Sea floor litter monitored using catches of the International Bottom Trawl Survey

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Summary

The Marine Strategy Framework Directive (MSFD) requires from 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 and trends of the marine waters on a regular basis and the effect of measures, 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 and distribution on litter on the seafloor. This data should be collected by statutory task fish surveys using standardized bottom trawling gears, as used in the International Bottom Trawl Survey (IBTS).

This report presents the results of the seafloor litter monitoring during the IBTS survey of Quarter 1 2015. Seafloor litter data is collected 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 conclusion is that the composition of the litter collected in 2015 compared to that of the 2014 and 2013 surveys is similar; plastic and specifically plastic sheets and rope/lines are the most dominant litter items found. The spatial extend of the survey in 2015 is smaller than in the earlier years, due to a refit of the vessel regularly used which forced the use of foreign vessel allowing less day-at-sea. Also the spatial distribution of the sampling stations varies due to the random sampling survey design within the ICES rectangles. This makes a comparison in spatial distribution of litter as well as in estimates of the amount of litter between years difficult. The slightly higher amount of litter in 2015 compared to the other two years could be driven by the spatial differences in the survey rather than due to an actual increase of litter in the environment. This sampling design makes it necessary to perform data analyses and assessments at the integrated North Sea level.

After three years of litter sampling as part of the IBTS still inconsistencies in categorising the litter items are found between individual observers. This years close cooperation with CEFAS staff showed that these inconsistencies exists also between countries. The still pleas for stricter guidelines in the manual.

Analysing the Dutch data by itself indicates a number of limitations, e.g. the spatial differences between years, which could be overcome by combining the international data of the IBTS. Work on the database to provide for this is still ongoing within the ICES datacentre. The limitations amongst others indicate that little is known on the relation between litter and habitats and other spatial variables such as current directions and velocities and local human inputs such as shipping intensity. Effort in understanding this could help with interpreting the data found by the survey.

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."

Photo 1: Glass bottle (E2) covered with eggs

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*" [1]. Other examples are bans or taxes on plastic bags in supermarket (In the Netherlands, it will no longer be allowed to give free plastic bags away from the first of January 2016) , "Green deals"[2] on Clean Beaches and on Fishery for a Clean Sea. The Green deal on fishery includes i.e. 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 requirement 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, litter washed ashore, litter in biota and litter deposited at the seafloor.

This report describes the methods used and data collected in 2015 for the Dutch part of the monitoring of litter deposited at the seafloor as commissioned by RWS. In OSPAR, it was proposed to collect this type of data by using information gathered from the fish catches of the International Bottom Trawl Survey (IBTS). In earlier work for RWS (van Hal and de Vries 2013; van der Sluis and 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 so-called '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) (The International Bottom Trawl Survey Working Group 2012). CEMP/JAMP protocols, which will

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[1] Regels afval zeeschepen per 1 januari 2013 aangescherpt
http://www.ilent.nl/actueel/regels_afval_zeeschepen_per_1_januari_2013_aangescherpt.aspx

[2] Green Deals are appointments between the National government and other parties, Citizens, companies, local councils and stakeholder organisations. The Dutch Government wants to help people with local sustainable projects that are hard to get off the ground, they would like to help to remove barriers in for example legislation and administration. http://www.government.nl/news/2014/11/24/two-green-deals-for-a-cleaner-sea-and-beach.html

likely become the standard procedures used by the OSPAR countries to monitor litter, were under development and concept versions (EIHA 15/5/14-E; EIHA 15/5/14 Add.1-E) were only provided after the survey and have thus not been used.

The earlier work done in 2013 (van Hal and de Vries 2013) was a successful pilot project after which it was decided to make monitoring of seafloor litter a regular part of the Dutch IBTS survey. Therefore the international protocol was included in the Dutch survey manual (van Damme et al. 2014) along with clarifying additions based on the work done during the pilot (van Hal and de Vries 2013). Since then the data on seafloor litter collected during the IBTS are stored and provided to RWS.
With the data collected in 2015, three years of data are available. Therefore RWS requested to place the new 2015 data in the context of the earlier years. This is done for litter composition, amount and spatial distribution.

2. Materials and Methods

2.1 Regular fish surveys

IBTS

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 in a grid, ICES rectangles, of 0.30° latitude and 1° longitude. Each of these rectangles is fished twice. The rectangles are distributed over the participating countries such that each rectangle is fished by two countries each fishing one 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. In 2015 the English Channel was not part of the Dutch area (Figure 2-1).

The fishing 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 fish pelagic species and those species which dwell just above the bottom. As the groundrope 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 groundrope 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 representatively (ICES 2003).
The horizontal opening of the net is determined by the pressure on the two doors (otterboards), one on each side of the net. The horizontal opening of the net varies with depth. The width between the doors (Doorspread) is therefore measured continuously during each haul. The doors are connected to the net by a 10 m backstrop 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 wingspread is calculated based on the doorspread in the normal Dutch situation.

The standard fishing practice is a trawl duration of 30 minutes, with a fishing speed of 4 knots. Trawling is carried out only during daylight hours.

The Netherlands normally uses the research vessel Tridens II. In 2015, due to a refit of the Tridens, the English research vessel CEFAS Endeavour was hired. Due to time constraints -the duration of the charter was restrictive to the normal activities- the English Channel was excluded from the Dutch planning. The

gear used was still the Dutch GOV-net 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 big box on deck from where sorting of the catch takes place. For catching litter and sorting the litter this has likely had no effect.

The scientific crew on board of the Endeavour existed of 4 experts from IMARES completed with 2 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 done these surveys for many years. The UK has initiated the collection of seafloor litter and has done this for many years (Maes et al. 2014). So both CEFAS experts were familiar with the methods provided by Thomas Maes to collect litter on English fish surveys.

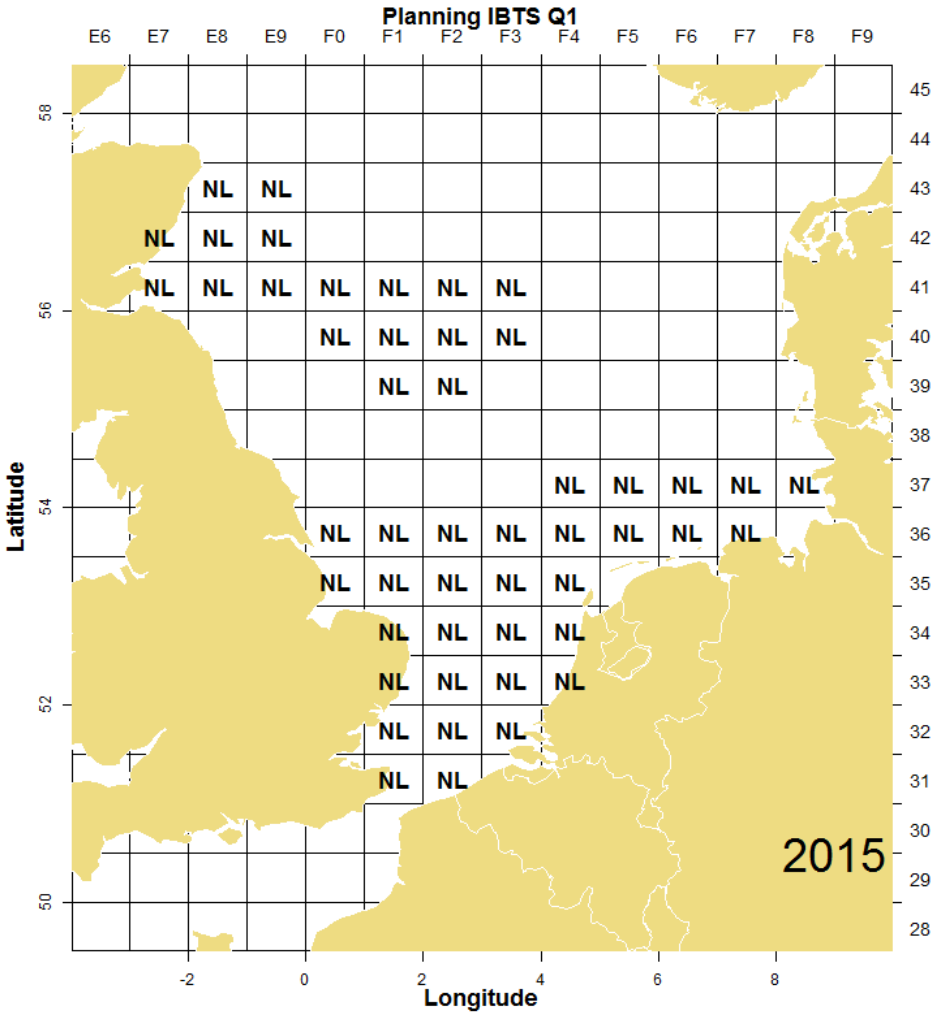

Figure 2-1: Planned rectangles in which GOV hauls had to be executed for the Dutch part of the IBTS.

2.2 Sampling litter

The manual of the IBTS states that litter has to be collected each haul and recorded as one of the categories (table 1) with an estimate of the size. There is no guidance on how detailed the catch should be sorted or on visual inspection of the net. Additional guidance will likely be provided by the guidelines that are or will be prepared according to the concept CEMP/JAMP protocols (EIHA 15/5/14-E; EIHA 15/5/14 Add.1-E)

On the Endeavour the complete net is hoisted on board and inspected and cleaned as far as possible after each trawl. Litter items in the net and in the catch are collected. Each litter item is then assigned to one of the categories (Table 2-1), weighed (after removing attached organisms and debris) and the size is estimated. In case very similar items were found in a single trawl these were recorded as a single category and then weighed together and the number of individual items is registered (Table 2-2), this happened most often by A7 (Synthetic ropes). When organisms were attached (Photo 1) this has sometimes been recorded as well. Occasionally an extended description of the litter item is given.

Table 2-1: Classification of marine litter items and the related size categories (The International Bottom Trawl Survey Working Group, 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			

Photo 2: Examples of plastic sheets (A2).

Table 2-2:Registration sheet with example data. Recording litter type, size and weight and the number of items in the category. Where possible a description is given and sometimes 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 report 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: doorspread and wingspread. The doorspread is the area between the doors 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 wing spread is considered the relevant measure for sea floor litter.
Because we could use the wing sensors of CEFAS, this is the first year wingspread is actually measured. In all other years wingspread was calculated based on the door spread and depth.
Of 5 trawls the wingspread records failed. In two of these cases also the recording of door spread failed. Also in two other cases the recordings of door spread failed. For these missing data, the door spread and wingspread are calculated. The parameters were fitted based on the estimations of the other trawls.

Doorspread= -22.20618*LOG(Depth)+85.99*LOG(Warp-length)-99.72
Wingspread= doorspread/(0.5273*LOG(Depth)+2.857)

The number of litter items per km^2 was than calculated as items/(wing spread*distance trawled).

3. Results and discussion

The Dutch 2015 IBTS Q1 performed 46 hauls in total. One of these hauls was invalid, because it was hauled after a couple of minutes as the net geometry sensors indicated ruptures of the net. In 44 of the valid hauls at least one litter item was found, meaning that only 1 haul contained no marine litter. In total 360 (including the total number of lines/ropes counted which are reported as a single type) litter items were registered.

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 Miscellaneous (5%) and Natural products (4.1%).

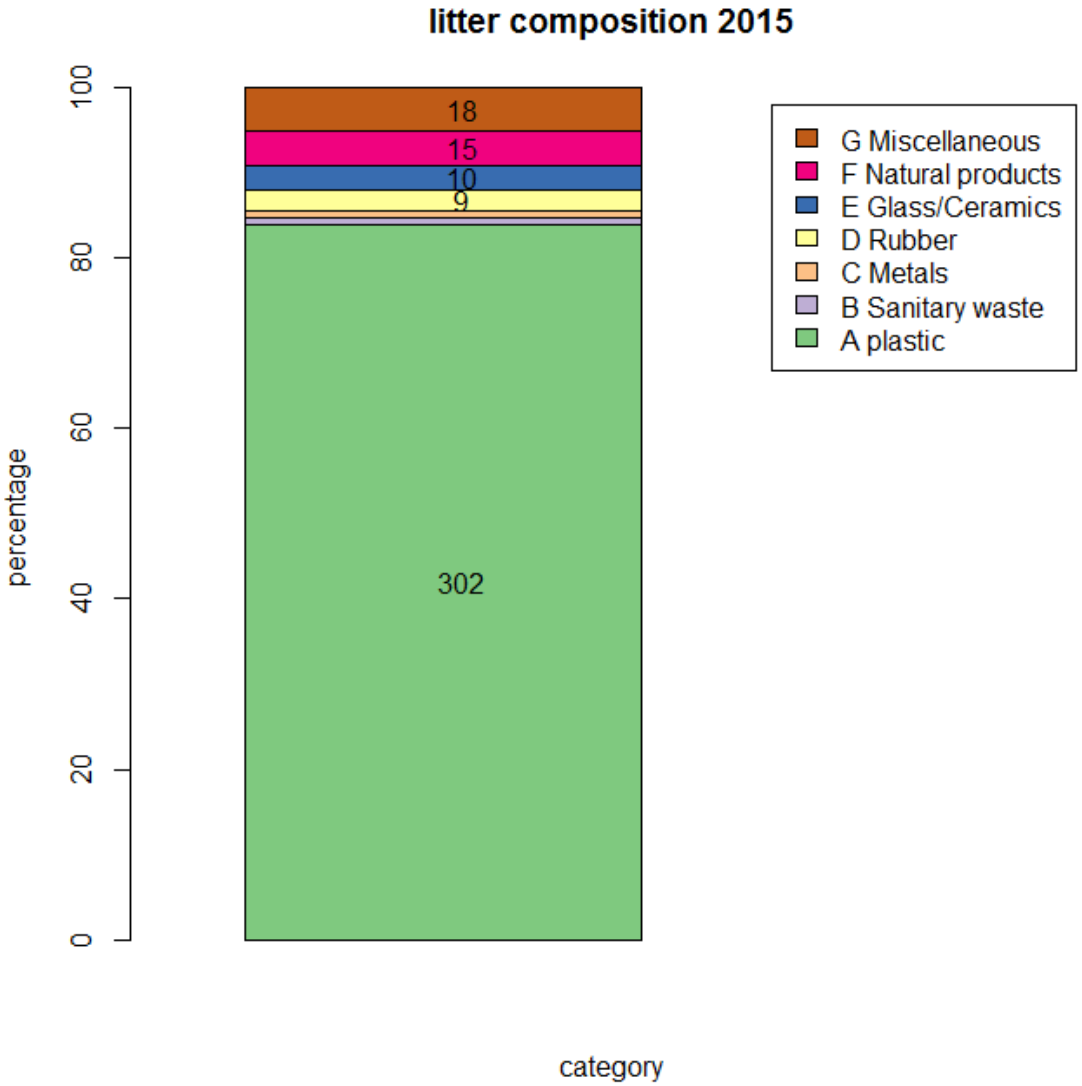

Figure 3-1: Composition of the seafloor litter in the catches of the IBTS Q1 2015. Values are the absolute number of items for the categories containing more than 1% of the items.

Focussing on the largest category Plastic shows that this category is dominated by A7 synthetic rope (55%, Photo 3) and A2 sheet (37%, Photo 2, Figure 3-2). Both of these subcategories contain more than 100 items, while the other subcategories had less than 10 items.

All items were given a size category based on an estimation of the surface. Most of the items (270), e.g. strings and pieces of rope, are classified as smaller than 5 * 5 cm (<25 cm^2). Only a single item was placed in the largest category (>10000cm^2) (Figure 3-3). This largest item (A2, some sort of canvas) was also the heaviest, weighing more than 25 kg. In weight this was followed by three pieces of processed wood. All other items were less than 1 kg. A large number of items was not weighed as it had absorbed a lot of water or many organisms were attached. As most items were size category A these weigh only a couple of grams. So the weight is very skewed, seen in the difference between average weight (229 g) and the median weight (12 g) (Table 3-1). The median is most likely more suited than the arithmetic average, because the median is robust against extreme values.

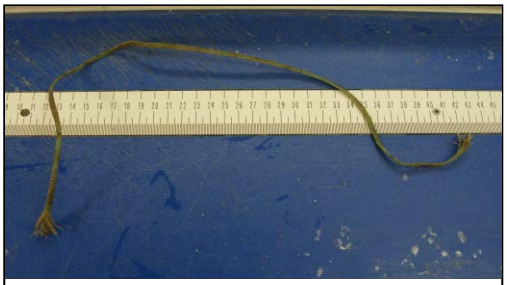

Photo 3: Example of a piece of synthetic rope (A7)

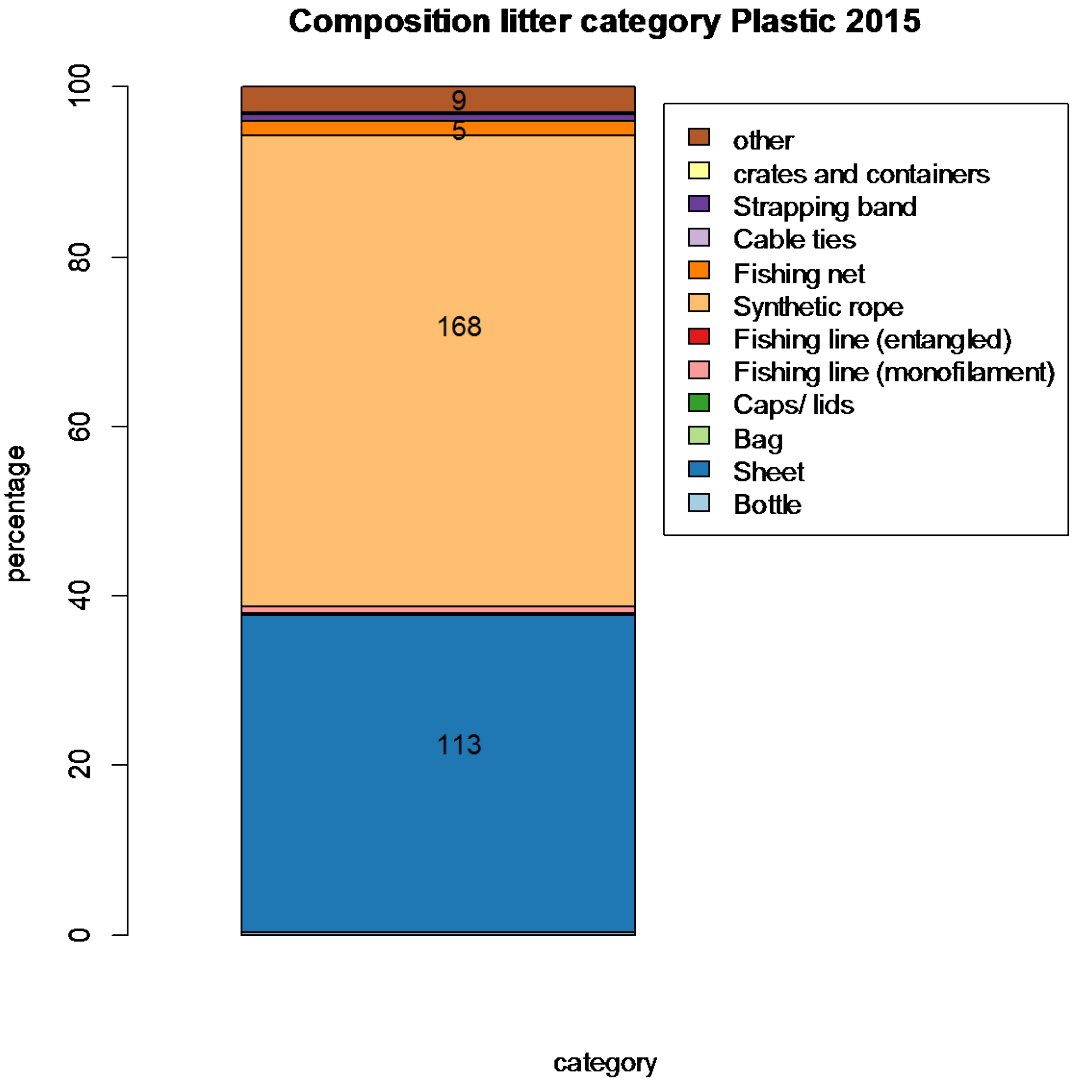

Figure 3-2: Composition of the seafloor litter category A Plastic in the catches of the IBTS Q1 2015. Values are the absolute number of items for the categories containing more than 1% of the items.

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 trawls vary between years, as the Dutch IBTS chooses its positions randomly within an ICES rectangle. This creates variation in the actual depth and habitat in which the trawls are done

between years. This complicates a one on one comparison between years. Personal experience of the last three 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 2015 is presented in Figure 3-4. This shows the single trawl without litter items in the catch as the minimum catch. This trawl is found next to a trawl with 68 items per km^2. The ranges presented by the bubbles in the plots are the same as those used in last year's report (van der Sluis and van Hal 2014). The maximum value of 700 items per km^2 is not reached this year. The maximum in this year is 330 items per km^2 which is found north of the island Texel and at the same latitude close to the English coast. The maximum value of 330 items per km^2 corresponds to 23 items reported from the catch. The median number of items is 102 items per km^2 corresponding to 7 items in the catch (Table 2-1).

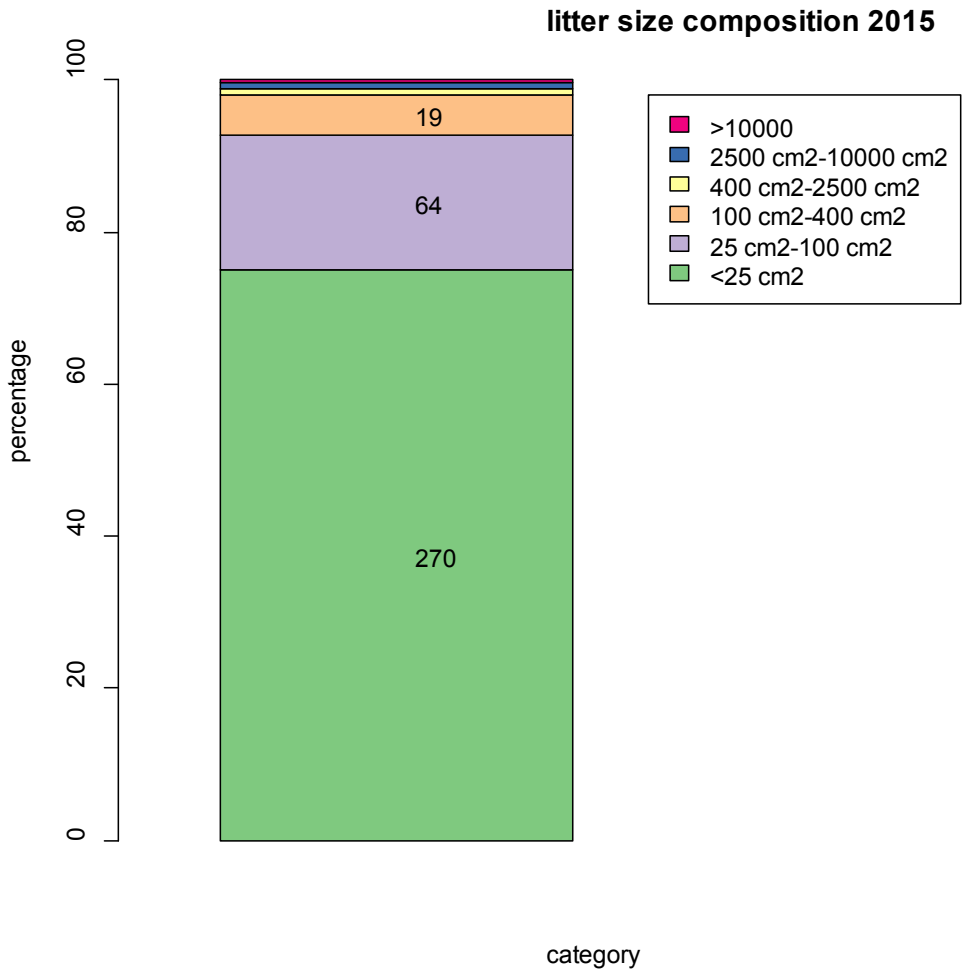

Figure 3-3: Size composition of the seafloor litter (categories A to G combined) in the catches of the IBTS Q1 2015. Values are the absolute number of items for the categories containing more than 1% of the items.

Table 3-1:Summary data of the 2015 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	23	8	7
Items per km2	0	330.03	116.89	102.88
Weight (g)	-	25660	229.25	12

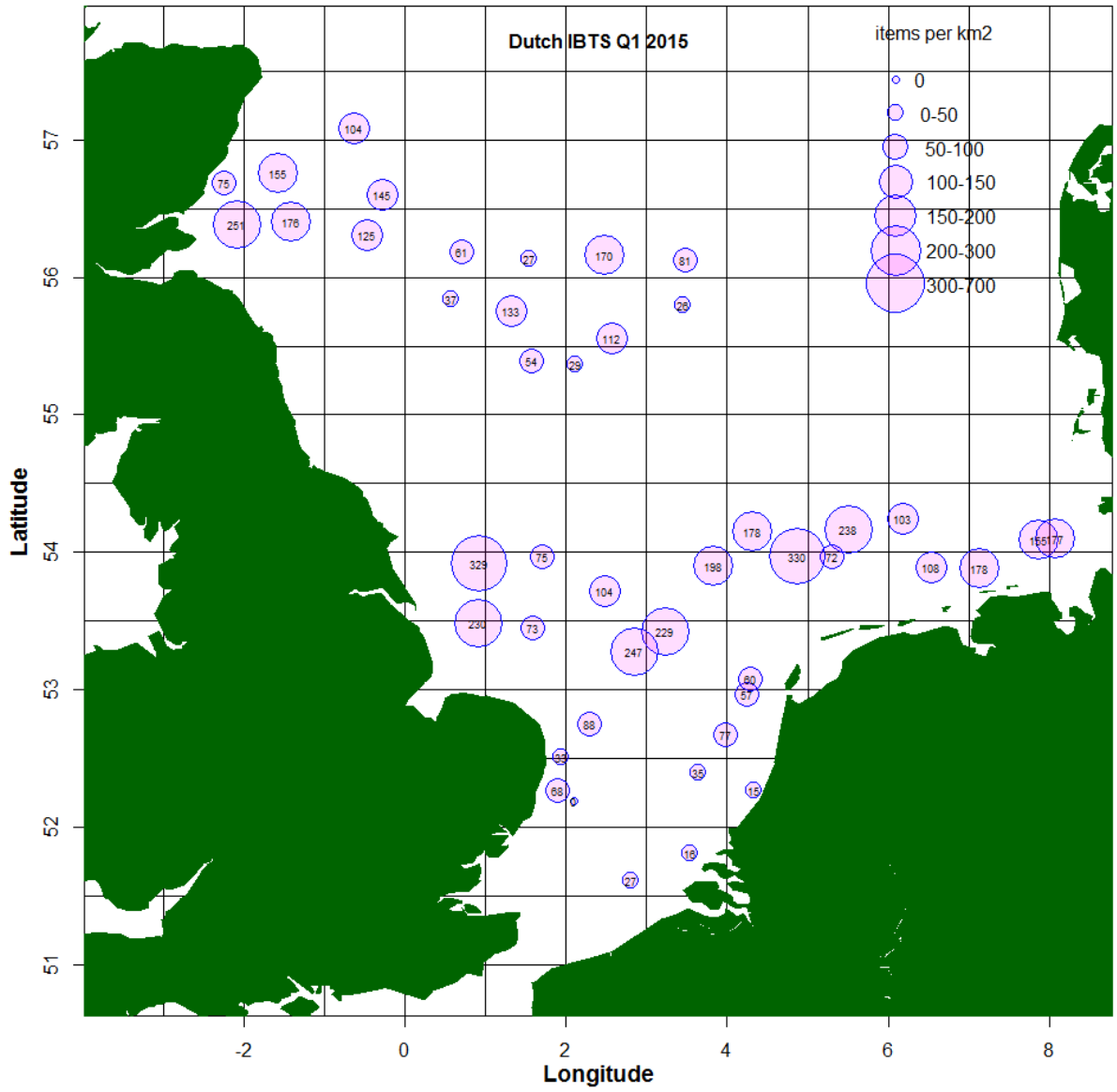

Figure 3-4: Density of litter items per haul per km^2 for the IBTS 2015. The numbers in the circle are the number of items per km^2. The numbers are the midpoint and correspond to the start position of the trawls, and thus determine the rectangle that is sampled. Empty rectangle have not been sampled by the Dutch IBTS, but are sampled by the other countries participating in the survey.

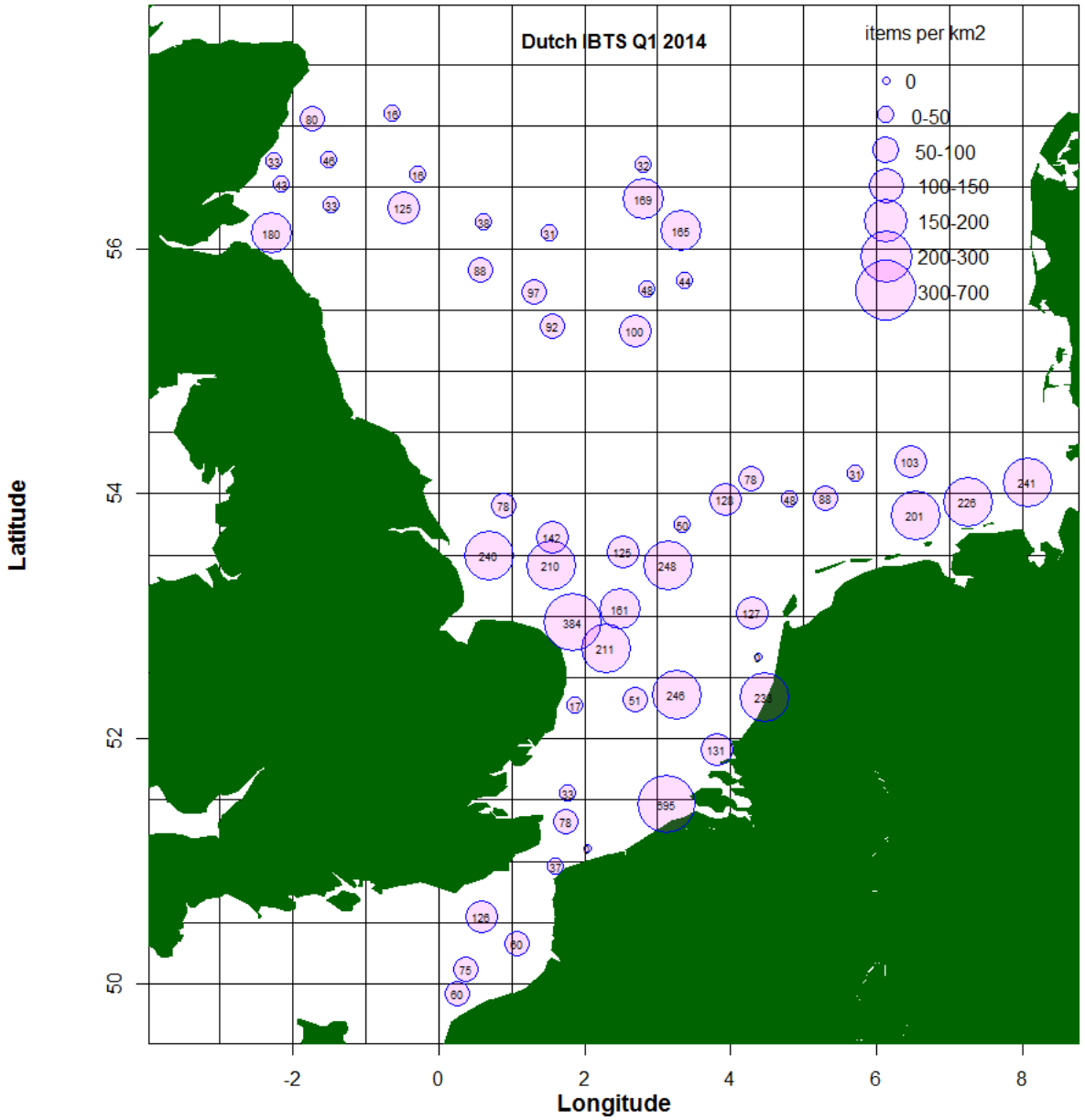

Figure 3-5: Density of litter items per haul per km^2 for the IBTS 2014. The numbers in the circle are the number of items per km^2. The numbers are the midpoint and correspond to the start position of the trawls, and thus determine the rectangle that is sampled. Empty rectangle have not been sampled by the Dutch IBTS, but are sampled by the other countries participating in the survey.

Comparison with earlier years (2013 & 2014)

The two earlier years showed that composition of the litter items was dominated by plastics as well. The dominance in those years was slightly higher with 87 and 88%. In those two years, the plastic category was dominated by A2 plastic sheets. While the 2015 data shows a dominance of A7 Synthetic rope followed by A2 sheets. Rather than a difference in composition this seems to be due to reporting more things in the A7 category rather than in the A5 and A6 categories. This often stays an arbitrary choice and a matter of registering and counting the number of individual pieces of rope/sheet correctly and in a consistent way (which has differed between the years). This year we followed the methods of CEFAS personnel who placed most of the lines in A7, where in earlier years we indeed sometimes made the choice to place them in A5.

The spatial distribution between 2014 and 2015 clearly differs (Figure 3-4, Figure 3-5 and Table 3-2).

Table 3-2:Summary of spatial comparison between 2014 and 2015

Area	2014	2015
North of the Dutch islands	Between 48-201 km^2	Between 72-330 km^2
German Bight	Between 226-241 km^2	Between 155-178 km^2
Northwest of East Anglia	Between 78-384 km^2	Between 73-329 km^2
West of East Anglia	17 km^2	Between 0-88 km^2
West of Aberdeen	Between 16-180 km^2	Between 75-251 km^2
Doggerbank	Between 31-169 km^2	Between 27-170 km^2
Dutch coast	Between 0- 695 km^2	Between 16-57 km^2

The amount of litter caught above the Dutch islands appears to be slightly higher in 2015 compared to 2014, while slightly lower in the German Bight. The area around East Anglia seems very similar between the years with higher catches northwest of East Anglia compared to west south west of it. The catches in the northern area (West of Aberdeen and Dogger Bank) seem to be in the same range. In contrast, the catches in the Dutch coastal area in 2015 seem smaller than in 2014. All in all, there was large variability in 2014 with empty hauls next to very large hauls.

Table 3-3:Comparison between the years. In minimum, maximum, mean, median and standard deviation.

2015	min	max	mean	median	stdev
items per trawl	0	23	8	7	5.73
items per km^2	0	330.03	116.89	102.88	83.57

2014	min	max	mean	median	stdev
items per trawl	0	21	6.47	5.00	4.89
items per km^2	0	695.46	117.00	87.61	113.68

2013	min	max	mean	median	stdev
items per trawl	0	11	3.73	4	2.27
items per km^2	0	166.51	58.24	55.35	36.55

The comparisons of items per trawl and per km^2 gives the impression that the catches were slightly lower in 2013 (Table 3-3 and Figure 3-6). While the maximum number of items per trawl does not differ much between 2014 and 2015. The items per km^2 largely differ. This is because the 2014 maximum number of items per km^2 is based on a shorter trawl (thus smaller swept area) in which 12 items were found. Rather than an increase in the amount of litter in the environment from 2013 onward, it is expected to be an effect of learning in working with the litter data. In the pilot of 2013 items of the same type were grouped as a single piece. In 2014 and 2015, this was done as well, but the number of individual items per subcategory was registered. Grouping occurs most often in the subcategories ropes/lines (A5 and A7). The CEFAS workers also appeared to show some inconsistencies in grouping items. Consistency in the registration of the items between years and internationally is required when analyses are done on the basis of numbers per trawl or per km^2.

Comparing the Dutch data of different years may provide a false impression of the amounts of litter present. The last three years the geographical coverage of the survey has varied due to weather conditions and the refit of the original vessel (RV Tridens). Especially the lack of trawls in the Channel and southern North Sea in 2015 might have resulted in difference in the presented values. Combining this data with the French and hopefully all the other countries participating in the IBTS would improve these estimates.

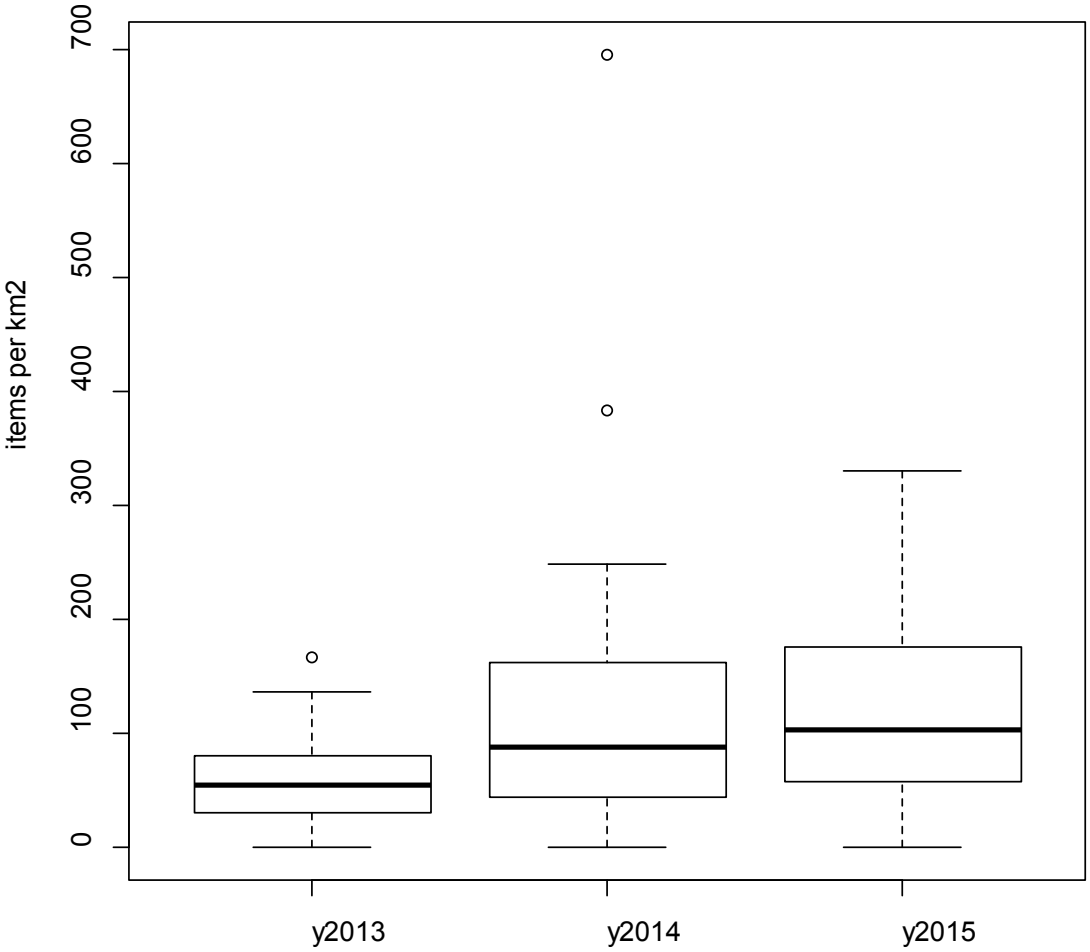

Figure 3-6: Boxplot of the items per km^2 for all the hauls in the three years. The black horizontal line is the median. Note: the geographical coverage between surveys differed.

A concern regarding the analysis of the amount of litter is the catchability of litter by the GOV net. The scientists involved in the IBTS all agree that the GOV, not designed for catching litter, has only a small chance 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 (Fraser et al. 2007; Piet et al. 2009; ICES 2003). Therefore the chance of catching these small litter items is assumed to be very small and random. The fact that these items are caught indicates that there are much more items in the trawl path that are not caught.

The majority of sampling stations have less than 8 items (Figure 3-7 and Table 3-3). Catching by chance a small number of items more in a trawl increases the estimates of the mean value. While in the field there is actually not a difference in the amount of items. The catchability issue is unfortunately not taken into account by the power analyses presented by Maes et al. (2014). Despite of that those analyses are a good step towards estimating the required number of trawls to be able to determine a trend in the litter data. Even without considering the catchability issue, those analyses indicate that much more trawls are required than currently done in the Dutch situation alone.

The low number of trawls, the low number of items found per sampling station combined with the small chance of catching an item when it is present in the trawl path, the spatial differences in the survey between years makes it difficult to draw conclusions on the absolute amounts of litter found, and to use only these data for trend analysis. The data are partly suitable for providing estimates of the composition of the litter. The composition is however biased towards items with a larger catchability, e.g. items that tend to float into the codend after disturbance or are likely to be entangled in the net. Combining multiple years could still be used to determine spatial hotspots.

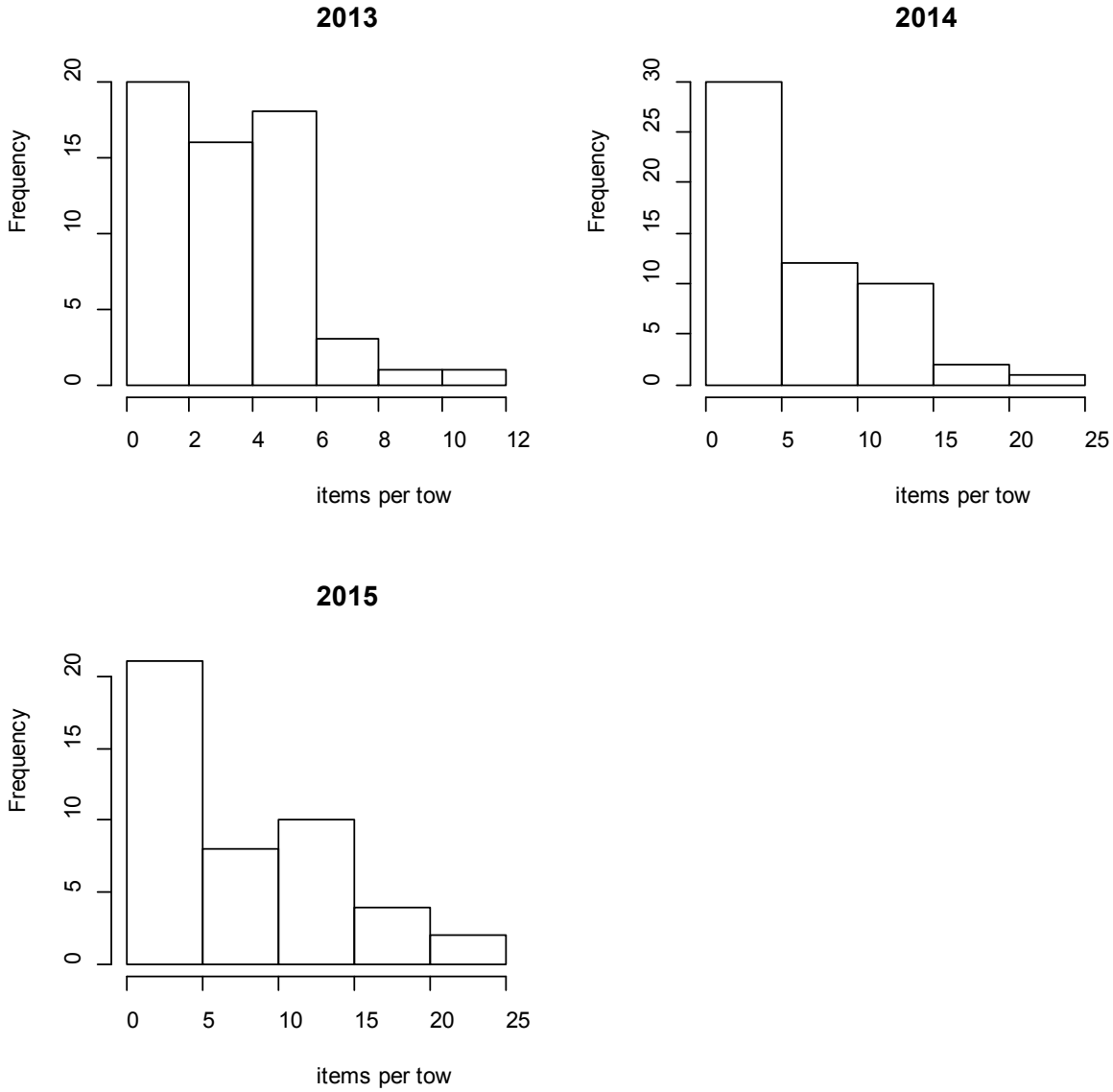

Figure 3-7: Frequency plots of the number of items per trawl in the three years. Note: the surveys had different geographical coverage.

4. Conclusions

The results are in line with those of previous years. The seafloor litter from the catches of the Dutch IBTS Q1 2015 contained mostly plastic items: 83.8% of the total number of litter items found was plastic. Also the composition of the litter itself is very much the same among the three 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.

Spatially the amount of litter differs somewhat between the years. It is however unclear if this is related to actual differences in the amounts of litter or the geographical spread of the sampling stations and/or the habitat coverage that differ. The local amount of litter is determined by the amount of input and removal by fisheries. However, in many cases the amount of litter caught seems to be related to seafloor structures rather than the actual location. 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 this can be approximated on the basis of the fish catches or existing habitat or sediment maps. As the trawling positions of the IBTS are more or less random, combining multiple years in a single map should eventually result in a representative presences of the various habitat types. Such a map could give the location of potential hotspots of marine litter if these exist.

The absolute average number of litter items per trawl and km^2 seems slightly higher in 2015. This is most likely related to the lack of stations in the Channel and southern North Sea as these were below average in 2014. Therefore, the higher average values are probably not an indication of an increase of litter in the North Sea. A better analysis can be done when the data in this report are combined with the international IBTS data, although at this moment in time the data are probably still inconsistent due to the lack of standardisation in the collection process. This was already anticipated as the current guidelines in the survey manual are vague. During the fieldwork it was clear that more standardisation was needed in collection methods, based on the observed differences between IMARES and CEFAS staff, as well as between individual workers.

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 data as done here 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 still in progress. This database is being developed by the ICES data centre and will be linked to the existing DATRAS database (http://datras.ices.dk). Until then, it is unlikely that all the international data collected so far will be combined. When the international data will be combined, the inconsistency issue needs to be dealt with. Currently, the protocol to collect data on litter that exists within the international IBTS surveys is limited and open for interpretation. Little steps in improving the protocols are made and further steps are suggested by the concept CEMP/JAMP protocols (EIHA 15/5/14-E; EIHA 15/5/14 Add.1-E).

The other issue is that even if everything is 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.

5. Recommendations

- Create more consistency in the Dutch and international data, e.g. stricter guidelines in the manual including photographic examples. The last might also reduce the difference in interpretation between individual observers. See JAMP/CEMP protocols.
- Combine the international data (in the ICES database) and redo these types of analyses on the combined set.
- Developing a protocol to use the habitat as additional metadata for the sea floor litter data.
- Analyse the relation between litter occurrence, habitat and other spatial variables to find out to what extend litter occurs differently in different habitats.
- Analyse the catch efficiency of the GOV in relation with litter.
- Further investigate the differences in litter catch efficiency of the GOV and beam trawl gears, and to further establish/corroborate a correction factor for this.

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Justification

Rapport C083/15
Project Number: 4316100005

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Dr Oscar Bos
Marine ecologist

Signature:

Date: 4th of June 2015

Approved: Drs. J.H.M.Schobben
Head of department Fish

Signature:

Date: 4th of June 2015

Appendix 1: data tables with all sea floor monitoring data of 2015.

Ship	Country	ICES-rectangle	Sample id	Bottom track (m)	Lat_s	Lat_h	Lon_s	Lon_h	Wing spread	Items	Swept area	Items/km^2
END	NED	33F4	3000001	4008	52.26183	52.28948	4.335987	4.373511	17	1	0.068136	14.67653
END	NED	33F3	3000002	3237	52.39261	52.38672	3.643639	3.685036	17.8	2	0.057523	34.76895
END	NED	34F3	3000003	3741	52.67036	52.6367	3.978536	3.982594	17.4	5	0.065093	76.8127
END	NED	34F4	3000004	3701	52.96645	52.93343	4.238171	4.229636	18.9	4	0.069949	57.1846
END	NED	35F4	3000005	3582	53.07361	53.04431	4.28064	4.259095	18.67	4	0.066876	59.81224
END	NED	36F6	3000006	3801	53.89386	53.89871	6.535879	6.477917	17	7	0.064617	108.3306
END	NED	36F7	3000007	3831	53.87945	53.87379	7.128969	7.071057	17.6	12	0.067426	177.9739
END	NED	37F7	3000008	3722	54.08856	54.08204	7.871716	7.815397	19.01	11	0.070755	155.4656
END	NED	37F8	3000009	3630	54.09487	54.09022	8.073321	8.018058	17.1	11	0.062245	176.721
END	NED	37F6	3000010	3684	54.24642	54.2495	6.174776	6.231078	18.5	7	0.068043	102.8754
END	NED	37F5	3000011	3697	54.16825	54.19258	5.507326	5.545956	18.2	16	0.067211	238.0546
END	NED	36F5	3000012	3688	53.96638	53.98627	5.296133	5.340045	18.8	5	0.069334	72.11428
END	NED	36F4	3000013	3666	53.96774	53.97864	4.871364	4.923961	19	23	0.069691	330.0299
END	NED	37F4	3000014	3709	54.14684	54.11349	4.309697	4.303343	19.7	13	0.073067	177.9182
END	NED	36F3	3000015	3769	53.89671	53.89648	3.824098	3.76679	18.8	14	0.070857	197.5805
END	NED	35F3	3000016	3675	53.42555	53.4189	3.22241	3.168186	19	16	0.069825	229.1443
END	NED	35F2	3000017	3715	53.277	53.31092	2.841988	2.842005	17.5	16	0.064901	246.5291
END	NED	36F2	3000018	3729	53.72078	53.72838	2.483769	2.428522	18	7	0.067308	103.9988
END	NED	36F1	3000019	3620	53.96437	53.96279	1.695448	1.639565	18.3	5	0.066246	75.47626
END	NED	40F1	3000020	3718	55.7553	55.72268	1.318801	1.33359	20.2	10	0.075104	133.1494
END	NED	39F1	3000021	3847	55.38937	55.35683	1.575868	1.554155	19.2	4	0.074055	54.01409
END	NED	39F2	3000022	3787	55.36627	55.37455	2.117283	2.175799	18	2	0.068166	29.34014
END	NED	40F2	3000023	3696	55.55375	55.55338	2.570721	2.628582	19.4	8	0.071702	111.5723
END	NED	40F3	3000024	3809	55.80151	55.80799	3.450319	3.510545	20.1	2	0.076561	26.12299
END	NED	41F3	3000025	3669	56.12832	56.12104	3.480918	3.422738	20.2	6	0.074114	80.95658
END	NED	41F2	3000026	3709	56.16374	56.13982	2.484624	2.442321	20.7	13	0.076628	169.6509
END	NED	41E8	3000027	3644	56.40015	56.37289	-1.40577	-1.43927	18.69	12	0.068106	176.195
END	NED	41E7	3000028	3716	56.38298	56.41643	-2.08427	-2.09114	18.22	17	0.067706	251.0874
END	NED	42E7	3000029	3717	56.69114	56.72479	-2.24999	-2.25103	18	5	0.066906	74.73171
END	NED	42E8	3000030	3729	56.76116	56.73996	-1.57194	-1.52555	19	11	0.071037	154.8479
END	NED	41E9	3000031	3735	56.31169	56.34533	-0.47694	-0.48343	21.5	10	0.080303	124.5291
END	NED	42E9	3000032	3724	56.6029	56.63655	-0.28461	-0.28748	20.4	11	0.07597	144.7948
END	NED	43E9	3000033	3564	57.08167	57.11255	-0.63306	-0.61993	18.9	7	0.067467	103.7552
END	NED	41F1	3000034	3734	56.13333	56.11433	1.542989	1.493292	19.7	2	0.073597	27.17497
END	NED	41F0	3000035	3793	56.1877	56.18593	0.709465	0.64835	21.5	5	0.081436	61.39813
END	NED	40F0	3000036	3696	55.84284	55.8099	0.571794	0.559051	21.7	3	0.080388	37.319
END	NED	36F0	3000037	3648	53.91871	53.90818	0.927599	0.976809	19.2	23	0.070005	328.5474
END	NED	35F0	3000038	2902	53.48001	53.45879	0.905786	0.931824	18	12	0.052265	229.5991
END	NED	35F1	3000039	3661	53.45319	53.41992	1.582558	1.580361	15	4	0.054805	72.98582
END	NED	34F2	3000040	3696	52.75222	52.71929	2.286408	2.297189	15.3	5	0.056559	88.40325
END	NED	34F1	3000042	3584	52.50511	52.53732	1.935261	1.939051	16.9	2	0.060427	33.09768
END	NED	33F1	3000043	3813	52.26215	52.29618	1.896732	1.905266	15.4	4	0.058854	67.96528

END	NED	33F2	3000044	3850	52.19039	52.2154	2.09396	2.133044	19.5	0	0.075037	0
END	NED	32F2	3000045	3673	51.60954	51.57991	2.804901	2.780656	19.9	2	0.073019	27.39004
END	NED	32F3	3000046	3690	51.80433	51.81352	3.530397	3.581787	17.1	1	0.063099	15.84811

Sample	date	Litter Type	Size category	Weight (g)	number of items
3000001	29-1-2015	G1	A	1	1
3000002	30-1-2015	A2	B	1	1
3000002	30-1-2015	A7	A	1	1
3000003	30-1-2015	A2	D	52	1
3000003	30-1-2015	A2	E	637	1
3000003	30-1-2015	G1	A	20	1
3000003	30-1-2015	D5	A	5	1
3000003	30-1-2015	A7	A	40	1
3000004	30-1-2015	A7	A	1	1
3000004	30-1-2015	A7	A	1	1
3000004	30-1-2015	A7	A	1	1
3000004	30-1-2015	A7	B	70	1
3000005	30-1-2015	A7	A	1	3
3000005	30-1-2015	D6	A	10	1
3000006	31-1-2015	F1	C	998	1
3000006	31-1-2015	A7	A	40	1
3000006	31-1-2015	A2	D	37	1
3000006	31-1-2015	A7	A	1	4
3000007	31-1-2015	A12	A	0.5	1
3000007	31-1-2015	C8	A	1	0
3000007	31-1-2015	D1	B	870	1
3000007	31-1-2015	A12	C	324	1
3000007	31-1-2015	G1	A	28	1
3000007	31-1-2015	A7	A	4	5
3000007	31-1-2015	A5	A	1	1
3000007	31-1-2015	A2	A	13	1
3000007	31-1-2015	F1	B		1
3000008	31-1-2015	E2	B	258	1
3000008	31-1-2015	E2	B	361	1
3000008	31-1-2015	E2	B	213	1
3000008	31-1-2015	E2	B	371	1
3000008	31-1-2015	E1	B	204	1
3000008	31-1-2015	E3	B	407	1
3000008	31-1-2015	A2	E	261	1
3000008	31-1-2015	A2	E	415	1
3000008	31-1-2015	A7	A	1	3
3000009	31-1-2015	A2	F	25660	1
3000009	31-1-2015	E4	A	94	1
3000009	31-1-2015	A12	A	201	1
3000009	31-1-2015	F1	B	2129	1
3000009	31-1-2015	F1	B	3258	1
3000009	31-1-2015	F1	A	319	1
3000009	31-1-2015	F1	A	403	1
3000009	31-1-2015	F1	A	269	1
3000009	31-1-2015	F1	A	631	1
3000009	31-1-2015	F1	A	109	1
3000009	31-1-2015	F1	A	410	1
3000010	1-02-15	C2	B	29	1
3000010	1-02-15	A2	B	34	1
3000010	1-02-15	A2	A	4	1
3000010	1-02-15	A2	A	1	1
3000010	1-02-15	A7	A	1	1
3000010	1-02-15	A7	A	1	1
3000010	1-02-15	A7	A	7	1
3000011	1-02-15	A5	A	2	1
3000011	1-02-15	C8	A	3	1
3000011	1-02-15	A2	B	14	1
3000011	1-02-15	A2	B	5	1
3000011	1-02-15	A2	A	14	1
3000011	1-02-15	A2	A	3	1
3000011	1-02-15	A2	A	20	1

3000011	1-02-15	A2	B	334	1
3000011	1-02-15	A2	A	5	1
3000011	1-02-15	A2	A	13	1
3000011	1-02-15	A2	A	5	1
3000011	1-02-15	A2	A	16	1
3000011	1-02-15	A7	A	56	1
3000011	1-02-15	B6	A	2	1
3000011	1-02-15	A7	A	1	1
3000011	1-02-15	A7	A	1	1
3000012	1-02-15	A7	B	251	1
3000012	1-02-15	A2	A	2	1
3000012	1-02-15	A2	A	2	1
3000012	1-02-15	A2	A	4	1
3000012	1-02-15	A2	A	4	1
3000013	1-02-15	A2	A	1	1
3000013	1-02-15	A2	A	23	1
3000013	1-02-15	A2	A	4	1
3000013	1-02-15	A2	B	165	1
3000013	1-02-15	A2	A	3	1
3000013	1-02-15	A2	A	1	1
3000013	1-02-15	A2	A	1	1
3000013	1-02-15	A12	B	27	1
3000013	1-02-15	A12	A	9	1
3000013	1-02-15	A7	A	1	14
3000014	2-02-15	A2	B		1
3000014	2-02-15	A2	A		1
3000014	2-02-15	A12	B		1
3000014	2-02-15	A2	A		1
3000014	2-02-15	A7	A		1
3000014	2-02-15	A7	A		6
3000014	2-02-15	A2	A		1
3000014	2-02-15	A2	A		1
3000015	2-02-15	A2	B		1
3000015	2-02-15	A7	A		1
3000015	2-02-15	A2	A		1
3000015	2-02-15	A2	A		1
3000015	2-02-15	A7	A		9
3000015	2-02-15	G3	A		1
3000016	2-02-15	A8	D	464	1
3000016	2-02-15	A2	A	1	1
3000016	2-02-15	A2	B	20	1
3000016	2-02-15	A2	B	17	1
3000016	2-02-15	A2	A	19	1
3000016	2-02-15	A2	A	3	1
3000016	2-02-15	A12	A	3	1
3000016	2-02-15	A7	A	1.00	9
3000017	3-02-15	F1	B	194	1
3000017	3-02-15	A8	C	204	1
3000017	3-02-15	A7	A	1	3
3000017	3-02-15	A2	C	159	9
3000017	3-02-15	G1	A	1	1
3000017	3-02-15	A7	A	1	1
3000018	3-02-15	A2	B	960	1
3000018	3-02-15	A2	B	60	1
3000018	3-02-15	A2	A	40	1
3000018	3-02-15	A2	A	4	1
3000018	3-02-15	A2	A	6	1
3000018	3-02-15	A2	A	3	1
3000018	3-02-15	A7	A	6	1
3000019	3-02-15	A2	A	1	1
3000019	3-02-15	A2	A	9	1
3000019	3-02-15	A2	A	3	1
3000019	3-02-15	A7	A	7	1
3000019	3-02-15	A7	A	23	1
3000020	4-02-15	A2	A	6	1

3000020	4-02-15	A2	A	12	1
3000020	4-02-15	A2	A	5	1
3000020	4-02-15	G2	A	12	1
3000020	4-02-15	A7	A	6	6
3000021	4-02-15	A8	A	19	1
3000021	4-02-15	A2	A	9	1
3000021	4-02-15	A7	A	1	2
3000022	4-02-15	A7	A	3	1
3000022	4-02-15	A2	A		1
3000023	4-02-15	A7	A	6	1
3000023	4-02-15	A7	A	1	7
3000024	5-02-15	A2	A	1	1
3000024	5-02-15	A7	A	1	1
3000025	5-02-15	G1	B	236	1
3000025	5-02-15	A7	A	1	2
3000025	5-02-15	A2	B	43	1
3000025	5-02-15	A2	A	6	1
3000025	5-02-15	A2	A	1	1
3000026	5-02-15	A2	C	111	1
3000026	5-02-15	A2	B	37	1
3000026	5-02-15	A2	A	28	1
3000026	5-02-15	A2	B	82	1
3000026	5-02-15	A2	A	14	1
3000026	5-02-15	A2	A	40	1
3000026	5-02-15	A2	A	7	1
3000026	5-02-15	A2	A	4	1
3000026	5-02-15	A7	A	2	5
3000027	6-02-15	A12	C	310	1
3000027	6-02-15	A2	B	32	1
3000027	6-02-15	A7	A	18	9
3000027	6-02-15	G1	B	173	1
3000028	6-02-15	A2	A	7	1
3000028	6-02-15	A7	A	1	2
3000028	6-02-15	A2	A	5	1
3000028	6-02-15	A7	A	6	1
3000028	6-02-15	A7	B	260	1
3000028	6-02-15	A1	B	56	1
3000028	6-02-15	A2	A	3	1
3000028	6-02-15	A2	A	17	1
3000028	6-02-15	A10	B	122	1
3000028	6-02-15	G3	C	526	1
3000028	6-02-15	D5	B	161	1
3000028	6-02-15	G1	B	133	1
3000028	6-02-15	G1	B	238	1
3000028	6-02-15	A2	B	94	1
3000028	6-02-15	A2	B	45	1
3000028	6-02-15	G1	B	120	1
3000029	6-02-15	G3	C	590	1
3000029	6-02-15	A2	B	22	1
3000029	6-02-15	A7	A	4	1
3000029	6-02-15	A7	A	1	1
3000029	6-02-15	F1	A	18	1
3000030	6-02-15	E4	A	125	1
3000030	6-02-15	A8	B	46	1
3000030	6-02-15	G3	A	7	1
3000030	6-02-15	A7	A	4	7
3000030	6-02-15	A7	A	10	1
3000031	7-02-15	A10	A	1	1
3000031	7-02-15	A7	A	1	2
3000031	7-02-15	E3	A	345	1
3000031	7-02-15	A2	A	7	1
3000031	7-02-15	A4	A	3	1
3000031	7-02-15	A7	A	65	3
3000031	7-02-15	G3	B	269	1
3000032	7-02-15	A7	A	5	1

3000032	7-02-15	A7	A	1	2
3000032	7-02-15	A2	A	2	1
3000032	7-02-15	A2	A	1	1
3000032	7-02-15	A2	A	8	1
3000032	7-02-15	A2	A	1	1
3000032	7-02-15	A2	A	14	1
3000032	7-02-15	A2	A	6	1
3000032	7-02-15	A7	A	114	1
3000032	7-02-15	A7	A	40	1
3000033	7-02-15	E1	B	301	1
3000033	7-02-15	F1	B	912	1
3000033	7-02-15	B6	A	1	1
3000033	7-02-15	A2	B	20	1
3000033	7-02-15	A2	A	6	1
3000033	7-02-15	A2	A	9	1
3000033	7-02-15	A2	C	150	1
3000034	8-02-15	D5	B	77	1
3000034	8-02-15	G1	B	102	1
3000035	8-02-15	A2	B	35	1
3000035	8-02-15	A2	A	3	1
3000035	8-02-15	F1	A	11	1
3000035	8-02-15	A8	C	650	1
3000035	8-02-15	G1	B	849	1
3000036	8-02-15	A2	A	39	1
3000036	8-02-15	D5	A	3	1
3000036	8-02-15	A7	A	1	1
3000037	9-02-15	A2	B	35	1
3000037	9-02-15	D6	A	129	1
3000037	9-02-15	A11	B	78	1
3000037	9-02-15	A2	C	225	1
3000037	9-02-15	D2	A	6	1
3000037	9-02-15	A7	A	27	18
3000038	9-02-15	G1	B	71	1
3000038	9-02-15	D6	B	99	1
3000038	9-02-15	A7	A	9	9
3000038	9-02-15	A2	A	1	1
3000039	9-02-15	A2	B	6	1
3000039	9-02-15	A7	A	2	2
3000039	9-02-15	F1	B	651	1
3000040	10-02-15	A2	B	23	1
3000040	10-02-15	A2	B	25	1
3000040	10-02-15	A2	A	1	1
3000040	10-02-15	A7	A	1	1
3000040	10-02-15	A12	B	35	1
3000041	10-02-15	Invalid			
3000042	10-02-15	A2	A	1	1
3000042	10-02-15	A7	B	61	1
3000043	10-02-15	C8	B	457	1
3000043	10-02-15	A2	A	5	1
3000043	10-02-15	A7	A	1	1
3000043	10-02-15	B6	A	1	1
3000044	10-02-15	EMPTY			
3000045	11-02-15	A2	A	1	1
3000045	11-02-15	A7	A	1	1
3000046	12-02-15	A2	A	2	1