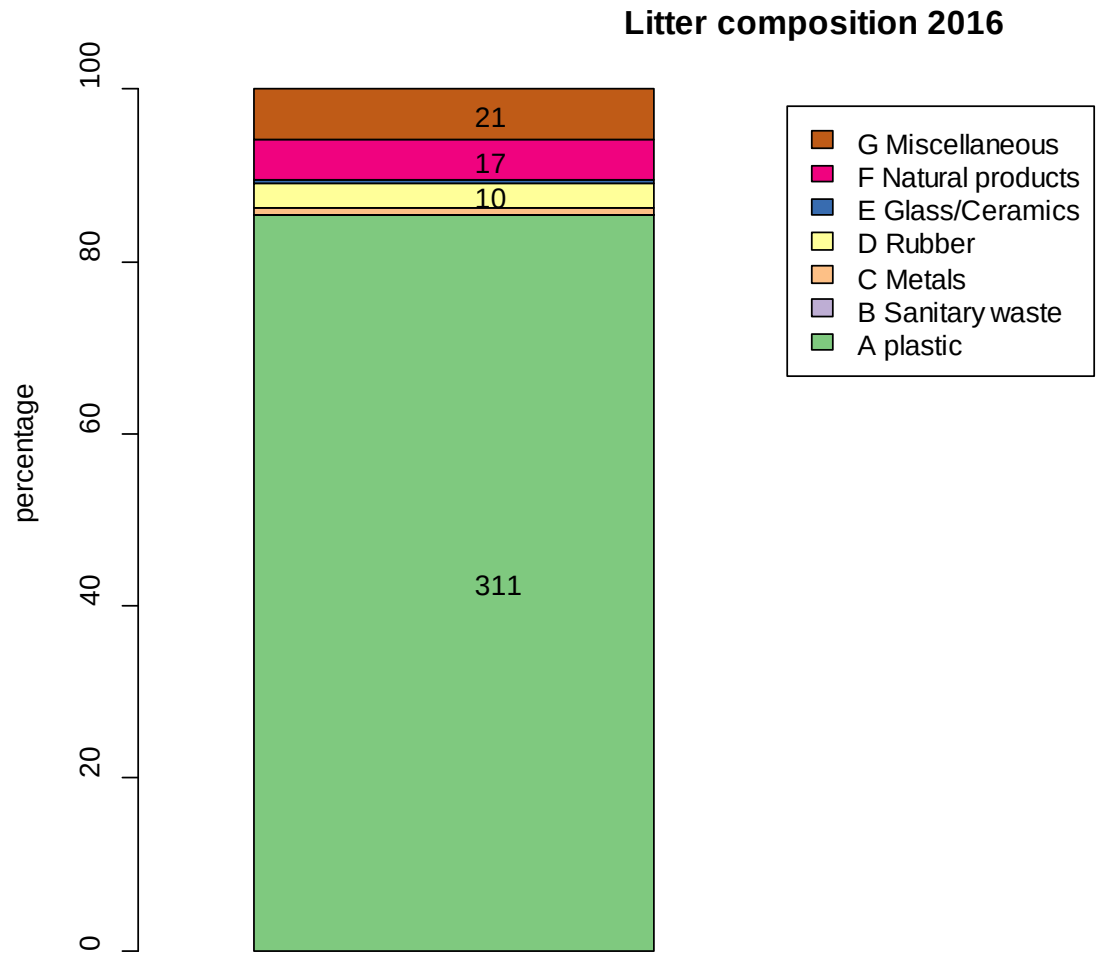

Figure 3-1: Composition of the seafloor litter in the catches of the Dutch IBTS Q1 2016. Values are the absolute number of items for the categories containing more than 1% of the total item count.

The largest category Plastic contains 12 subcategories. The most dominant category is Fishing line (monofilament) with 32.1% of the items. This is followed by Plastic sheet with 28.3% of the items (**Figure 3-2**).

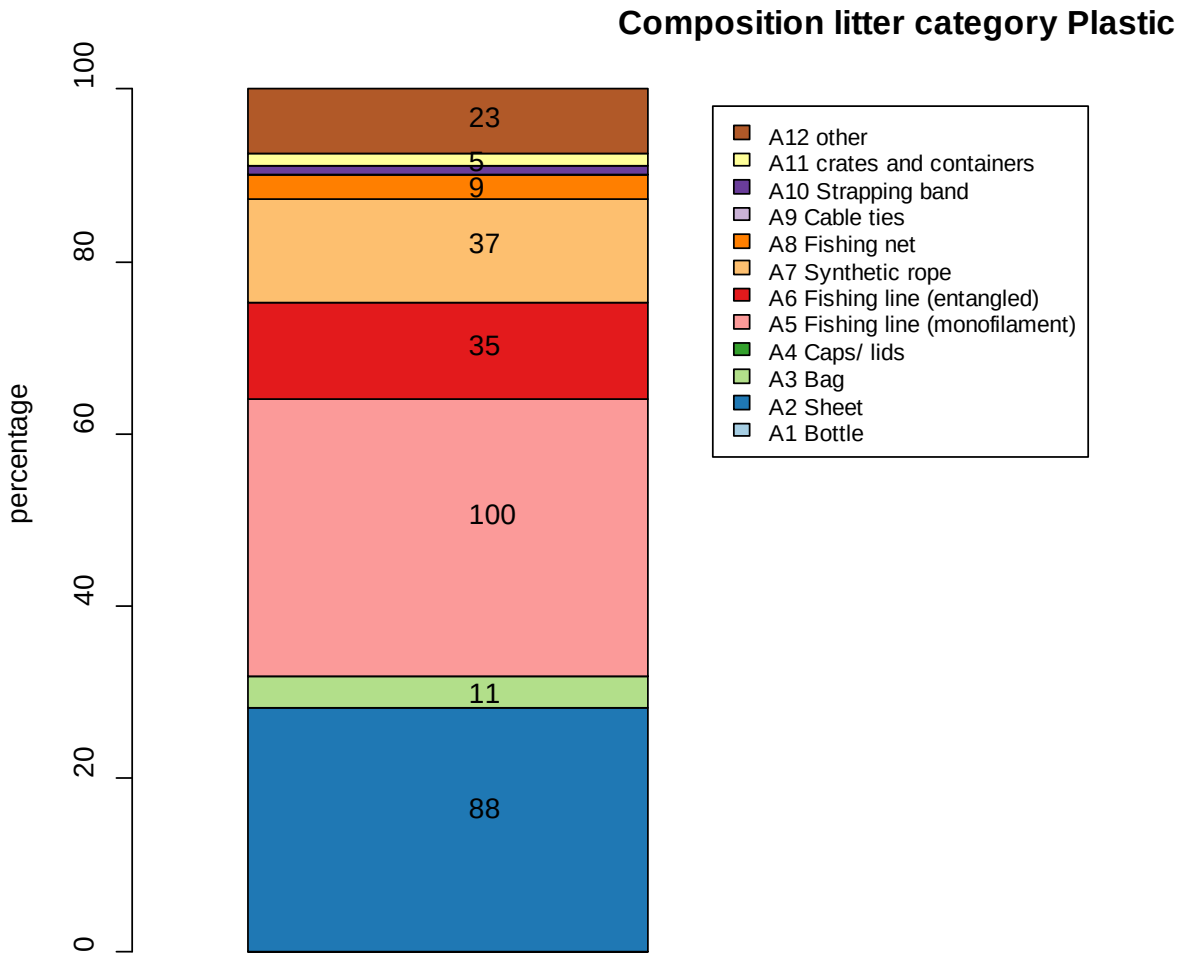

Figure 3-2: Composition of the seafloor litter category A Plastic in the catches of the Dutch IBTS Q1 2016. Values are the absolute number of items for the categories containing more than 1% of the items.

All items were given a size category based on an estimation of the surface. Most of the items (221), 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 items placed in category E (2500-10000 cm^2) were lobster/shellfish cages and a large metal plate (Photo 2). In total 7 shellfish cages were caught of which six in the same haul. The cages were unmarked, damaged and fully overgrown thus likely these were abandoned cages.

Photo 2: Left side one of the shellfish cages caught, right side the large metal plate.

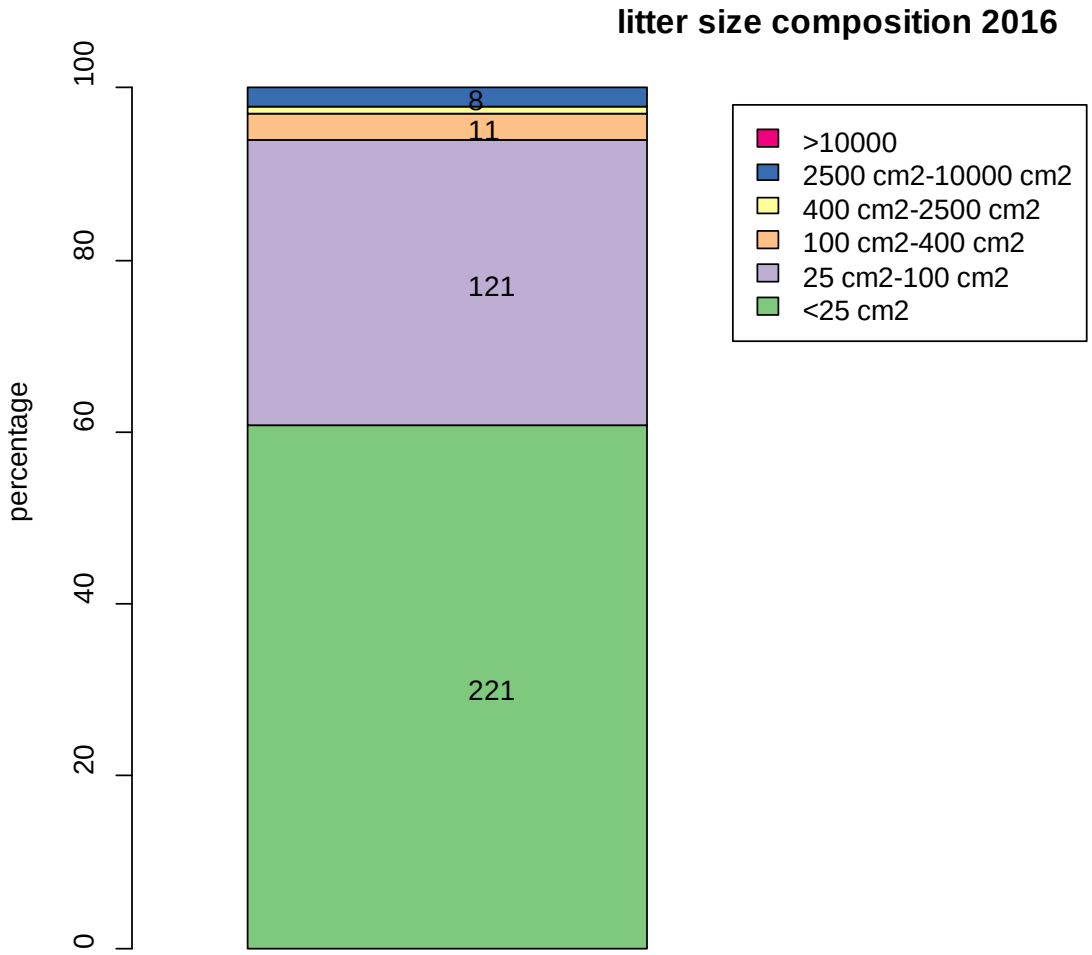

Figure 3-3: Size composition of the seafloor litter (categories A to G combined) in the catches of the IBTS Q1 2016. Values are the absolute number of items for the categories containing more than 1% of the items.

This largest items, the shellfish cages and metal plate, were not weighed as the scales on board are not suitable for these kind of items. For the same reason a long and heavy steel cable (Photo 3) was not weighed.
The heaviest item weighed was a tyre of 26.78 kg (Photo 1). 10 items were in the range of 1-10 kg, all other items weighed less than 600g. The 10 items were pieces of wood, pieces of netting material and fibreglass pieces of a boat.
Most items weigh only a couple of grams. So the distribution of the weight is very skewed, seen in the difference between average weight (349 g) and the median weight (6 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	21	7	6
Surface trawled (km^2)	0.03319	0.08620	0.06634	0.06864
Items per km^2	0	298.1	106.9	99.4
Weight (g)	-	26780	349.2	6

Photo 3: Left side red crate and a blue plastic item; right side steel cable on top of earlier caught litter, placed on top of our own spare cables which are part of our fishing equipment.

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. The exact locations of these trawl hauls vary between years, as the Dutch IBTS chooses its positions 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 that 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 2016 is presented in **Figure 3-4**. This shows the two hauls without litter items in the catch as the minimum catch. One of these is located northwest while the other is one is located southeast just north of the Channel. As in previous years, locations with large amounts of litter are located next to location with low numbers of litter.

The ranges presented by the bubbles in the plots are the same as those used in the 2015 report (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 2016 is only 298 items per km^2 which is found west of the island Texel. The maximum value of 298 items per km^2 corresponds to 21 items reported from the catch. The median number of items is 99.4 items per km^2 corresponding to 6 items in the catch (**Table 3-1**).

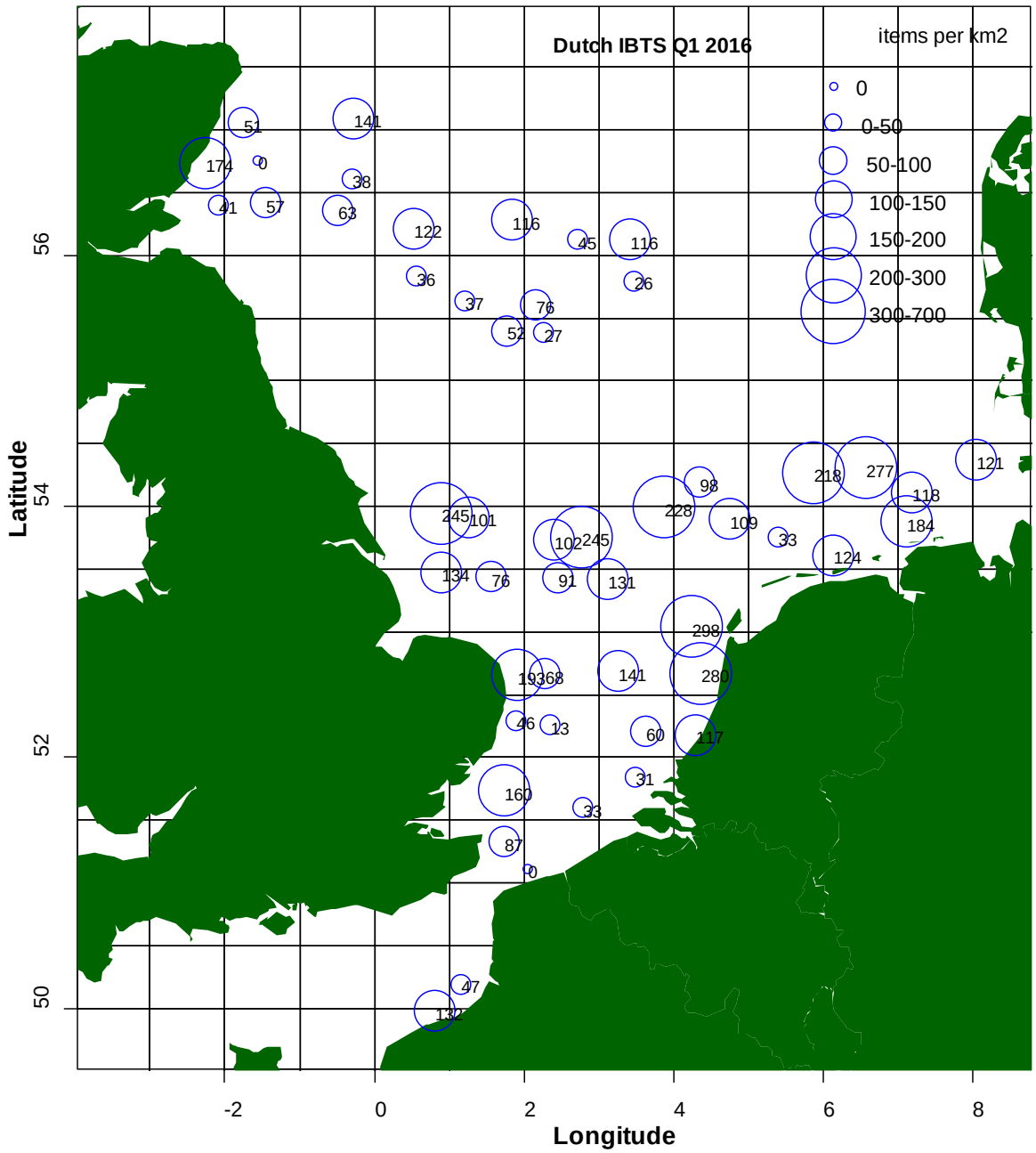

Figure 3-4: Density of litter items per haul per km^2 for the IBTS 2016. The numbers in the circle are the number of items per km^2. The numbers are the midpoints of the circles and correspond to the start position of the trawls, and thus determine the rectangle that is sampled. Empty rectangle have 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 2016 the largest plastic category was A5 Fishing line (monofilament), while in 2015 A7 Synthetic rope and in earlier years A2 Sheets dominated the number of plastic items. Rather than a difference in composition this seems to be due to reporting more things in the A5 Fishing line (monofilament) category rather than in the A6 Fishing line (entangled) and A7 Synthetic rope categories. Like in 2015 we left the decision on A5, A6 or A7 to the CEFAS crew. This were two other persons than in 2015 and looking back at the pictures they clearly made different choices than the crew in 2015, where necessary these differences were corrected. The decision on A5, A6 or A7 but also on A2 Sheet 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 4 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 had 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.

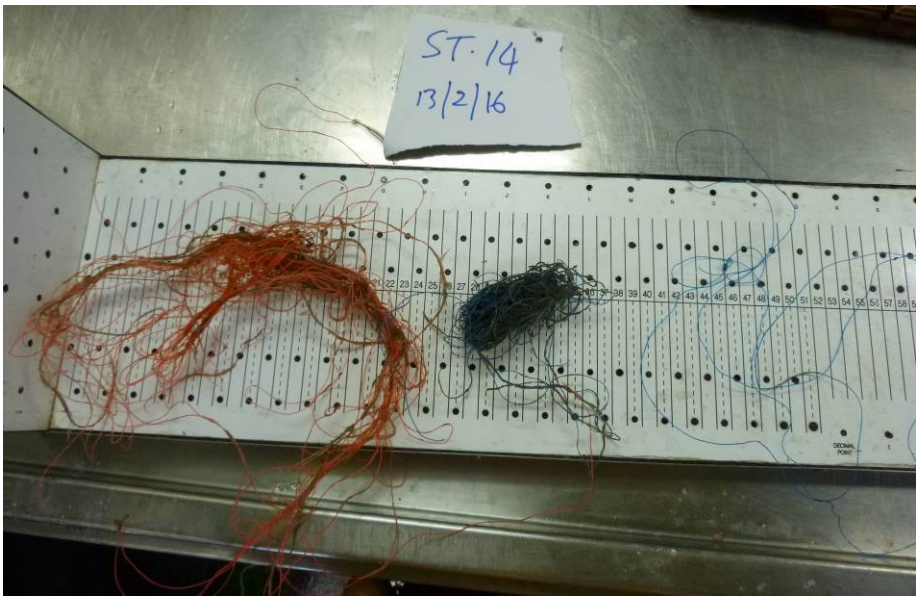

Photo 4: Litter items of haul 14.

Overall the values in 2016 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 2016 map with those in the reports 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**). 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 2013-2016.

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

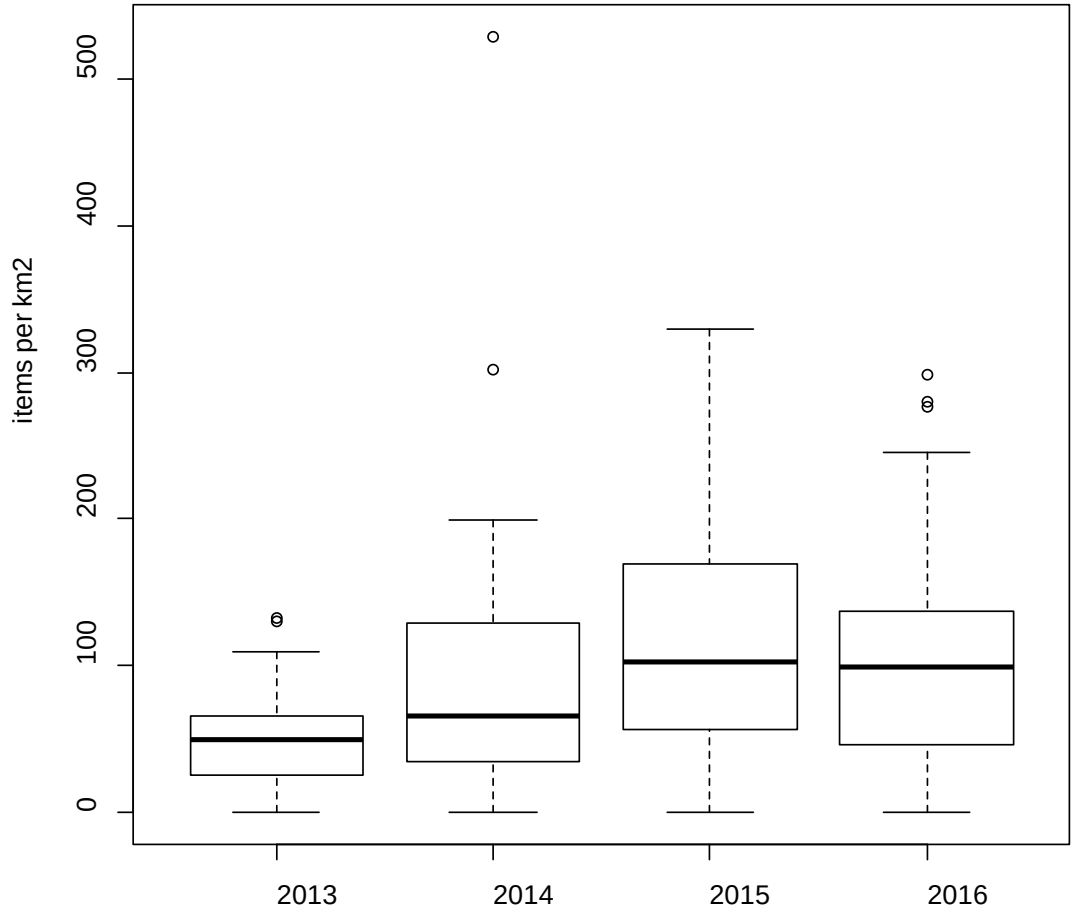

Figure 3-5: Boxplot of the items per km^2 for all the hauls in the three years. The black horizontal line is the median. Note: the geographical coverage between surveys differed.

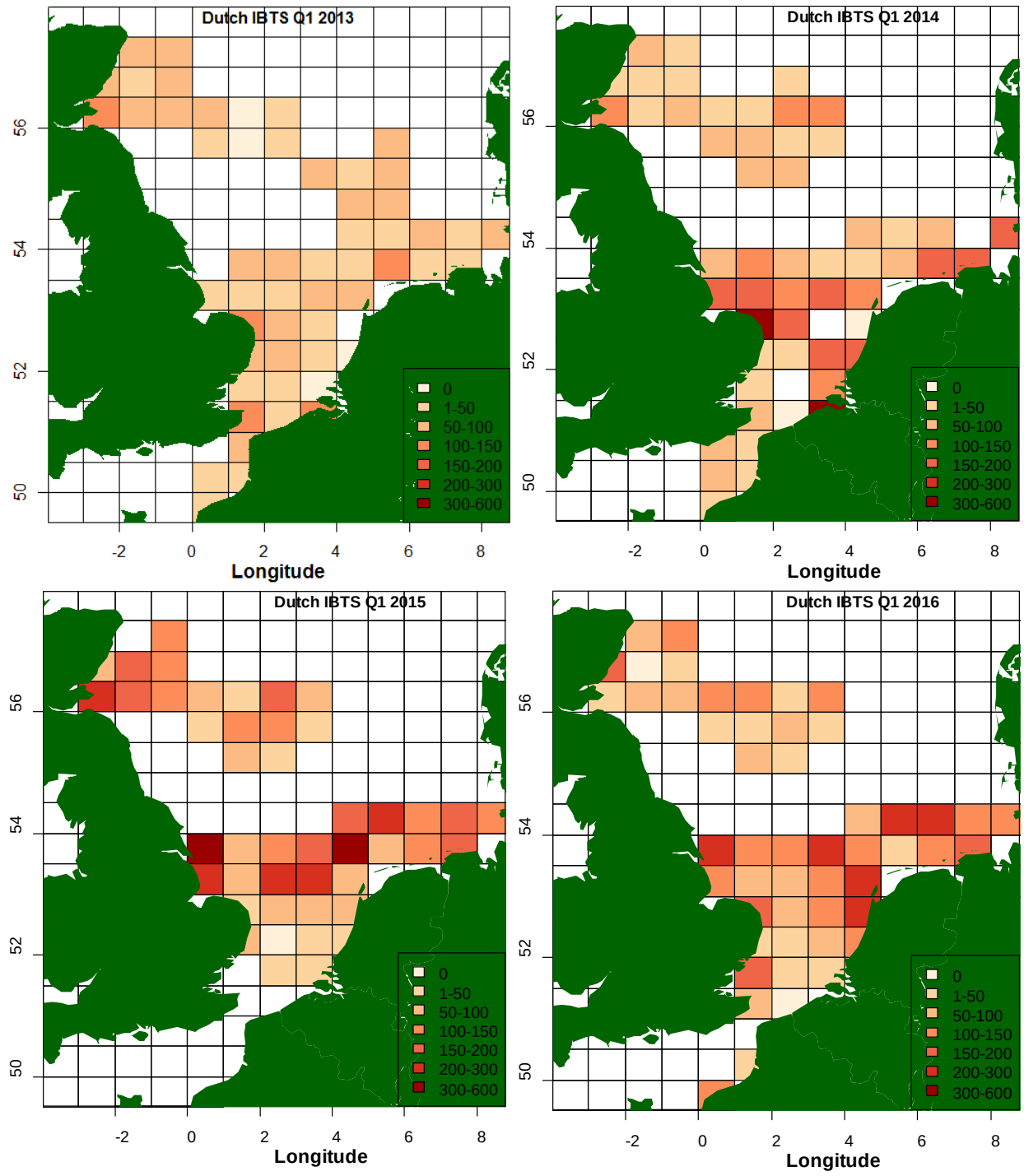

Figure 3-6: Density of litter items per km^2 for the IBTS 2013, 2014, 2015 and 2016. The colour range is the same in all maps.

4 Discussion and Conclusions

The results of 2016 are in line with those of previous years. The seafloor litter from the catches of the Dutch IBTS Q1 2016 contained mostly plastic items: 85.4% 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. 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 chance 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 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 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. 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 only 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 stated in Moriarty et al. (2016) as well. It was expected that the CEMP/JAMP protocols would provide these stricter guidelines, however currently these protocols are still in draft and the draft versions do 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 years 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.

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.

References

EIHA 15/5/14-E OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic Meeting of the Environmental Impact of Human Activities Committee (EIHA), Santander (Spain): 13 - 17 April 2015, Agenda Item 5.

EIHA 15/5/14 Add.1-E OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic Meeting of the Environmental Impact of Human Activities Committee (EIHA) Santander (Spain): 13 - 17 April 2015, Agenda Item 5.

Fleet D, van Franeker J, Dagevos J, Hougee M. 2009. Marine Litter. Thematic Report No. 3.8. In: (Eds), 2009. Quality Status Report 2009. WaddenSea Ecosystem No. 25. Common Wadden Sea Secretariat, Trilateral Monitoring and Assessment Group, Wilhelmshaven, Germany.

Fraser HM, Greenstreet SPR, Piet GJ (2007) Taking account of catchability in groundfish survey trawls: implications for estimating demersal fish biomass. ICES Journal of Marine Science 64:1800-1819

ICES. 2003. Study Group on Survey Trawl Gear for the IBTS Western and Southern Areas ICES, Copenhagen.

ICES. 2012. Manual for the International Bottom Trawl Surveys. ICES, Copenhagen, Denmark.

Maes T, Nicolaus M, Van Der Molen J, Barry J, Kral F. 2014. Marine Litter Monitoring, Defra project ME5415. CEFAS, Lowestoft.

Moriarty M, Pedreschi D, Stokes D, Dransfeld L, Reid DG (2016) Spatial and temporal analysis of litter in the Celtic Sea from Groundfish Survey data: Lessons for monitoring. Marine Pollution Bulletin 103:195-205

Piet GJ, van Hal R, Greenstreet SPR (2009) Modelling the direct impact of bottom trawling on the North Sea fish community to derive estimates of fishing mortality for non-target fish species. ICES Journal of Marine Science 66:1985-1998

van Damme C, Bakker K, Bolle L, de Boois I, Couperus B, van Hal R, Hoek R, Fässler S. 2016. Handboek en protocollen voor bestandsopnamen en routinematige bemonsteringen op het water. CVO.

van der Sluis MT, van Hal R. 2014. Collecting marine litter during regular fish surveys. Report number C065/14, IMARES, IJmuiden.

van Hal R. 2015. Sea floor litter monitored using catches of the International Bottom Trawl Survey. Rapport / IMARES Wageningen UR C083/15, IMARES, IJmuiden.

van Hal R, de Vries M. 2013. Pilot: collecting Marine litter during regular fish surveys. IMARES, IJmuiden.

Justification

Report C021/17
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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: Cindy van Damme
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Signature: 

Date: 15th of March 2017

Approved: Drs. Jakob Asjes
MT member Integration

Signature: 

Date: 24th of March 2017

Annex 1 Data tables with sea floor litter monitoring data of Dutch IBTS Q1 2016.

Annex 1 table 1: Complete dataset of the Dutch IBTS Q1 2016: 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
END	NED	33F4	3000001	52.17642	52.1553	4.29792	4.25577	18	3668	14.00	6	116.84
END	NED	36F5	3000002	53.75003	53.74668	5.40465	5.3487	31	3595	17.00	2	32.73
END	NED	36F6	3000003	53.6089	53.60815	6.14232	6.08627	22	3534	16.00	7	123.80
END	NED	36F7	3000004	53.87182	53.86502	7.11552	7.06232	24	3510	17.00	11	184.35
END	NED	37F7	3000005	54.10553	54.10155	7.19335	7.23908	36	3002	17.00	6	117.57
END	NED	37F8	3000006	54.36427	54.38103	8.04655	8.0935	17	3611	16.00	7	121.16
END	NED	37F6	3000007	54.29938	54.29823	6.58218	6.63827	41	3612	18.00	18	276.85
END	NED	37F5	3000008	54.26207	54.27572	5.8721	5.92393	38	3626	19.00	15	217.73
END	NED	36F4	3000009	53.8922	53.89247	4.7656	4.82033	40	3681	20.00	8	108.67
END	NED	37F4	3000010	54.18833	54.18838	4.3532	4.40882	50	3580	20.00	7	97.77
END	NED	36F3	3000011	53.98647	53.98735	3.8814	3.93858	45	3725	20.00	17	228.19
END	NED	40F2	3000012	55.60253	55.62047	2.15995	2.20895	81	3678	21.53	6	75.75
END	NED	39F2	3000013	55.37852	55.39553	2.26413	2.31318	36	3659	20.00	2	27.33
END	NED	39F1	3000014	55.39415	55.40138	1.78197	1.83833	46	3673	21.00	4	51.86
END	NED	40F1	3000015	55.63147	55.63995	1.22467	1.28182	76	3730	22.00	3	36.56
END	NED	40F3	3000016	55.79093	55.8063	3.4712	3.5237	57	3712	20.59	2	26.17
END	NED	41F3	3000017	56.12015	56.1279	3.42177	3.47957	72	3705	21.00	9	115.67
END	NED	41F2	3000018	56.1185	56.12635	2.716	2.77378	79	3683	18.00	3	45.25
END	NED	41F1	3000019	56.27347	56.2691	1.85508	1.91505	87	3748	23.00	10	116.00
END	NED	40F0	3000020	55.82743	55.79815	0.56998	0.5483	95	3576	23.00	3	36.48
END	NED	41F0	3000021	56.20905	56.18077	0.54057	0.57183	88	3714	22.00	10	122.39
END	NED	41E9	3000022	56.352	56.37148	-0.48068	-0.48145	76	2154	22.00	3	63.31
END	NED	42E8	3000024	56.7511	56.72578	-1.54647	-1.50683	54	3751	21.00	0	0.00
END	NED	41E8	3000025	56.41312	56.39105	-1.44365	-1.44435	58	2473	21.16	3	57.34
END	NED	41E7	3000026	56.39477	56.36188	-2.08598	-2.08005	56	3675	19.84	3	41.15
END	NED	42E7	3000027	56.73193	56.69865	-2.24805	-2.25075	53	3691	20.21	13	174.24
END	NED	43E8	3000028	57.04738	57.0224	-1.74823	-1.7798	122	3358	23.23	4	51.27
END	NED	43E9	3000029	57.08518	57.10652	-0.26638	-0.31343	82	3692	21.16	11	140.82
END	NED	42E9	3000030	56.60378	56.63735	-0.2831	-0.28567	81	3745	21.35	3	37.53
END	NED	36F0	3000031	53.94177	53.94082	0.90367	0.84685	48	3718	16.44	15	245.40
END	NED	36F1	3000032	53.90873	53.9339	1.26128	1.29747	40	3670	18.89	7	100.96
END	NED	35F1	3000033	53.4316	53.4624	1.56487	1.58592	27	3676	17.95	5	75.78
END	NED	35F0	3000034	53.46935	53.44477	0.90907	0.93993	23	3426	17.38	8	134.33
END	NED	33F1	3000035	52.29	52.25775	1.89315	1.88868	30	3606	17.95	3	46.35
END	NED	33F2	3000036	52.2547	52.2214	2.35522	2.3599	43	3712	20.21	1	13.33
END	NED	34F2	3000037	52.6585	52.6912	2.29292	2.29337	43	3632	20.21	5	68.10
END	NED	34F1	3000038	52.65212	52.68532	1.92283	1.914	46	3726	19.46	14	193.09

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
END	NED	32F1	3000039	51.7325	51.76092	1.73565	1.76367	31	3719	16.82	10	159.89
END	NED	31F1	3000040	51.32502	51.35133	1.74558	1.75707	47	3029	19.08	5	86.51
END	NED	28F0	3000041	49.97605	49.9745	0.81418	0.77713	28	2652	20.01	7	131.90
END	NED	29F1	3000042	50.18783	50.21748	1.16793	1.19007	27	3669	17.38	3	47.04
END	NED	31F2	3000043	51.10837	51.10132	2.05362	2.03005	37	1811	18.33	0	0.00
END	NED	32F2	3000044	51.59633	51.5707	2.79438	2.77107	30	3279	18.70	2	32.61
END	NED	32F3	3000045	51.83977	51.82858	3.49802	3.4496	30	3537	18.52	2	30.54
END	NED	33F3	3000046	52.2031	52.19873	3.63797	3.66422	30	1843	18.14	2	59.83
END	NED	34F3	3000047	52.67997	52.6499	3.26865	3.29627	32	3830	18.52	10	141.01
END	NED	35F3	3000048	53.41042	53.4176	3.12767	3.18245	30	3722	18.52	9	130.59
END	NED	35F2	3000049	53.42695	53.39828	2.46957	2.48625	31	3613	18.33	6	90.61
END	NED	36F2	3000050	53.72502	53.71887	2.41728	2.47312	31	3732	18.33	7	102.34
END	NED	36F2	3000051	53.75023	53.76315	2.77408	2.79178	31	1838	20.00	9	244.83
END	NED	35F4	3000052	53.03808	53.06563	4.2483	4.2798	37	3729	18.89	21	298.07
END	NED	34F4	3000053	52.66663	52.69987	4.37122	4.37337	20	3691	16.44	17	280.16

Annex 1 table 2: Complete dataset of the Dutch IBTS Q1 2016. Sample= haulnumber; Litter type = subcategory;

Sample	date	Litter Type	Size category	Weight (g)	number of items
3000001	2/9/16	A2	A	1	1
3000001	2/9/16	A2	A	1	1
3000001	2/9/16	A2	B	4	1
3000001	2/9/16	A12	A	1	1
3000001	2/9/16	A12	A	2	1
3000001	2/9/16	A12	B	7	1
3000002	2/10/16	A2	A	1	1
3000002	2/10/16	A12	A	2	1
3000003	2/10/16	F1	B	25	2
3000003	2/10/16	A10	A	4	1
3000003	2/10/16	A2	B	7	2
3000003	2/10/16	A5	A	1	1
3000003	2/10/16	A12	B	2	1
3000004	2/10/16	F1	B	1036	4
3000004	2/10/16	A7	A	22	2
3000004	2/10/16	A2	A	3	2
3000004	2/10/16	A5	A	1	2
3000004	2/10/16	A12	A	1	1
3000005	2/10/16	F1	C	1690	1
3000005	2/10/16	A5	A	3	3
3000005	2/10/16	A2	A	4	2
3000006	2/11/16	A5	A	14	1
3000006	2/11/16	A7	A	1	4
3000006	2/11/16	A2	A	4	2
3000007	2/11/16	F1	C	5400	2
3000007	2/11/16	A8	D	2760	1
3000007	2/11/16	A7	B	550	1
3000007	2/11/16	A5	A	2	10
3000007	2/11/16	A7	A	1	2
3000007	2/11/16	A2	B	6	2
3000008	2/11/16	C1	B	25	1
3000008	2/11/16	A7	B	4020	1
3000008	2/11/16	A12	B	5	1
3000008	2/11/16	A2	B	150	6
3000008	2/11/16	D5	B	50	2
3000008	2/11/16	A12	B	15	1
3000008	2/11/16	A6	A	5	3
3000009	2/12/16	A2	B	2	1
3000009	2/12/16	D5	C	1	1
3000009	2/12/16	A5	A	1	4

Sample	date	Litter Type	Size category	Weight (g)	number of items
3000009	2/12/16	A7	A	5	1
3000009	2/12/16	A10	A	2	1
3000010	2/12/16	A2	B	73	5
3000010	2/12/16	A6	B	88	1
3000010	2/12/16	A7	A	6	1
3000011	2/12/16	A2	B	210	3
3000011	2/12/16	A3	B	195	6
3000011	2/12/16	A6	B	70	6
3000011	2/12/16	D6	B	335	1
3000011	2/12/16	G1	B	150	1
3000012	2/13/16	A2	B	6	1
3000012	2/13/16	G3	B	1	1
3000012	2/13/16	A6	A	1	3
3000012	2/13/16	A12	A	1	1
3000013	2/13/16	A2	B	22	1
3000013	2/13/16	D3	C	7110	1
3000014	2/13/16	A5	A	1	3
3000014	2/13/16	A7	A	9	1
3000015	2/13/16	A6	A	32	2
3000015	2/13/16	A5	A	1	1
3000016	2/14/16	A5	A	1	2
3000017	2/14/16	A2	B	142	4
3000017	2/14/16	A3	B	12	1
3000017	2/14/16	F1	B	168	1
3000017	2/14/16	A5	A	1	2
3000017	2/14/16	G1	B	177	1
3000018	2/14/16	A2	A	4	1
3000018	2/14/16	A5	A	1	2
3000019	2/14/16	A5	A	1	3
3000019	2/14/16	A2	A	1	2
3000019	2/14/16	A3	A	1	2
3000019	2/14/16	A11	B	193	1
3000019	2/14/16	D5	B	86	1
3000019	2/14/16	A8	B	130	1
3000020	2/15/16	A5	A	1	1
3000020	2/15/16	A7	B	42	1
3000020	2/15/16	A11	A	4	1
3000021	2/15/16	A5	A	4	4
3000021	2/15/16	A2	A	2	2
3000021	2/15/16	A11	B	1	1
3000021	2/15/16	G1	A	1	1
3000021	2/15/16	A7	A	1	1
3000021	2/15/16	A12	A	1	1
3000022	2/15/16	A6	A	1	2
3000022	2/15/16	A12	B	8	1
3000023	2/16/16	INVALID			
3000024	2/16/16	EMPTY			
3000025	2/17/16	A2	B	48	2
3000025	2/17/16	A12	B	23	1
3000026	2/17/16	A2	A	1	1
3000026	2/17/16	D5	A	3	1
3000026	2/17/16	A8	B	27	1
3000027	2/17/16	F1	B	412	1
3000027	2/17/16	A12	B	92	2
3000027	2/17/16	A2	A	6	4
3000027	2/17/16	A12	A	2	1
3000027	2/17/16	A12	A	2	1
3000027	2/17/16	A12	B	1595	1
3000027	2/17/16	G3	C	1720	1
3000027	2/17/16	A11	C		1
3000027	2/17/16	A11	C	3260	1
3000028	2/17/16	A2	A	5	3
3000028	2/17/16	D5	C	363	1
3000029	2/18/16	A7	B	46	4
3000029	2/18/16	A6	B	80	2
3000029	2/18/16	A2	A	1	2
3000029	2/18/16	G1	B	335	2
3000029	2/18/16	A12	A	3	1

Sample	date	Litter Type	Size category	Weight (g)	number of items
3000030	2/18/16	A5	A	1	1
3000030	2/18/16	A7	A	12	1
3000030	2/18/16	G3	C	192	1
3000031	2/19/16	G3	E		6
3000031	2/19/16	A10	B	54	1
3000031	2/19/16	A2	A	9	2
3000031	2/19/16	A7	B	237	3
3000031	2/19/16	A5	A	1	2
3000031	2/19/16	A12	A	5	1
3000032	2/19/16	A2	B	48	3
3000032	2/19/16	A3	B	35	1
3000032	2/19/16	A6	B	82	2
3000032	2/19/16	A8	B	70	1
3000033	2/19/16	A2	A	10	2
3000033	2/19/16	A6	A	3	1
3000033	2/19/16	G1	B	82	1
3000033	2/19/16	A7	A	1	1
3000034	2/19/16	G3	E		1
3000034	2/19/16	A7	A	8	3
3000034	2/19/16	A12	A	17	1
3000034	2/19/16	A6	A	26	1
3000034	2/19/16	A2	A	1	2
3000035	2/20/16	A5	A	1	1
3000035	2/20/16	A2	A	3	2
3000036	2/20/16	A2	A	1	1
3000037	2/20/16	A2	B	15	1
3000037	2/20/16	A7	A	1	2
3000037	2/20/16	A5	A	1	2
3000038	2/20/16	A2	A	1	1
3000038	2/20/16	A7	A	24	1
3000038	2/20/16	A5	A	1	6
3000038	2/20/16	A6	B	16	2
3000038	2/20/16	E2	B	500	2
3000038	2/20/16	C8	E		1
3000038	2/20/16	C3	D		1
3000039	2/21/16	A2	A	2	2
3000039	2/21/16	A8	B	186	2
3000039	2/21/16	A7	B	353	2
3000039	2/21/16	D5	B	83	1
3000039	2/21/16	G1	B	78	1
3000039	2/21/16	A12	A	19	1
3000039	2/21/16	A12	A	6	1
3000040	2/21/16	A2	A	1	1
3000040	2/21/16	A6	B	42	2
3000040	2/21/16	A7	A	24	1
3000040	2/21/16	G3	A	45	1
3000041	2/22/16	D4	D	26780	1
3000041	2/22/16	A2	A	3	1
3000041	2/22/16	G1	A	19	1
3000041	2/22/16	A6	B	143	2
3000041	2/22/16	A8	A	31	1
3000041	2/22/16	A12	A	22	1
3000042	2/22/16	A8	A	3	1
3000042	2/22/16	F2	B	230	1
3000042	2/22/16	A3	B	41	1
3000043	2/22/16	EMPTY			
3000044	2/23/16	A7	A	43	1
3000044	2/23/16	A6	A	3	1
3000045	2/23/16	A2	A	1	2
3000046	2/23/16	A5	A	1	2
3000047	2/23/16	A5	A	1	7
3000047	2/23/16	A2	A	1	2
3000047	2/23/16	A6	A	1	1
3000048	2/24/16	A2	A	2	4
3000048	2/24/16	A5	A	3	3
3000048	2/24/16	F1	A	9	2
3000049	2/24/16	A5	A	1	4
3000049	2/24/16	A2	A	1	1

Sample	date	Litter Type	Size category	Weight (g)	number of items
3000049	2/24/16	A7	A	37	1
3000050	2/24/16	A2	A	1	3
3000050	2/24/16	A6	B	138	1
3000050	2/24/16	A5	A	1	2
3000050	2/24/16	A7	A	33	1
3000051	2/24/16	A6	A	16	2
3000051	2/24/16	A5	A	1	4
3000051	2/24/16	G3	B	168	1
3000051	2/24/16	G3	B	1281	1
3000051	2/24/16	A2	A	3	1
3000052	2/25/16	A5	A	2	18
3000052	2/25/16	A8	C	355	1
3000052	2/25/16	A7	A	48	1
3000052	2/25/16	A2	A	1	1
3000053	2/25/16	A5	A	1	9
3000053	2/25/16	A6	A	3	1
3000053	2/25/16	A2	B	4	4
3000053	2/25/16	F1	B	67	3

Annex 2 Photos of seafloor litter in the Dutch IBTS Q1 2016

Photo P1000005: All litter of sample 3000001

Photo P1000006: All litter of sample 3000003

Photo P1000007: All litter of sample 3000004

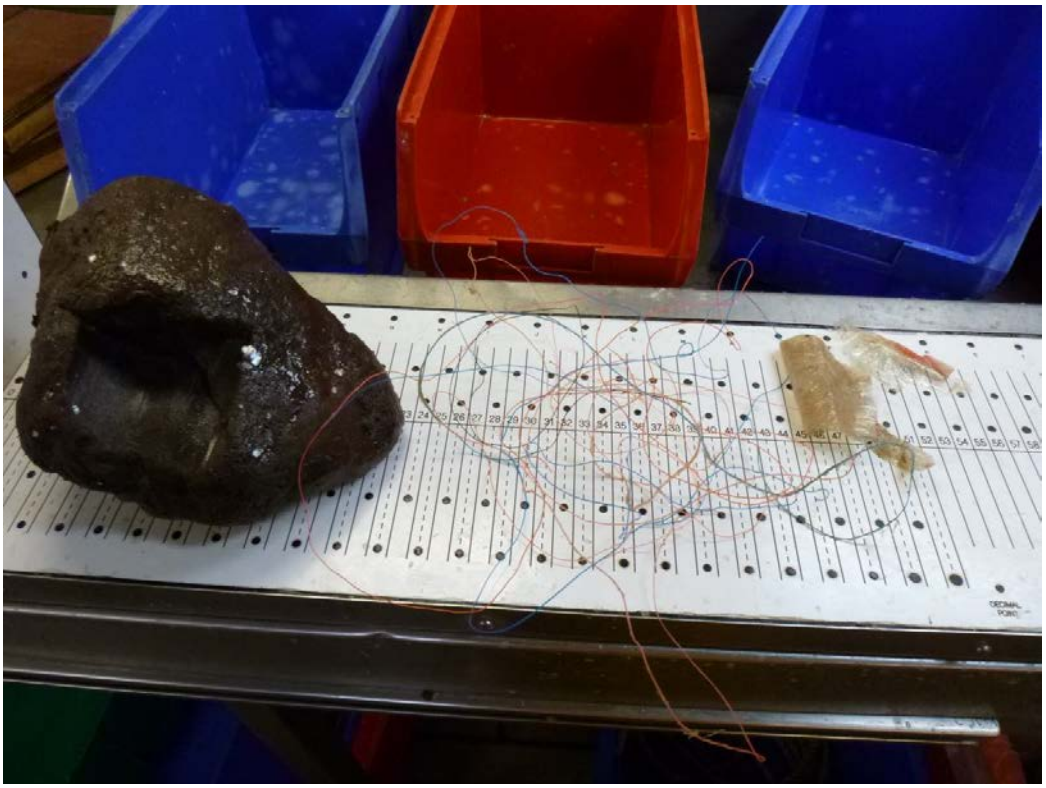

Photo P1000008: All litter of sample 3000005

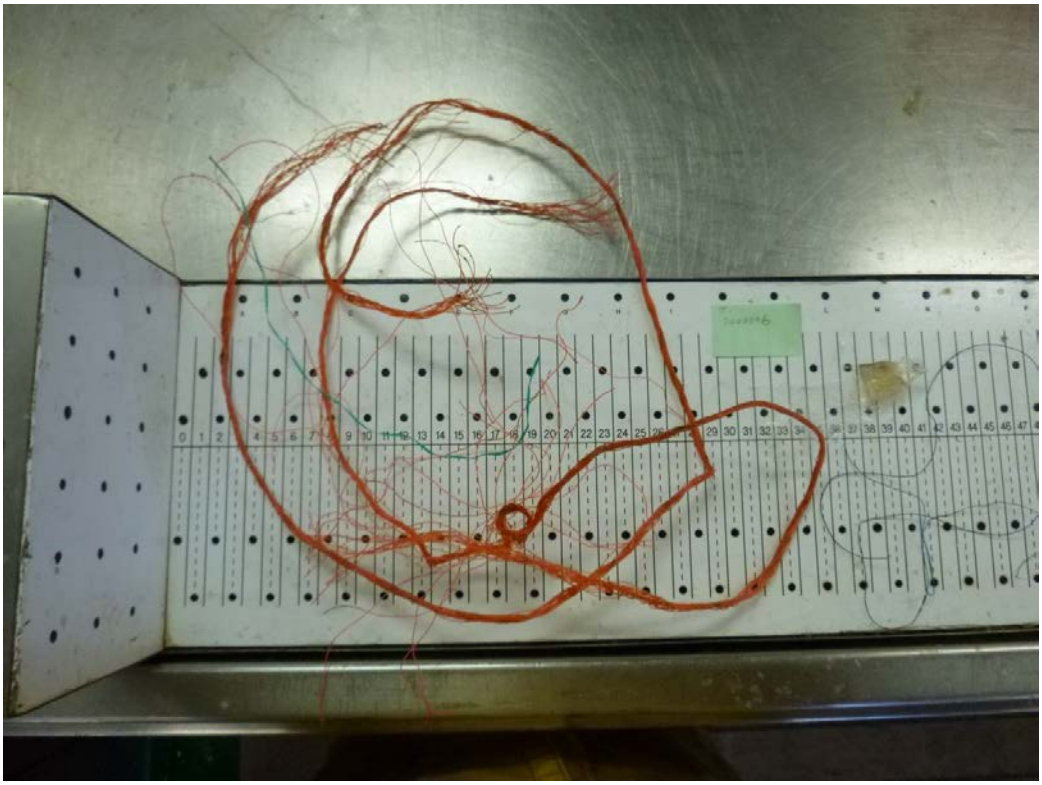

Photo P1000009: All litter of sample 3000006

Photo P10000011: All litter of sample 3000007

Photo P10000012: All litter of sample 3000008

Photo P10000013: All litter of sample 3000009

Photo P10000014: All litter of sample 30000010

Photo P10000015: All litter of sample 3000011

Photo P10000016: All litter of sample 3000012

Photo P10000017: All litter of sample 3000013

Photo P10000018: Detailed picture of a D3 item 3000013

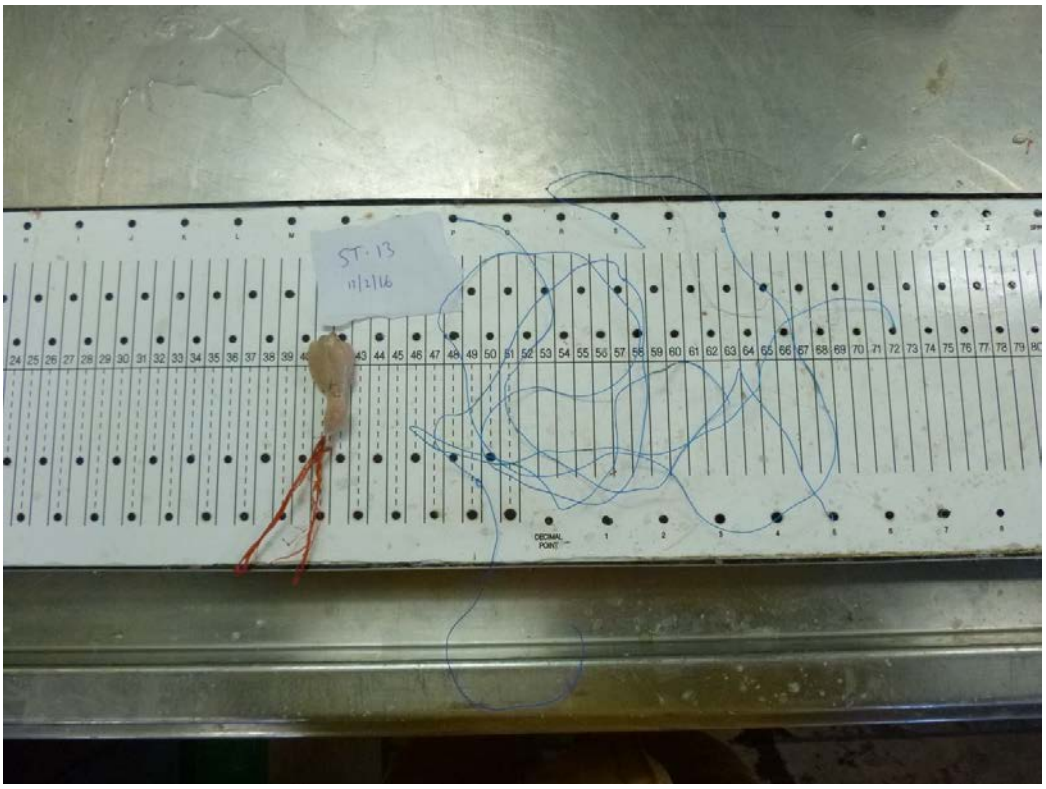

Photo P10000022: All litter of sample 3000014 (wrong station number on the paper)

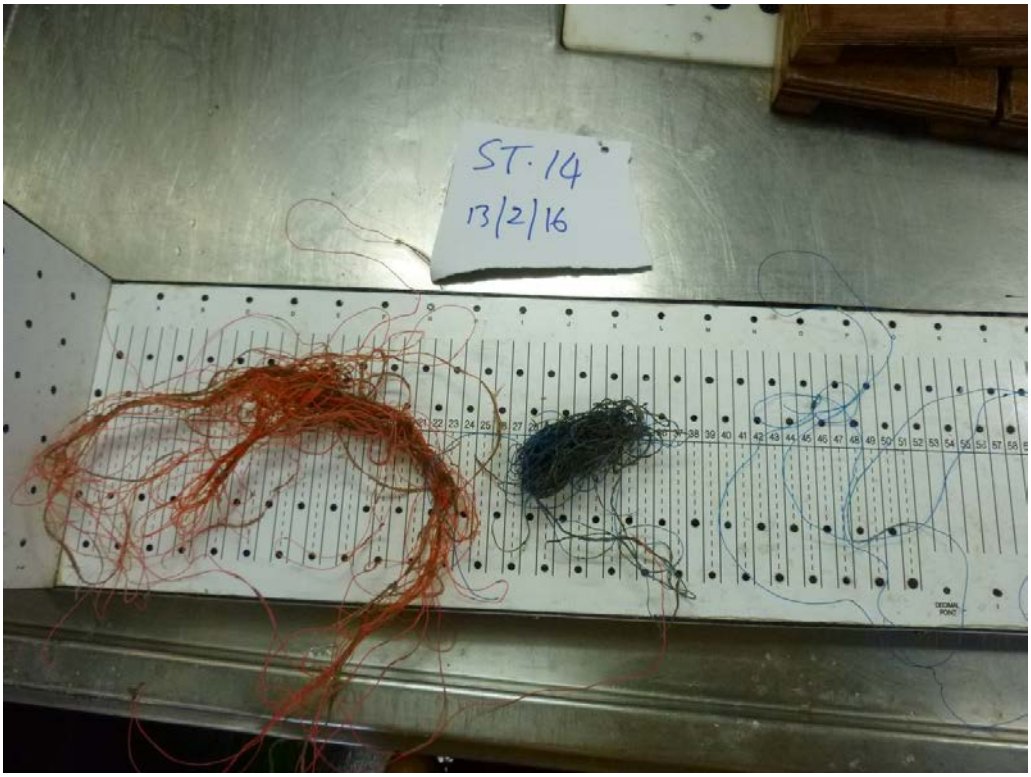

Photo P10000023: All litter of sample 3000015 (wrong station number on the paper)

Photo P10000028: All litter of sample 3000016

Photo P10000029: All litter of sample 3000017

Photo P10000030: All litter of sample 3000018

Photo P10000031: All litter of sample 3000019

Photo P10000032: All litter of sample 3000020

Photo P10000033: All litter of sample 3000021

Photo P10000034: All litter of sample 3000022

Photo P10000035: All litter of sample 3000025

Photo P10000036: All litter of sample 3000026

Photo P10000037: All small litter of sample 3000027

Photo P10000038: Part of the larger litter of sample 3000027

Photo P10000058: The red crate is part of the larger litter of sample 3000027

Photo P10000040: All litter of sample 3000028

Photo P10000041: Part of the larger litter of sample 3000029

Photo P10000045: All litter of sample 3000030

Photo P10000046: On of the shellfish cage of sample 3000031

Photo P10000047: On of the shellfish cage of sample 3000031

Photo P10000048: On of the shellfish cage of sample 3000031

Photo P10000049: On of the shellfish cage of sample 3000031

Photo P10000050: On of the shellfish cage of sample 3000031

Photo P10000051: On of the shellfish cage of sample 3000031

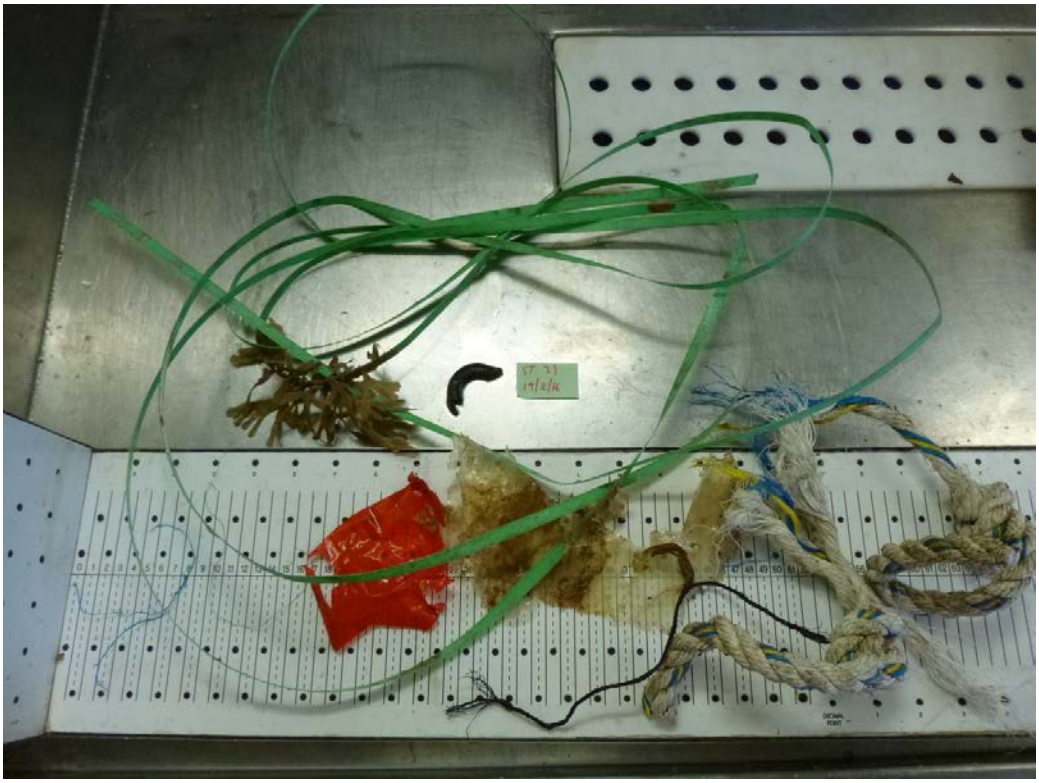

Photo P10000052: All small litter of sample 3000031

Photo P10000053: All litter of sample 3000032 (wrong sample on paper)

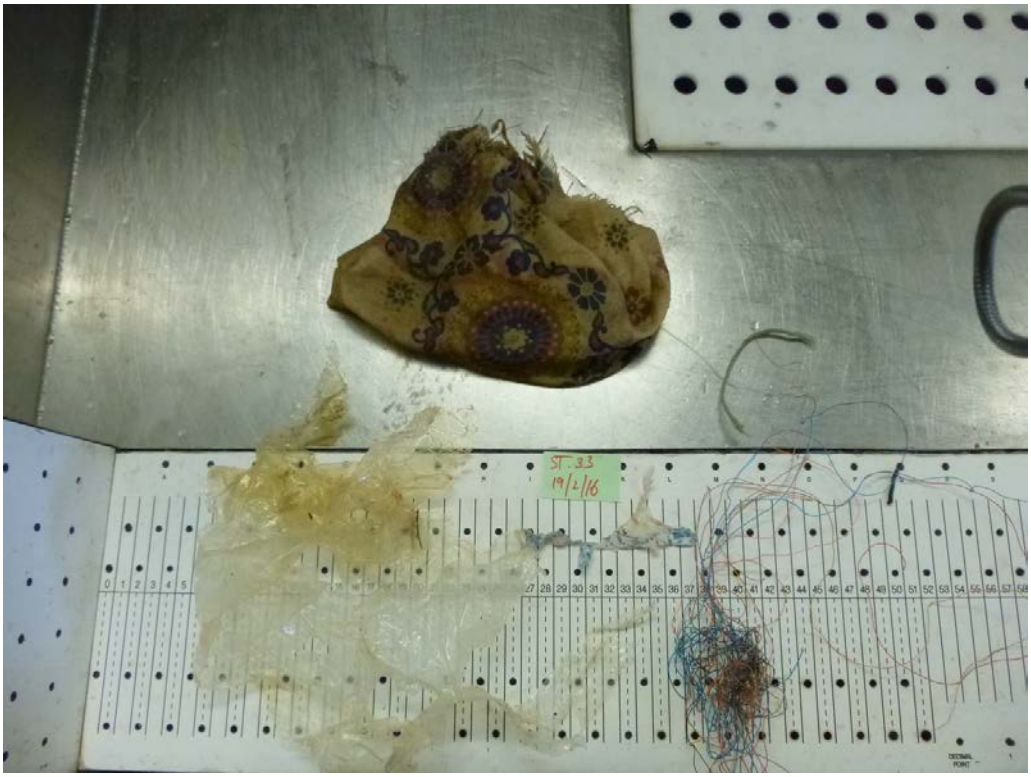

Photo P10000054: All litter of sample 3000033

Photo P10000055: All litter of sample 3000034

Photo P10000056: The shellfish cage from sample 3000034

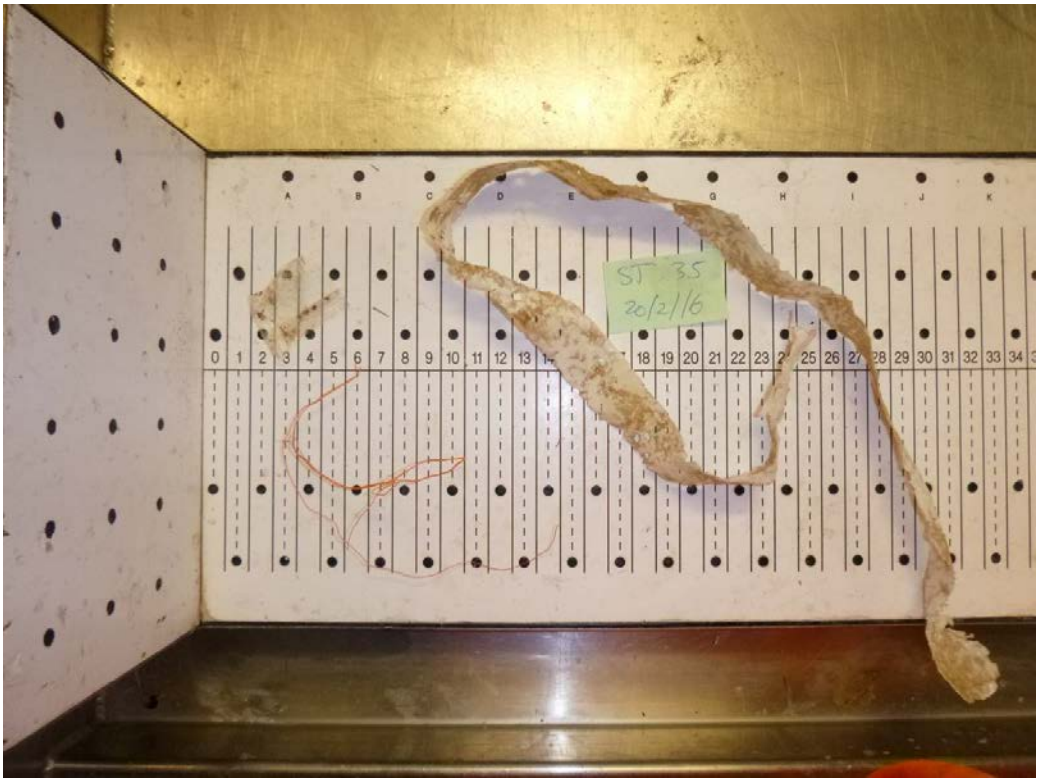

Photo P10000057: All litter of sample 3000035

Photo P10000059: All litter of sample 3000036

Photo P10000060: All litter of sample 3000037

Photo P10000061: Steel plate of sample 3000038

Photo P10000062: Steel cable of sample 3000038

Photo P10000063: All small litter of sample 3000038

Photo P10000064: All litter of sample 3000039

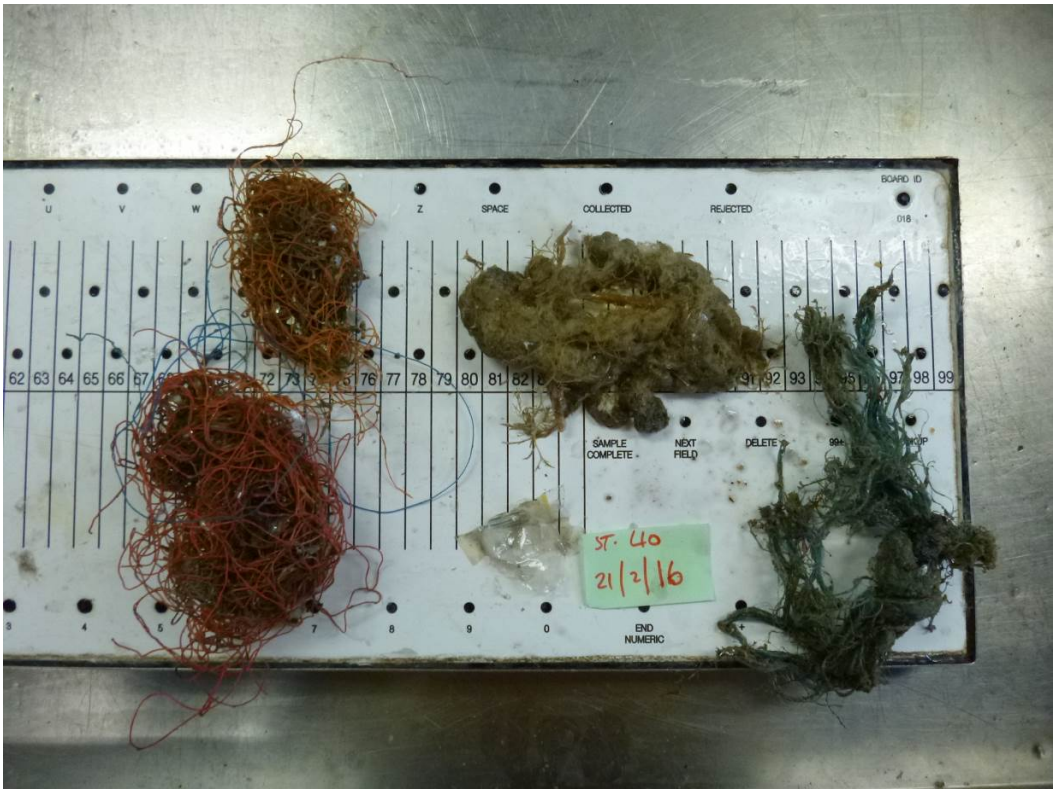

Photo P10000065: All litter of sample 3000040

Photo P10000066: Tire of sample 3000041

Photo P10000067: All small litter of sample 3000041

Photo P10000068: All litter of sample 3000042

Photo P10000069: All litter of sample 3000044

Photo P10000070: All litter of sample 3000045

Photo P10000071: All litter of sample 3000046

Photo P10000072: All litter of sample 3000047

Photo P10000073: All litter of sample 3000048


Photo P10000074: Edible crab entangled in litter of sample 3000048

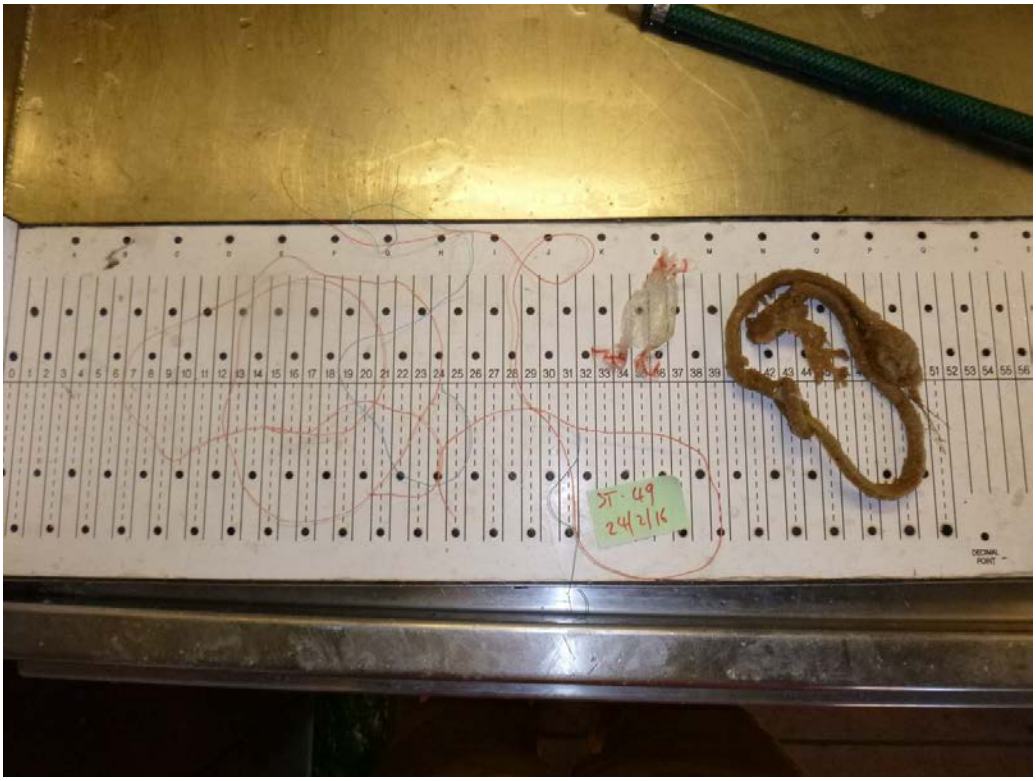

Photo P10000075: All litter of sample 3000049

Photo P10000076: All litter of sample 3000050

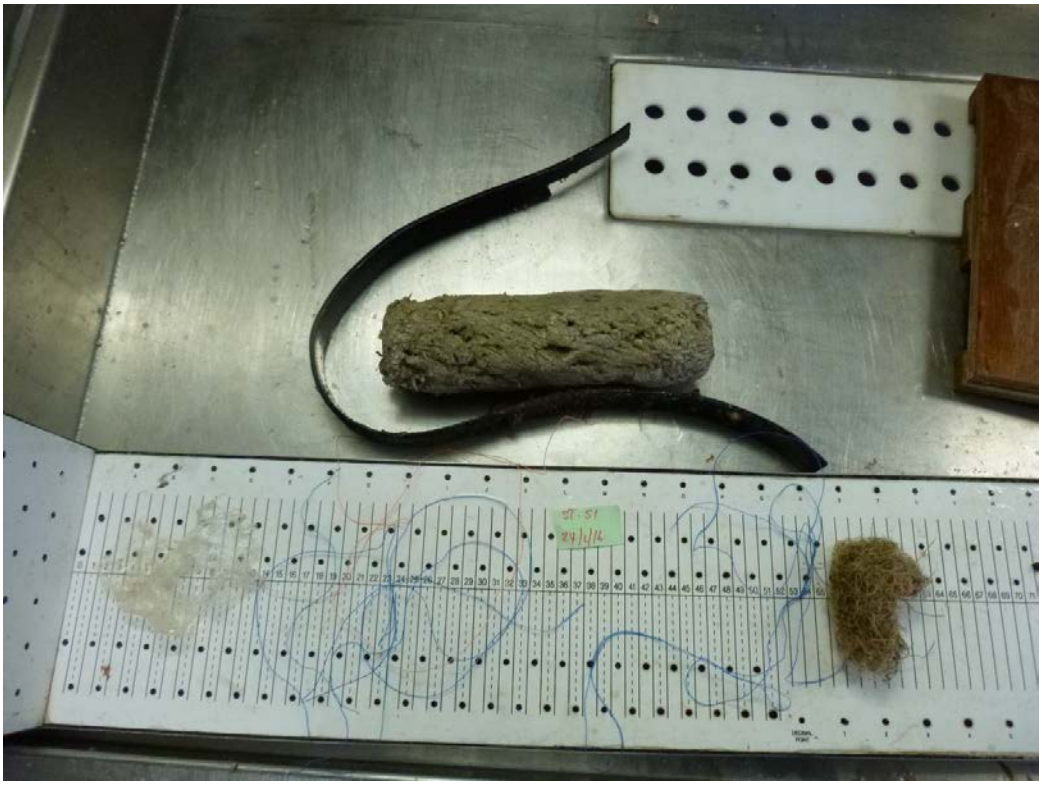

Photo P10000077: All litter of sample 3000051

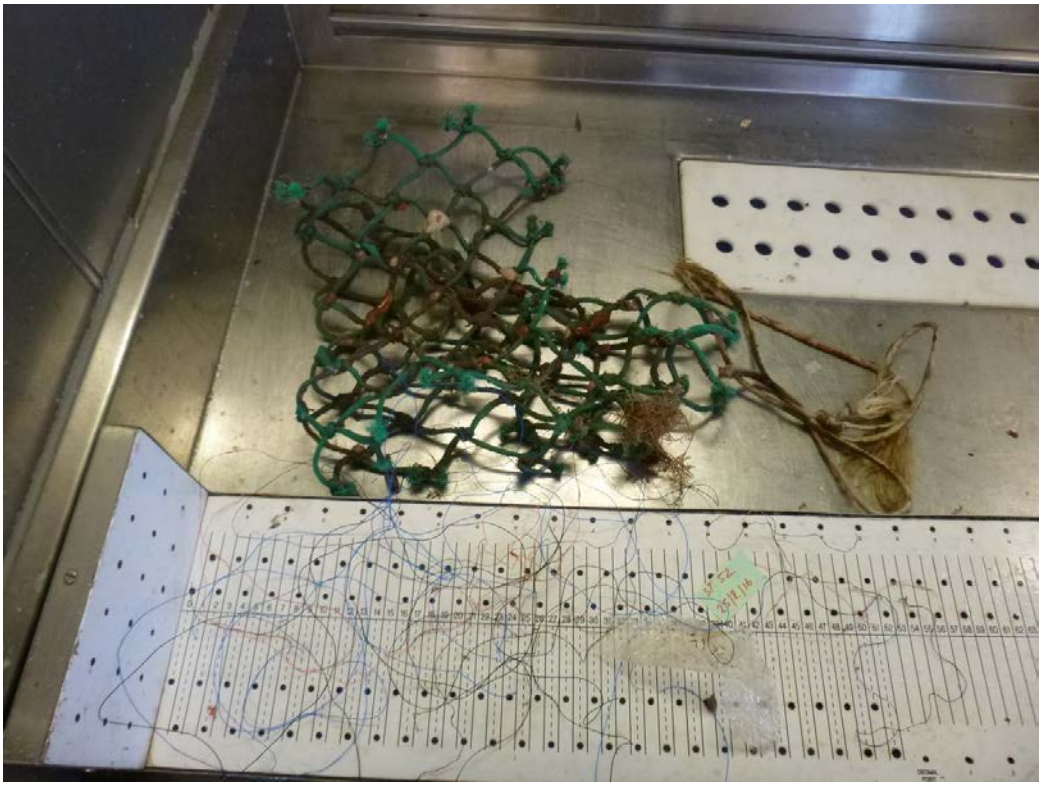

Photo P10000078: All litter of sample 3000052

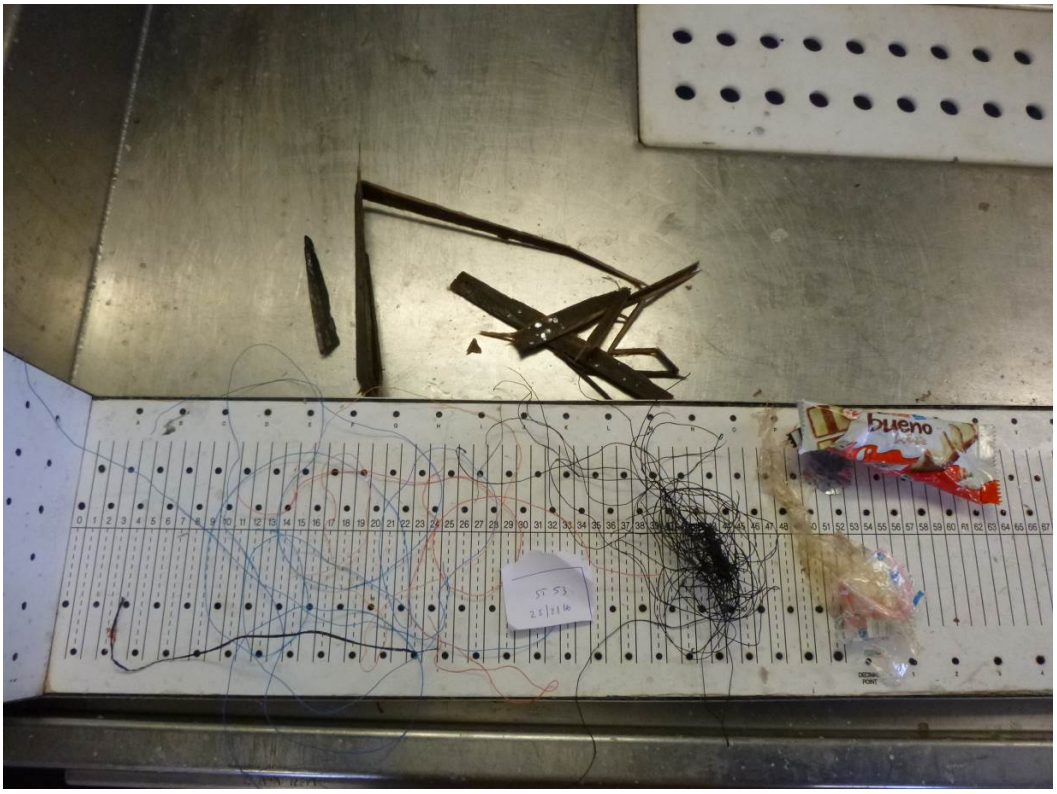

Photo P10000079: All litter of sample 3000053

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'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.
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