OSPAR Beach Litter Monitoring in the Netherlands 2012-2017

Annual Report

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Summary

Large quantities of marine litter are washed ashore worldwide. Marine litter is an environmental concern of global scale that may harm species in our seas; it affects the ecological, social, and economic status of coastal areas. Qualitative and quantitative information about marine litter in our seas and oceans is required for policy development aiming to reduce marine litter and/or to assess effectiveness of existing programmes of measures.

This annual report provides an overview of the Dutch beach monitoring and analysis results for 2012-2017. During the 2012-2017 period (January – December) 95 surveys were performed. The surveys took place in the Winter, Spring, Summer and in the Autumn. This research aims to provide insight in the Dutch situation; therefore, analyses with aggregated results of all four Dutch beaches are displayed in this report. The number of specific litter items and total litter counts is given using 6-year median and arithmetic averages. Significance of trends of counts of specific and total litter types over time were assessed by non-parametric regression using untransformed data from item counts set out against the monitoring date. Analysis of beach litter monitoring data was performed using the tool Litter Analyst (version 3.1) (Baggelaar and Van der Meulen, 2014; AMO Icastat, 2015).

In the period 2012-2017 during 49 surveys, other pollutants such as paraffin were recorded.

The six-year data set suggests that the Dutch beaches are getting cleaner. On average 313 items were found per 100 meter beach during the period 2012-2017. The data shows a decreasing trend in average item counts per year for all beaches of -21.2 items per year. The trend has no statistical significance (p-value = 0.157). The periods 2010-2015 and 2011-2016 both show a significant decreasing trend and large decreasing trend slopes of more than -40,0.The trend seem to be stagnating in 2017, the decreasing trend slope is lower than the two six years periods before. In 2017, between 40 (Veere) and 1.121 (Bergen) items were found, the total average number of items counts for all beaches was 286 items per 100m beach.

The top-80% resulted in a top 15 of most found litter items on the four monitored beaches. The data shows decreasing trends for 11 of the top 15 most found items; 6 of these trends are significant. The largest decreasing trend in average item counts per year is from net and ropes (-10.5 counts/year). In the period 2012-2017 net and ropes account for 40,2% of all litter items found.

Sources of beach litter in the period 2012-2017 are allocated to the fishing (40,7%) and shipping (19,8%) industries followed by tourism (17,4%), rivers (17,8%) and sewages (4,3%) based on the application of the Tudor & Williams method. Most items found originate from sea-based sources.

1 Introduction

Litter in the marine environment is harmful for marine life and a potential threat to biodiversity. Marine litter and in particular the accumulation of plastic litter in the marine environment, has been identified as a major global problem alongside other key environmental issues of our time (Sutherland et al., 2010; G7 Leader´s declaration 2015). It harms marine life in particular due to ingestion and entanglement, at least 817 marine species are affected by marine litter (CBD, 2016). To give an example, worldwide at least 45% of marine mammals species that were recorded to have been affected were on the IUCN red list of threatened species (CBD, 2016).

Marine litter is travels long distances with oceans currents and is found all over the globe in marine environments, even in very remote areas (Werner et all. 2016). Recent research shows that even at depths of ten kilometres deep, plastic is found. The deepest record is a plastic bag found at 10.898 m in the Mariana Trench (Chiba et all., 2018). Apart from the ecological impacts there are socioeconomic impacts such as costs for cleaning activities and reduced attractiveness for recreational activities. In addition, lost and discarded fishing nets can cause propeller issues and can consequently lead to shipping delays and lost fishing time.

Figure 1: Various type of waste, Bergen

Qualitative and quantitative information about marine litter entering our seas and oceans is required for the development of policies and measures aiming to reduce marine litter and/or

to assess effectiveness of existing measures. Marine litter (marine debris) is any persistent, manufactured or processed solid material discarded, disposed of, abandoned or lost in the marine and coastal environment. This also includes such items entering the marine environment via rivers, sewage outlets and storm water outlets.

In the year 2000, a standardized protocol for the 'OSPAR Pilot Project on Monitoring Marine Litter' was developed aiming to monitor the amounts and sources of marine litter in the North East Atlantic region. The protocols for 100-metres and 1-km surveys were developed, tested and used during fieldwork from 2000 onwards. The initial pilot project was executed for a period of six years (2000-2006) by nine countries: The Netherlands, Belgium, Germany, United Kingdom, Sweden, Denmark, France, Spain and Portugal. In 2007, after the pilot ended, it was decided to transfer the pilot in a regular OSPAR monitoring programme. The Netherlands and Belgium coordinated this regular programme.

The Dutch Ministry of Environment and Infrastructure (I&M) decided to continue with the beach litter monitoring. With the installation of an Intersessional Correspondence Group Marine Litter (ICGML) the project was embedded in OSPAR on an official basis

Within the European Marine Strategy Framework Directive (MSFD) marine litter is one of the descriptors (DG10) in order to assess the 'Good Environmental Status' of the marine environment. Monitoring beached litter is one of the obligations within this directive. Beach surveys performed according to the protocol can be used to monitor trends in amounts (quantitative), materials (quantitative), and sources (qualitative) of marine litter washed ashore. The Ministry of Transport and Environment (RWS Waterdienst) has assigned the North Sea Foundation to monitor the beaches according to the OSPAR protocol in the Netherlands during 2012-2017. The North Sea Foundation is: an independent, objective and authoritative non-governmental organization that provides knowledge necessary for an integrated sustainable protection, exploitation and spatial use of the North Sea and its coastal zones. This report provides an overview and analysis of the field results from the 2012-2017 beach surveys.

Figure 2 Tangled net and baseball cap, Terschelling

A guideline for monitoring marine litter on beaches has been developed by OSPAR (OSPAR Commission, 2010) as a tool to collect data on litter in the marine environment. This tool has been designed to generate data on marine litter according to a standardized methodology. A uniform way of monitoring allows for regional interpretation of the litter situation in the OSPAR area and comparisons between regions. The guideline has been designed in such a way that all OSPAR countries can participate, bearing in mind adequate quality assurance of the data generated. The guideline is based on the method developed during the OSPAR pilot project 2000-2006 and is complimented with information derived from UNEP's own realisation of a worldwide guideline.

The first dataset has been analysed and provides an indication of the presence of different types of litter in the marine environment. The report 'Marine litter in the North-East Atlantic Region' (OSPAR, 2009) serves as a background document for the marine litter paragraphs in OSPAR's Quality Status Report (QSR) 2010.

The current report aims to:

- provide an annual update of Dutch beach litter monitoring data of 2017;
- provide an overview of the Dutch beach litter data analysis results for 2012-2017 using Litter Analyst.

2 Materials and methods

2.1 Selection of reference beaches

Within the OSPBAR Beach Monitoring Guideline (OSPAR Commission, 2010) the following criteria have been identified for selecting reference beaches. The beaches should be:

a) composed of sand or gravel and exposed to the open sea;
b) accessible to surveyors all year round;
c) accessible for ease of marine litter removal;
d) have a minimum length of 100 metres and if possible over 1 km in length;
e) free of 'buildings' all year round;
f) not subject to any other litter collection activities.

In each case, these criteria should be followed as closely as possible. However, the monitoring coordinators can use their expert judgement and experience of the coastal area and marine litter situation in their particular country when making the final selection of the reference beaches. For example, in some countries the local conditions do not allow for selection of beaches composed mainly of sand, and in some places survey sections of 1 km in length cannot be selected.

The Dutch reference beaches are:

- Bergen (NL1)
- Noordwijk (NL2)
- Veere (NL3)
- Terschelling (NL4)

All the Dutch reference beaches are composed of sand, are accessible all year round, are easy accessible for marine litter removal, have a length of 100 metres and 1 km, are free of buildings all year round and comply with the OSPAR criteria a, b, c, d, e. The compliance of criteria (f), 'no collection of any other litter activities', does not apply to the beaches. The reference beach Bergen is cleaned on a weekly basis all year round. Volunteers or local authorities incidentally clean the other beaches.

Therefore contact with local beach authorities is essential. Before a monitoring on a reference beach is executed, the local beach coordinator is contacted to check for any local activities that can influence the monitoring session, e.g. a local clean-up, an accident with cargo, a recent storm, etc. In 2012-2017 all local beach coordinators have been contacted on a regular basis. As a guideline, no local beach cleaning should have occurred within the two weeks before a planned beach monitoring date. If this has occurred, it is attempted to postpone the monitoring to about two weeks after the cleaning date. However, in cases of extreme weather events, unexpected changes in employee schedules, or for any reason poor communication with local beach coordinators, the monitoring may occur within two weeks after a cleaning activity.

Table 1 Contact information of local beach coordinators.

Gemeente Veere Strand exploitatie Walcheren (SSW) Jacoliene van Weele Tel. 0118 586275 Jacoliene@strandexploitatieveere.com	**Gemeente Noordwijk** Petri Biegstraaten Tel. 071 3660370 handhaving@noordwijk.nl
Gemeente Bergen Theo Kraan Tel. 072 8880000 TheoKraan@debuch.nl	**Gemeente Terschelling** gemeente@terschelling.nl Tel: 0562 4462518

Figure 3 Dutch monitoring beaches (map provided by RWS).

2.2 Sampling areas

Once sampling areas have been identified a beach is chosen. A sampling unit is a fixed section of beach covering the whole area between the water line to the back of the beach i.e. start of the dunes. Two sampling units are used within the OSPAR area: 100-metres: for identifying all marine litter items; and 1-km: for identifying objects larger than 50 cm. The monitoring sessions start at the back of the beach on the landside. A small strip of about 2-3 meters is monitored; walking distance between the two surveyors is about 2-3 meters. Two surveyors

walk parallel with the beach towards the end of the 100 metre monitoring area and draw a line in the sand during monitoring of the litter items. After reaching the 100-metre border of the monitoring area, the surveyors make a turn and proceed with the next strip. All litter is collected in garbage bags. The drawn line is now the border of the monitoring strip. This method is repeated until the sea line is reached. See also the picture below.

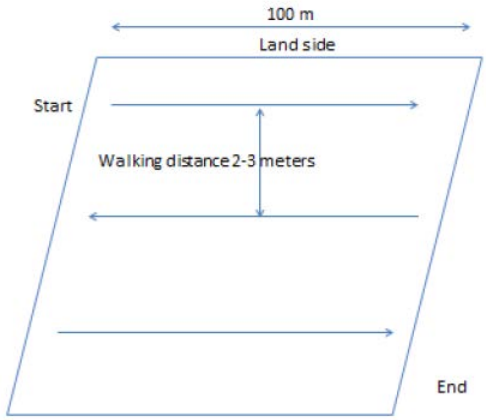

Figure 4 Walking pattern used for the beach litter monitoring. A monitoring strip is typically 2-3 m wide

For both 100 m and 1 km units a separate survey form is available from the OSPAR method and filled in (OSPAR, version 2010). The 100 metres is the standard sampling unit. The 100-metre stretch must be part of the 1-km stretch; but the surveyors must use a fixed part of the 1-km. An example is given in 2-3.

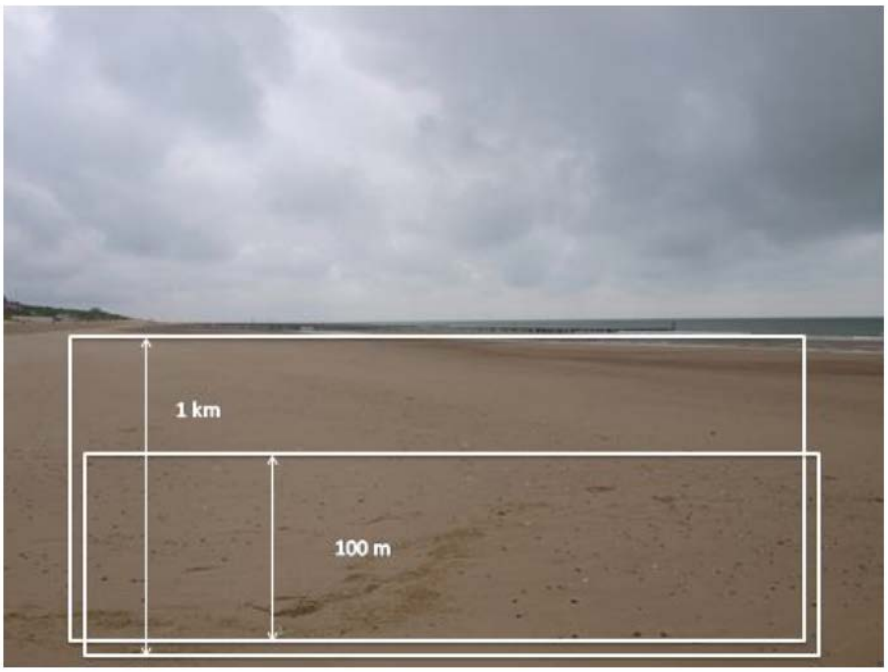

Figure 5 Photograph of the Dutch reference beach Terschelling

Permanent reference points are used to ensure that exactly the same site will be monitored for all surveys. The start and end points of each sampling unit can be identified by different methods. In the Netherlands the reference beaches are identified by marked beach poles.

Table 2 Details of the 4 Dutch OSPAR Beach Litter reference beaches

#	*Beach name*	*Access point*	*Start Beach Pole (start of 100 survey)*
NL1	Bergen	Boulevard Noord Egmond aan Zee	35.250
NL2	Noordwijk	Langevelderslag	72.250
NL3	Oostkapelle / Veere	Oranjezon	10.300
NL4	Terschelling	Oosterend Badweg	18.200

2.2.1. 1 kilometre surveys

During the 11th meeting of the Intercessional Correspondence Group on Marine Litter (ICGML) the results of the 1km surveys were discussed. It was concluded that based on the analysis of beach litter surveys of 1 kilometre in The Netherlands from 2005-2012, shown a highly significant decrease in larger litter items ($p<0.001$). Factors such as increased effort by authorities, non-governmental organisations and public in cleaning beaches, in which the larger items are most easily removed, play a role (OSPAR Commission, 2013). These efforts have continued the following years. It was therefore decided by Rijkswaterstaat to stop with the conducting 1 kilometre surveys in 2016.

2.3 Monitoring frequency and period

The reference beaches are surveyed 4 times a year. However, circumstances may lead to inaccessible situations for surveyors: such as stormy wind, and hazards such as rain, snow or ice and may result in a postponed or even cancelled beach survey.

The survey periods are as follows:

- Winter (first two weeks of January);
- Spring (April);
- Summer (between mid-June and end of July); and
- Autumn (between mid-September and mid-October).

2.4 Item classification

Items are classified according to the 'Guideline for monitoring Marine Litter on the Beaches in the OSPAR Maritime Area, Edition 1.0' using OSPAR scoring lists (OSPAR Commission, 2010).

2.5 Collection, identification and registration of litter

All items found on the sampling unit are entered on the survey forms provided (OSPAR, version 2010). On the survey forms, each item is given a unique OSPAR identification number. The survey forms also provide a box for a UNEP identification number. This is for UNEP use only. Unknown litter or items that are not on the survey form are noted in the appropriate "other item box". A short description of the "other" item will be included on the survey form. If possible, digital photos should be taken of unknown items in order for them to be identified later. The presence of recurring 'unknown' items may lead to the creation of a new category on the survey form. Following the advice from Van Franeker (2013), North Sea Foundation will

continue to monitor OSPAR Item #117 (plastic/polystyrene pieces < 25mm); since this is essential for data continuity and statistical tests of trends over time.

2.6 Data Management

The national coordinator must complete a questionnaire for each reference beach. (OSPAR Commission, 2010). The questionnaire includes information on the location and the physical and geographical characteristics of each beach, including the proximity of possible sources of marine litter. Also included are questions regarding factors that could help explain the amounts, types, and composition of marine litter found on that beach, for example, cleaning activities. It is advisable to contact local, regional or national authorities for information on cleaning schemes etc. For questions on the proximity of shipping lanes, river mouths, waste water outlets, etc. official data from responsible authorities are used only. When circumstances change, the questionnaire will be updated.

The beach litter monitoring data are entered in the OSPAR database within three working days after the monitoring took place, in order to have a good visual memory of the results and circumstances. The transcribed monitoring forms are scanned and digitally stored and added to the annual report. The monitoring data are (digitally) presented in an export of the OSPAR database in Appendix I. The scanned field forms are added in Appendix III. Until 2013 the data was entered by North Sea Foundation surveyors into an Excel file, and RWS transferred the data from the Excel file into the online database. From 2014 onwards the North Sea Foundation enters the data from the (fresh) paper monitoring forms into the online database. The Marine Conservation Society now hosts this database[1]. In the near future, RWS CIV will also store the beach litter data in the RWS DONAR database.

2.7 Data analysis procedures

2.7.1 Data preparation: item clustering

The item list for 100-meter surveys is part of the data in Appendix I. The current 100m-survey form contains 116 categories (marked by item-codes).

2.7.2 Data preparation and analysis using Litter Analyst

The data preparation (i.e. clustering, removal, and addition of items) is performed by the new tool Litter Analyst (version 3.1). Litter Analyst is able to read the data-exports from the OSPAR database (in the .CSV format), preparing the data for analysis, to export data as a .CSV file or a Microsoft Excel™ file, and perform trend analysis on individual litter items and total items with the Mann-Kendall test and Theil-Sen slope estimator. For more details on the chosen analysis and Litter Analyst, the reader is kindly referred to Baggelaar en Van der Meulen (2014) and the User Manual of Litter Analyst[2]. Outputs of Litter Analyst are evaluation tables of items, sources, and materials, but also a data series plot, boxplots of item counts per year, a table of data series, and a data density matrix can be created and saved externally (Meulen & Baggelaar, december 2014). For the analyses in this report, the following settings in Litter Analyst were used:

[1] http://www.mcsuk.org/ospar/home

[2] http://www.amo-nl.com/pdf/User%20manual%20Litter%20Analyst.pdf

- Aggregation condition 75%, minimum percentage of counts of items in top-X list 80%.

2.7.3 Trend analyses

In the annual report trend analyses are performed on the total item counts and the top-80% items. The top-80% is defined as the list of most abundant items that during a six-year period constitutes on average at least 80% of the total counts. Trends are analysed by non-parametric Mann Kendall trend analysis of specific item counts against the year of the survey. In the current beach analysis, the dataset of 6 years (2012-2017) was used.

2.7.4 Calculation of total item counts

The occurrence of considerable fluctuations in the total counts of beach litter surveys was avoided by using 6-year arithmetic averages and median values to describe total abundance. The averages are calculated from individual beach survey counts, and not from annual averages.

2.7.5 Source analysis

The assignment of sources categories to litter items by Litter Analyst, based on an older OSPAR list, is still under debate because it is complex and not always clear-cut. Therefore these results have not been added to this annual report. It was decided by ICGML that the Tudor & Williams method is best to use for source allocation. The results of application of the method are presented in paragraph 3.3.

2.7.6 Material analysis

It is also essential for the MSFD to connect monitoring results to the litter material composition. Especially the fraction of plastic/synthetic items is of interest for MSFD policy makers, in light of the increased awareness and attention on plastic in the seas and oceans. A relative contribution of each litter material is provided as an average for the period 2009-2014. Trend analysis is performed of the total abundances of items (period 2010-2015) which have been assigned with sufficient confidence to either of the following material categories: Plastic/polystyrene [406], Rubber [407], Sanitary [414], Paper/cardboard [409], Wood [410], Glass [412], Cloth/textile [408], Metal [411], Ceramic/pottery [413], and Medical [415].

2.7.7 Unknown items

Photographs of unknown items are stored in a photo database at the North Sea Foundation, sent to ICGML Basecamp for judgment of other marine litter experts and are displayed in the annual report.

2.7.8 Special circumstances

Special circumstances, such as extreme weather conditions, nearby sand suppletions or any other activities that may influence the monitoring, are listed on the field forms and published in the annual report.

2.8 Reporting

The North Sea Foundation produces an annual report with an update of the state and trend analyses of Dutch beach litter using data from the current and preceding years. This report will be finished within four months after the last monitoring activity.

3 Results & Discussion

Exports from the OSPAR database containing all litter data from 2012- 2017 have been added in the digital Appendix II. In the following sections, the total counts for each beach and for all beaches aggregated are shown. The top-80% analysis of total item abundance, source analysis, and material analysis will be elaborated on in more detail. In table 3 the dates of surveys conducted in 2017 are presented.

Table 3 Dates of surveys conducted in 2017

Beach ID	*Location*	*Date of survey*
NL002	Noordwijk	5-1-2017
NL003	Veere	6-1-2017
NL004	Terschelling	11-1-2017
NL001	Bergen	19-1-2017
NL004	Terschelling	14-4-2017
NL002	Noordwijk	20-4-2017
NL003	Veere	27-4-2017
NL001	Bergen	28-4-2017
NL002	Noordwijk	6-7-2017
NL004	Terschelling	11-7-2017
NL001	Bergen	17-7-2017
NL003	Veere	18-7-2017
NL001	Bergen	11-10-2017
NL003	Veere	12-10-2017
NL002	Noordwijk	16-10-2017
NL004	Terschelling	18-10-2017

3.1 Total counts

The average total item counts per 100-meter beach, the trend and the significance of the trend are displayed in table 4, 6-year arithmetic averages and median values are presented. An increasing trend is found for Bergen and a decreasing trend for Noordwijk, Terschelling and Veere. The total average number of items counts for all beaches aggregated amounts to 313 items per 100 m beach. The decreasing aggregated trend does not have statistical significance (p value 0.157). In 2017, between 40 (Veere) and 1.121 (Bergen) items were found, the total average number of items counts for all beaches was 286 items per 100m beach.

Table 4 Average total item counts, trend and significance of the trend for Bergen, Noordwijk, Terschelling and Veere and for all four beached aggregated for the period 2012-2017. Significant trends are printed in bold.

Location	*Period*	*Litter abundance* *Average total counts per survey*	*Median counts per survey*	*Trend (counts/year)*	*Significance of trend* *(p-value)*
Bergen	01/01/2012-31/12/2017	376,6	302,5	39,5	0,244
Noordwijk	01/01/2012-31/12/2017	346,9	254,5	-16,4	0,413
Terschelling	01/01/2012-31/12/2017	299,3	252,0	-35,2	0,076
Veere	01/01/2012-31/12/2017	231,3	164,5	-28,2	0,074
Ber|Noo|Ter|Vee	01/01/2012-31/12/2017	313,1	303,1	-21,2	0,157

It appears that the decreasing trend of the total count trend found for the period 2011-2016 is again observed in the period 2012-2017. However the trend does not have statistical significance compared to the period 2011-2016. This situation is in marked contrast with the 6-year periods before 2010-2015 (see Table 10).

The seasonal data points in Figure 6 show a considerable variation, as is well known for beach litter. This underlines the importance of conducting at least surveys every 3 months, resulting in four datasets per beach per year, as described in the OSPAR CEMP guideline (OSPAR, 2017).

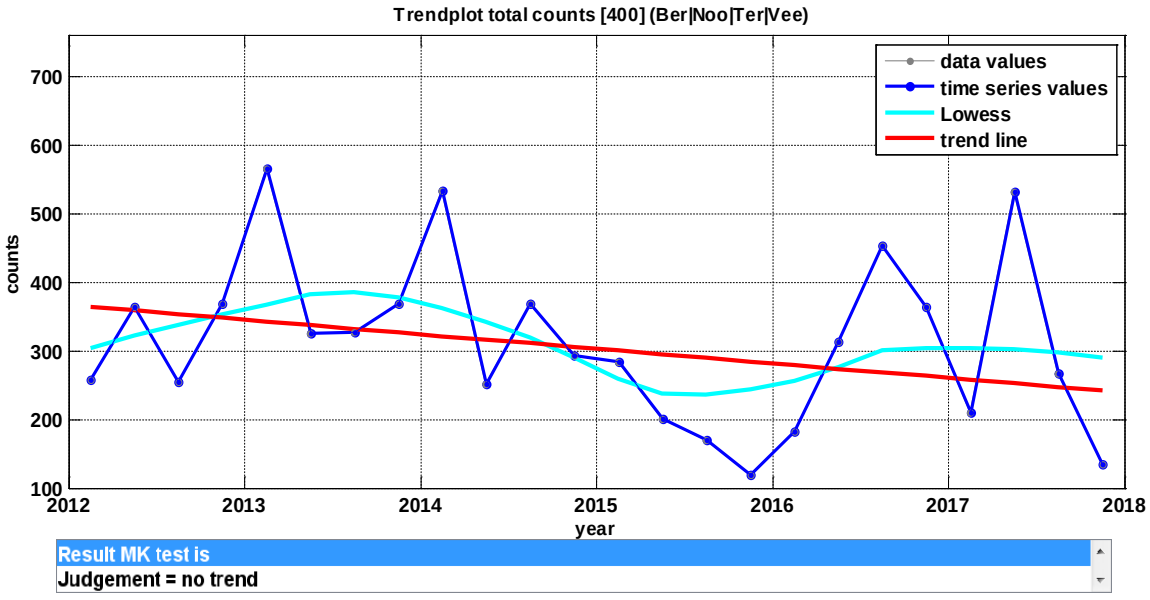

Figure 6 Trendplot Total counts period 2012- 2017 with no statistical decreasing significant trend (p 0.157)

3.2 Top-80% Analysis

Top-80% analysis has resulted in a top-15 for all four beaches for the period 2012-2017. Since this research aims to provide insight in the Dutch situation, results are displayed as aggregated results for all four beaches. The aggregated results for the four Dutch beaches are given in table 5. Figure 6 shows the trend plot for the total counts in the period 2012-2017. Figure 7 shows the trend plot for the top 1 category found; net and ropes. It shows that there is decreasing trend though without statistical significance. Trend plots of the top 5 most found categories in the period 2012-2017 are included in Appendix VII. Most found items, median and average item count per 100 meter beach (6-year arithmetic averages), the relative abundance of each item (%) related to total litter count, the trend per item in counts per year, and the significance of the trend, are provided.

Nets and ropes rank as the number one most found item and plastic polystyrene pieces smaller than 50 cm were the second most found item. Together, they account for more than half of the total number of litter items found (58,2%).

The data shows decreasing trends with a high ($p < 0.05$) significance for six of the top 15 items from the top 80% list.

Table 5 Top 80% of most found items along the Dutch coast, including median and average count per 100 meter, percentage of total count, trend [counts/year], and significance of trend for the period 2012-2017.Significant trends are printed in bold.

Aggregated results for Terschelling / Bergen / Noordwijk / Veere						
Rank	*Litter category [OSPAR-100-ID]*	*Med. Count / 100 m*	*Litter abundance Aver. count/ 100 m*	*% of total count*	*Trend (counts/ Year)*	*Significance of trend (p-value)*
1	Nets and ropes [300]	114,0	125,9	40,2%	-10,5	0,107
2	Plastic polystyrene pieces < 50 cm [301]	57,6	56,4	18,0%	-2,6	0,457
3	Plastic: Caps [15]	13,9	16,4	5,2%	-0,4	0,673
4	Plastic: Foam_sponge [45]	12,4	13,4	4,3%	0,3	0,766
5	Plastic: Crisp [19]	9,5	12,1	3,9%	0,2	0,823
6	Rubber: Balloons [49]	8,9	10,4	3,3%	-1,1	**0,005**
7	Plastic: Tangled [33]	9,1	9,3	3,0%	-0,9	0,143
8	Plastic: Industrial [40]	8,0	9,2	2,9%	0,4	0,243
9	Plastic: Small_bags [3]	6,3	6,7	2,1%	-0,8	**0,007**
10	San: Buds [98]	3,9	4,7	1,5%	-0,7	**0,039**
11	Plastic: Drinks [4]	4,5	4,2	1,4%	-0,5	**0,049**
12	Plastic: Other [48]	4,3	4,1	1,3%	-0,7	0,073
13	Plastic: Cutlery [22]	3,4	3,8	1,2%	0,0	1,000
14	Plastic: Bags [2]	2,1	2,9	0,9%	-1,1	**0,000**
15	Plastic: Strapping [39]	2,1	2,7	0,9%	-0,5	**0,004**

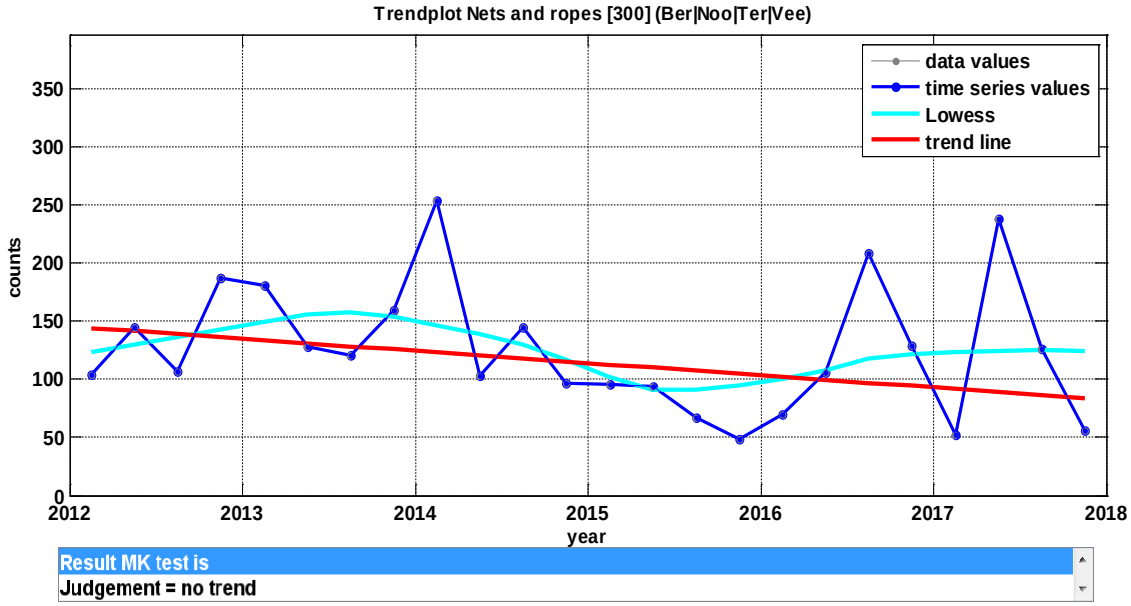

Figure 7 Trendplot Net & Ropes period 2012- 2017 with no decreasing significant trend (p 0.107)

3.2.1. Differences between surveys sites

When comparing the results of the different surveys sites, the Top 15 most found items are very similar (see Appendix VII). Though, there are some differences in the type of items found. In particular, the sanitary cotton bud sticks appear high on the Top 15 most found items list in Veere. Comparing total sanitary cotton bud sticks found, Veere scores highest followed by Noordwijk. Shotgun cartridges only appear in the Top 15 items list in Veere. Comparing total shotgun cartridges found, Veere scores highest followed by Bergen.

Figure 8 Blue foam packaging material, Bergen

3.3 Sources of litter items

OSPAR identified the following sources: fishing, shipping, tourism, sanitation and a category 'other' for unknown sources. The assignment of source categories to litter items is complex. In many cases, litter items can originate from different sources. Nets and ropes for example, often originate from fishing vessels, but can also originate from cargo vessels. During the IGCML meeting in Brussels in 2017 it was decided that the Tudor & Williams method was

picked as one of the best methods for source allocation. An action was formulated, to begin with the development of the source allocation for the Southern North Sea. In figure 9 the source allocation for beach litter in the Netherlands period 2012 -2017 applying the Tudor & Williams by expert judgement of the North Sea Foundation is presented. Most sources of beach litter in the period 2012-2017 are allocated to the fishing (40,7%) and shipping (19,8%) industries followed by tourism (17,4%), rivers (17,8%) and sewages (4,3%). In Appendix V the source allocation categorisation for the abundance of beach litter in the period 2012-2017 is included.

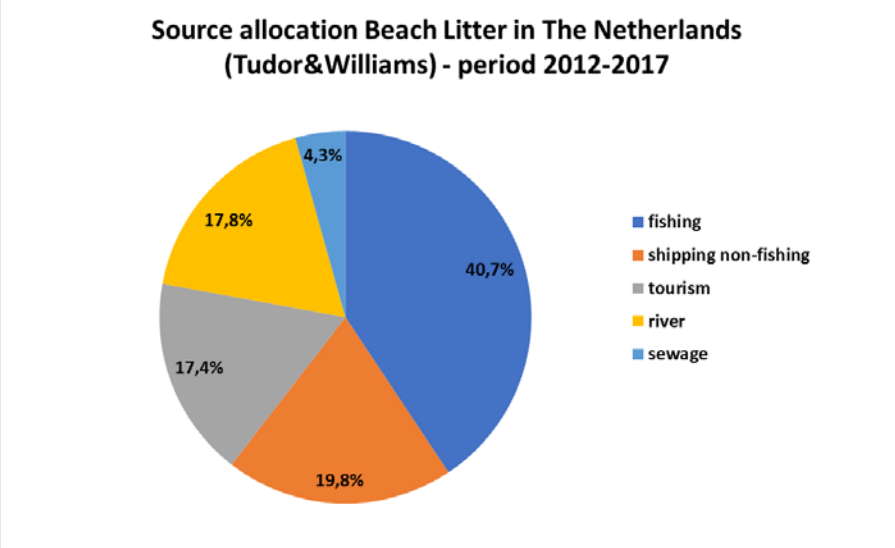

Figure 9 Source allocation of beach litter in The Netherlands in the period 2012-2017.

3.4 Materials of litter items

Trend analyses of litter materials for the period 2012-2017 are provided in table 6.

The data shows decreasing trends for plastic/polystyrene, sanitary and metal material categories. For wood, glass, cloth/textile and ceramic/pottery materials no trends were found. The largest decreasing trend is from plastic/polystyrene material (-19.7 counts/year). Rubber and medical materials show an decreasing trend with statistical significance.

Table 6 Material trend analysis of litter items for each material category at Bergen, Veere, Terschelling, and Noordwijk including trend in counts/year and significance of trend for the period 2012-2017. Significant trends are printed in bold.

Aggregated results for Terschelling / Bergen / Noordwijk / Veere		
Material category	**Trend [counts/year]**	**Significance of trend (p-value)**
plastic/polystyrene [406]	-19,7	0,137
rubber [407]	-0,9	**0,050**
sanitary [414]	-0,6	0,066
paper/cardboard [409]	0,0	1,000
wood [410]	0,2	0,251

glass [412]	0,3	0,123
metal [411]	-0,1	0,617
cloth/textile [408]	0,0	0,726
ceramic/pottery [413]	0,0	0,079
medical [415]	0,0	**0,003**

3.5 Unidentified Beach Objects (UBO's)

Figure 10 show one unknown that was found during the surveys in 2017. The item shown on figure 10 looks like is a piece of blue plastic.

Figure 10 Piece of plastic, Terschelling

3.6 Registration of other pollutants

The presence of pollutants such as paraffin is separately recorded on the OSPAR Marine Litter Monitoring Survey Form since the beginning of the beach litter monitoring from 2002. The size (range 0->10 cm) and the frequency of paraffin per 100m (estimated number per metre of strandline) is recorded.

In 2016 the EIHA 2016 Environmental Impact of Human Activities Committee (EIHA) requested ICG-ML to examine the information held in the beach litter database on paraffin items to determine if there is a cause for concern that should be brought to the attention of the IMO. It was concluded *"The results show that the monitoring of floating pollutants (note: in this case paraffin) washed ashore on the coast in the OSPAR region using the OSPAR beach litter surveys appears to supply feasible results" (OSPAR, 2017).*

The analysis of the registration of other pollutants in the period 2002 – 2015 (appendix VI) shows that The Netherlands belong to the Top 3 countries where most paraffin is recorded. In the period 2012-2017 where 95 surveys were conducted, during 49 surveys, other pollutants such as paraffin were recorded. In 2017, during 69% of the surveys conducted other pollutants such as paraffin was found (figure 11). Paraffin was found more often than in 2016.

The average number of paraffin or wax pieces recorded for all sites in the period 2012-2017* is presented below:

- size range 0-1cm 281 pieces/m²
- size range 1-10cm 338 pieces/m²
- size range >10cm 25 pieces/m²

*average of all surveys where paraffin & wax was recorded as present in the given size range

Whether the presence of paraffin on the Dutch coastline has increased is difficult to determine due to registration method of the pollutants. It was recommended to improve the value of the results by standardized analysis of samples of pollutants and by monitoring and registering paraffin in every Dutch beach survey.

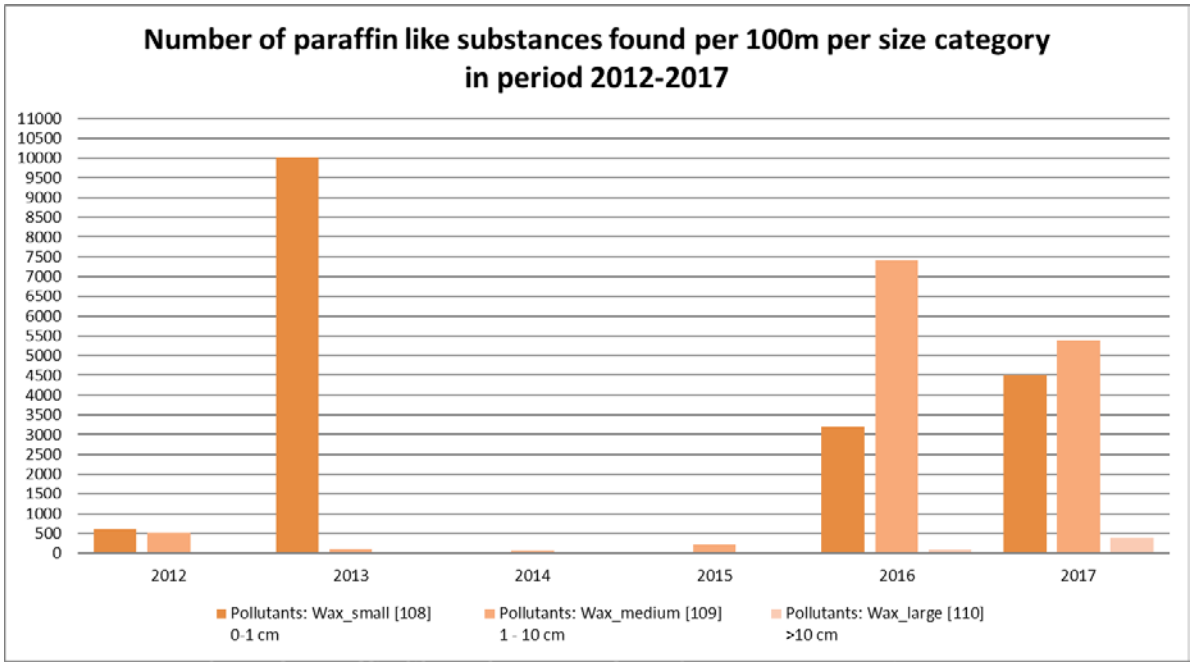

Figure 11. Number of paraffin like substances found per 100m per size category in period 2012-2017

Figure 12 Photograph of paraffin found during beach litter monitoring in Veere, 2017.

3.7 Pellets

In 2017 during every survey the presence of plastic pellets was recorded. In 2017, during 10 (71%) of the 16 surveys conducted, plastic pellets were found. In some cases, it was only a few (1-50), in other cases more than (50 - <500) pellets. In table 7 the periods where plastic pellets were found are included. Plastic pellets were mostly found in Q2 and Q3 in Bergen and Noordwijk.

Table 7 Presence of pellets during quarterly measurements in 2017.

Location	*Period*				
	Q1	*Q2*	*Q3*	*Q4*	*Total number of times pellets found*
Bergen		x	x	x	3
Noordwijk		x	x	x	3
Terschelling		x	x		2
Veere	x	x			2
Total number of times pellets found per period	**1**	**4**	**3**	**2**	**10**

Figure 13 Pellets, Noordwijk

3.7 Plastic bags

On January 1st 2016, a ban on free plastic bags in shops was introduced in the Netherlands. The purpose of this ban was to reduce street- and marine litter. The trend plot for OSPAR item – Plastic Bags [002] is included in figure 14. This category includes plastic shopping bags. In the period 2012-2017 the average count per year was 2.9 plastic bags per 100m beach and shows a decreasing trend of -1,1 counts/year (p value = 0,00002). In figure 15 the trend plot for the period 2004-2017 is shown. The average count per year is 8.3 plastic bags per 100m of beach and shows a decreasing trend of -1,3 counts/year (p value = 0,00000).

In 2017 the average count per year was 0.6 plastic bags per 100m beach. Compared to 2016, the average count per year was 0,8 plastics bags per 100m beach. The average count decreased in 2017 compared to 2016 by 0,2 plastic bag per 100m beach. Since 2012, the trend is decreasing and it seems that the ban possibly has contributed to the already decreasing trend, however future results must determine if the trend continues to decrease.

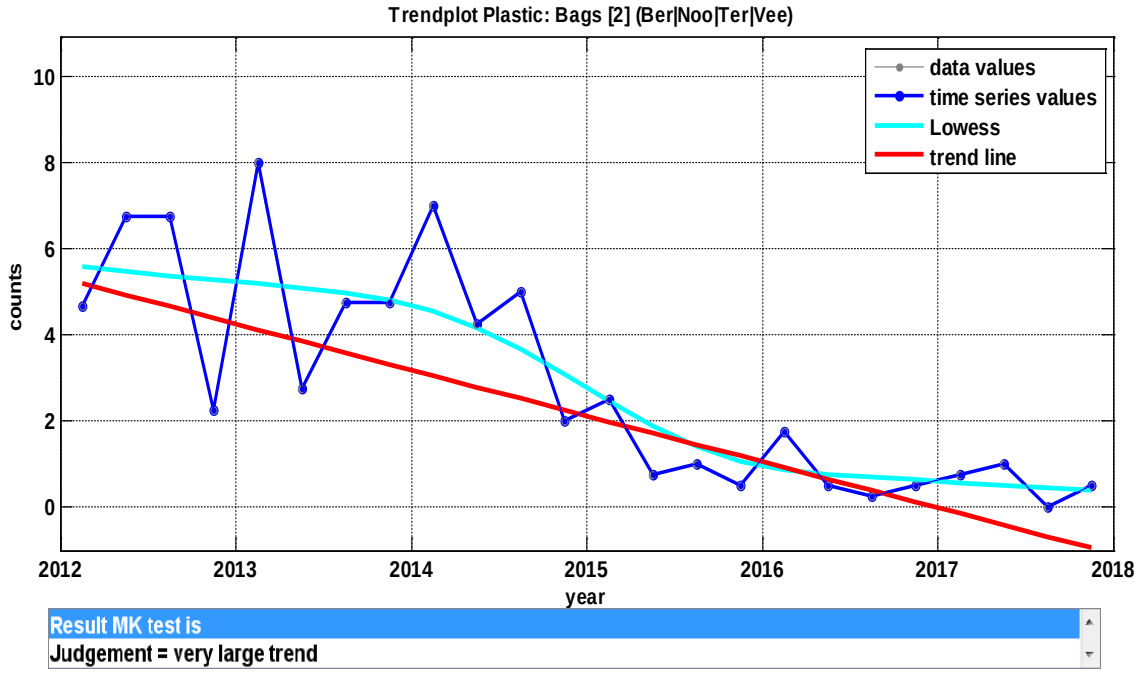

Figure 14 Trendplot Plastic bags in period 2012-2017 with decreasing significant trend (p 0.00002)

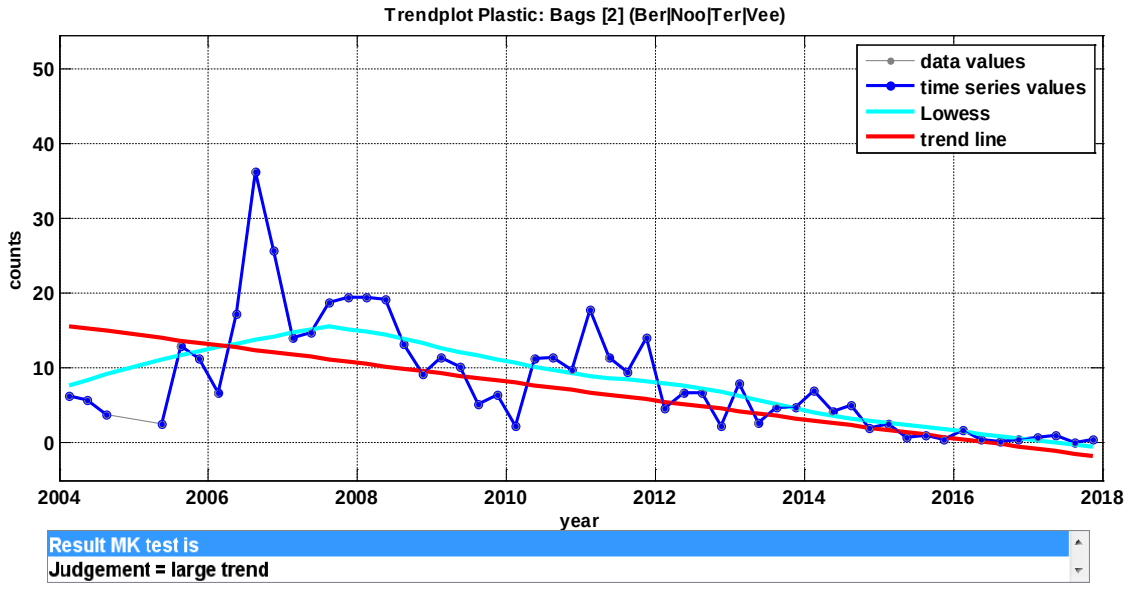

Figure 15 Trendplot Plastic bags in period 2004-2017 with decreasing significant trend (p 0.00000)

3.9. Plastic drinks (bottles, containers and drums)

The trend plot for OSPAR item – Drinks (bottles, containers and drums)[004] is included in figure 16. In the period 2012-2017 the average count per year was 4.2 plastic drinks per 100m beach and shows a decreasing significant trend of -0.5 counts/year (p value = 0.049).

In 2017 the average count per year was 3.9 plastic drinks per 100m beach. Compared to 2016 the average count per year increased from 2.1 to 3.9 plastic drinks per 100m beach. The average count increased in 2017 compared to 2016 by 1.8 plastic drinks per 100m beach.

3.9.1. Drink packaging

The trend plots for OSPAR item – Drinks (bottles, containers and drums)[004] is included in table 10. In the period 2012-2017 the average count per year was 4.2 plastic drinks per 100m beach and shows a decreasing significant trend of -0.5 counts/year (p value = 0.049).

Table 8: Drink packaging 2012 – 2017 and trend slopes and p-values. Significant trends are printed in bold.

Aggregated results for Terschelling / Bergen / Noordwijk / Veere						
Rank	*Litter category [OSPAR-100-ID]*	*Med. Count / 100 m*	*Aver. count/ 100 m*	*% of total count*	*Trend (counts/ Year)*	*Significance of trend (p-value)*
	Plastic: Drinks [4]	4,5	4,2	1,4%	-0,5	**0,049**
	All cartons/tetrapacks [302]	1,0	1,4	0,4%	-0,3	**0,012**
	Metal: Drink [78]	1,3	1,2	0,4%	-0,1	0,258
	Glass: Bottles [91]	1,0	1,1	0,3%	-0,1	0,367

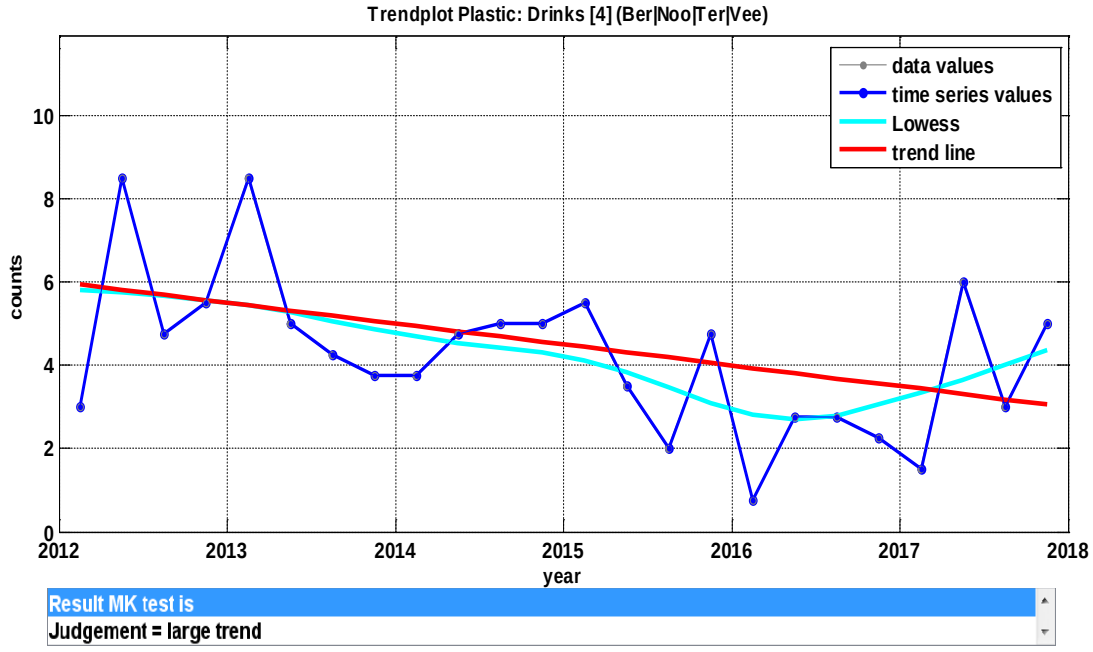

Figure 16 Trendplot Plastic Drinks in period 2012-2017 with decreasing significant trend (p 0.049)

3.10. Supplementary research

Since 2016, supplementary research has been conducted. A pilot has started to weigh marine litter. The first pilot involved the weighing of marine litter after each monitoring to get a better insight in the weight amount of kilo's and thereby the volumes of marine litter washing ashore. In 2017, marine litter was weighed at 16 surveys.

All items were collected in a plastic bin bag after the sand was manually removed by shaking off the sand as much as possible. The bag was weighed with a digital weighing device. The average weight based on 16 surveys was 7,6 kg per survey. Compared to 2016, the weight increased by 1,6 kg in 2017. At two surveys in Bergen, amounts of 14 and 20 kg were recorded. More surveys must be conducted before enough data is collected to draw conclusions.

The second pilot includes the separate recording of dolly rope. Dutch surveyors estimated that 90% of the items under OSPAR Litter category [OSPAR- 0032] String and cord and [OSPAR-0033] Tangled nets/ cord/rope and string consist of dolly rope. In order to test this assumption, the dolly rope was recorded separately. The pilot was carried out without affecting the OSPAR dataset. An extra field form was developed where the number and the colour (blue, red/orange, black and other) of each dolly rope is recorded separately. This was done because the assumption is that the colour could be related to the type of fishing industry and preference of colour use of Belgium and Dutch fishermen. Black and blue coloured dolly rope is mainly used by Belgium fishermen and Southern Dutch fishermen and orange dolly rope is mainly used by Northern Dutch fishermen (Strietman,2017).

The data is later added to the string and cord category on the regular OSPAR field form. In 2017, the separate recording of dolly rope was done at 15 surveys. Most dolly rope was found in Bergen and was blue. Blue dolly rope accounted for more than 56% of the total of 1772 dolly rope items recorded separately.

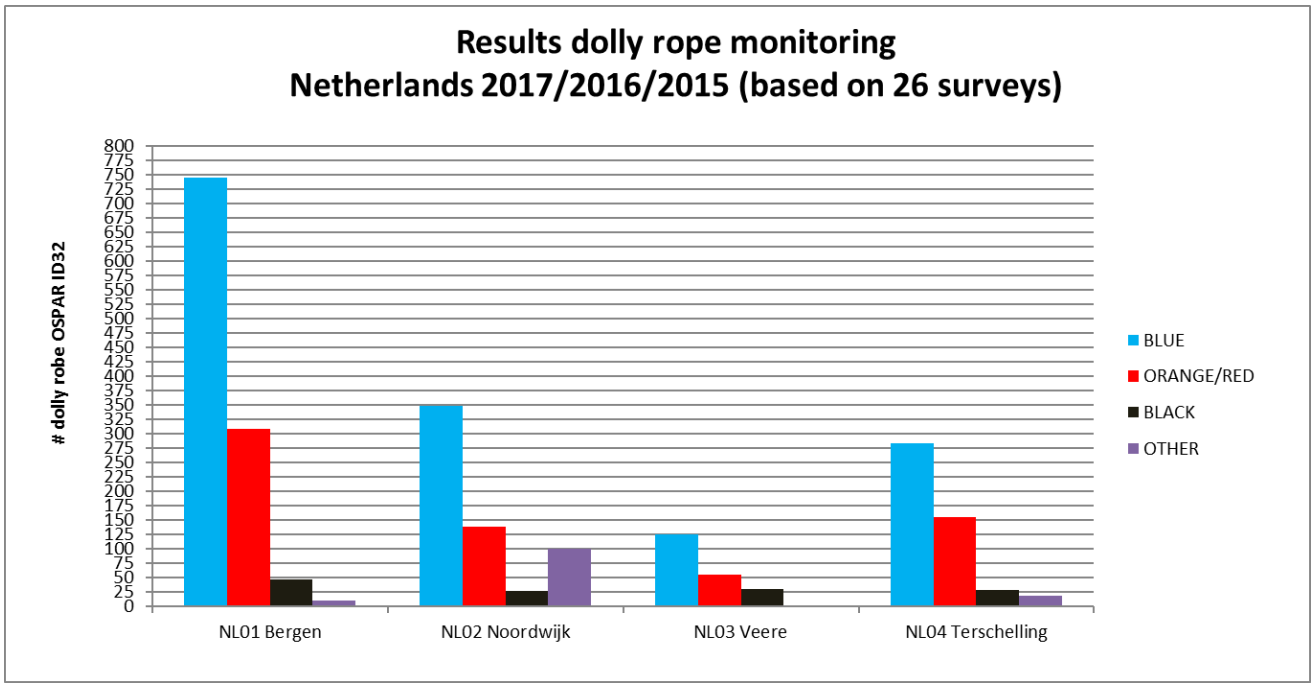

Figure 27 Results dolly rope monitoring during Beach Litter surveys in The Netherlands

In figure 17 the results of 26 beach litter surveys is presented. The results show that are similarity between in the proportions of the colours of dolly rope found on all beaches. Only in Noordwijk more different colours are found. It seems that there are no strong links between the locations and colours found. This supplementary research pilot will therefore end in the next monitoring rounds during 2018.

3.11. Moving Averages

The data of 2012-2017 shows a decreasing trend without significance. Table 9 includes the moving averages, median, trend slope and p values during six year periods from 2004 – 2017. The total abundance of litter lies between 447 – 303 items per 100m of beach. In the first six periods the trends slope shows various results e.g. an increasing slope in 2008-2013 and relatively minor decreasing trends slopes of maximum -4,3. The periods 2010-2015 and 2011-2016 both show a significant decreasing trend and large decreasing trend slopes of more than -40,0.The trend seem to be stagnating in 2017, the decreasing trend slope is lower than the two six years periods before. In the last column the overall trend of the period 2004-2017 is presented. The total abundance of litter is 368,2 litter items per 100m of beach with an p value of 0,110.

Table 9: Six year moving of litter abundance in periods 2004 – 2017 and trend slopes and p-values. Significant trends are printed in bold.

Period	**2004-2009**	**2005-2010**	**2006-2011**	**2007-2012**	**2008-2013**	**2009-2014**	**2010-2015**	**2011-2016**	**2012-2017**	**2004-2017**
6-year arithmetic averages	397	406	447	399	393	383	364	354	313,1	368,2
Median	352,4	404,0	430,6	408,8	368,9	368,6	366,6	345,9	303,1	352,4
Trend, slope	7,2	-4,3	-4,2	-3,0	25,7	2,0	-40,0	-42,1	-21,2	-8,9
Trend, p value	0.573	0.712	0.901	0.823	0.785	0.941	**0.011**	**0.011**	0.157	0,110

3.12 Special circumstances

During one survey, the beach in Veere (Q4 2017) was extremely clean compared to past surveys. However, no recorded cleaning activities have taken place before the survey. During another survey in Bergen (Q2 2017) the beach was abundant with marine litter, more than 1000 items were found. During all surveys in 2017, tractor and car tracks were visible in the survey areas.

3.12.1. Garbage bins on survey site

During the surveys in Bergen and Noordwijk, garbage bins were present on the surveys sites. It seems they are placed during the summer months. The garbage bins were filled with marine litter, indicating that marine litter was collected by beach visitors near or on the survey site. No information is available when the garbage bins were emptied and how much litter was collected through the garbage bins. The municipalities have been contacted regarding the garbage bins but have not yet given specific information.

3.13 Discussion

The data show decreasing trend for marine litter. There are various factors that could play a role to explain this decreasing trend and it means that results in this report should be interpreted with care.

An important development is the adjustment of the international legislation for waste disposal, in the MARPOL Annex V. Since 2013, it does not allow dumping of litter in the sea. Simultaneously , the disposal of waste by the shipping industry in Dutch harbours has improved in the following years after the introduction of these laws. Also, the public attention for marine litter and the "plastic soup" is increasing in the Netherlands leading to an increase in the beach cleaning initiatives.

According to the Fulmar Litter monitoring in the Netherlands, trend analyses of fulmars beached over the past ten years (2007-2016) show a modest, but statistically significant decrease in mass of ingested plastics in stomachs of fulmars beached in the Netherlands (Van Franeker et all, 2016). Though, still 91% of the fulmars contained plastic, on average 22.3 particles per stomach, weighing 0.28 gram.

For coastal municipalities, a clean beach is high on the agenda, with tourism and the rise in (international) tourists as important drivers. (NBTC Holland Marketing, 2018). Coastal municipalities participate in "Clean Beach Elections" that are organised since 2003. All reference beaches are currently participating in this competition. Some municipalities have placed garbage bins on the beaches to encourage beach tourist to dispose their litter in the garbage bin. These garbage bins are also used to dispose marine litter found on the beach.

In addition, the yearly Boskalis Beach Cleanup Tour (a coastal cleanup where the entire Dutch coast is cleaned up in the month August) was organised for the fifth time in 2017. Reference beaches are also cleaned up during this beach cleanup. Furthermore, the so called "jutbakken[3]" placed by municipalities in cooperation with the initiative "Doe Mee Verlos de Zee" have been placed in a growing number of coastal municipalities. Other activities such as river cleanup's have also been initiated on a larger scale. At the same time, the plastic production continue to increase. In 2016 the production amounted 335 million tonnes of plastic materials (Plastics Europe, 2017).

It is difficult to assess how these developments and increased cleaning activities affect the OSPAR Beach Litter Monitoring, as no exact information is available on litter collected by municipalities and other cleaning initiatives on an annual basis. One cannot with certainty draw the conclusion that the amount of litter entering the North Sea is decreasing. It might be the case that the decreasing trend found during the surveys is the result of increased beach cleaning activities. Further research in the amount of litter collected by municipalities as well as litter collected during voluntary clean-ups is needed in order to be able to assess this. Preferably over a multi year period.

[3] "Jutbakken" are beachcomber bins that placed on the beach. Beachcomber can dispose litter found on beaches in these bins. These bins are emptied by the municipality. There is variety of type of bins placed on beaches.

4 Conclusions

The data suggests that the Dutch beaches are getting cleaner. On average 313 items were found per 100 meter beach during the period 2012-2017. There is a decreasing trend in total litter counts (-21.2) with no statistical significance (p=0.517). In 2017, 286 items were found on average. Despite a further decrease in total counts compared to 2016, the 6 year trend is negative, the trend has no statistical significance.

The beaches Noordwijk, Terschelling, Veere show a decreasing trend in average items counts per year. Terschelling has the highest decreasing trend in average item counts per year, namely -35.2. Bergen shows an increasing trend for average item counts per year of +39.5. At the same time, Bergen fluctuates. In 2017, between 40 (Q1 Veere) and 1.121 (Q2 Bergen) items were found, the total average number of items counts for all beaches was 286 items per 100m beach.

The top-80% resulted in a top 15 of most found litter items on the four Dutch beaches monitored. The most found items are nets and ropes (nr. 1) and plastic/polystyrene pieces smaller than 50 cm (nr. 2). Together these two items account for more than half of the total number of litter counts.

Sources of beach litter in the period 2012-2017 are allocated to the fishing (40,7%) and shipping (19,8%) industries followed by tourism (17,4%), rivers (17,8%) and sewages (4,3%) based on the application of the Tudor & Williams method. Most items found originate from sea-based sources. Nets and ropes, mostly originating from the fishing sector, account for 40,2% of all litter items found.

Decreasing trends in average counts per year were found for plastic/polystyrene, rubber, sanitary and metal material categories. For paper/cardboard, glass, metal, cloth/textile, ceramic/pottery and medical materials no trends were found. For wood and glass small increasing trends were found. The largest decreasing trend in material categories is from plastic/polystyrene with -19.7 average item counts per year.

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Appendix I OSPAR database exports of Dutch beach litter monitoring, year 2016.
Appendix II Scans of OSPAR litter survey forms, year 2016.
Appendix III Litter Analyst evaluation tables of items, materials and sources.
Appendix V Source allocation of beach litter in the Netherlands
Appendix VI Recording the presence of “pollutants” on OSPAR Beach Litter Survey beaches
Appendix VII Trends plots Top 5 Most Found Items

Appendix VI Recording the presence of “pollutants” on OSPAR Beach Litter Survey beaches

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Table 2: Number of surveys with records of chemicals in each country

Country	paraffin or wax 0-1cm	paraffin or wax 1-10cm	paraffin or wax >10cm	other pollutants
Belgium	2	4	1	1
Denmark	4	14	8	2
France	8	48	29	20
Germany	22	34	16	9
Netherlands	24	44	11	15
Norway	4	8	5	4
Portugal	5	15	4	12
Spain	4	19	2	14
Sweden	9	42	20	10
United Kingdom	1	1	0	4

Appendix VII Trends plots Top 5 Most Found Items