



OSPAR Beach Litter Monitoring in the Netherlands 2013-2018

Annual Report



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Table of Contents

List of abbreviations	6
Summary	7
1 Introduction	8
1.1. The development of a standardized protocol and guideline	8
1.1.1 Developments baselines, threshold values and data analysis tool	9
1.2. European Marine Strategy Framework Directive (MSFD)	9
1.3. Related macro-litter monitoring projects	11
1.3.1. Pilot monitoring Wadden Sea	11
1.3.2. The Clean River project	11
1.3.3 OSPAR Marine Litter Monitoring pilot on Bonaire	11
2 Materials and methods	12
2.1 Selection of reference beaches	12
2.2 Sampling areas	13
2.2.1. 1 kilometre surveys	15
2.3 Monitoring frequency and period	15
2.4 Item classification	15
2.5 Collection, identification and registration of litter	15
2.6 Data Management	16
2.7 Data analysis procedures	16
2.7.1 Data preparation: item clustering	16
2.7.2 Data preparation and analysis using Litter Analyst	16
2.7.3 Trend analyses	17
2.7.4 Calculation of total item abundance	17
2.7.5 Source analysis	17
2.7.6 Material analysis	17
2.7.7 Single Use Plastics	17
2.7.8 Unknown litter types	18
2.7.9 Survey dates and special circumstances	18
2.7.10. Monitoring of other pollutants	18
2.7.11. Monitoring of pellets	18
2.8 Reporting	18
3 Results	19
3.1 Total abundance	19
3.2 Top-80% Analysis	20
3.2.1. Differences between surveys sites	21
3.3 Materials of litter types	22

3.4 Other plastics litter types found	23
3.5 Registration of other pollutants	24
3.6 Pellets	26
3.7 Plastic bags	27
3.8. Plastic drinks (bottles, containers and drums)	28
3.8.1. Drink packaging	28
3.9 Litter types included in the European Single Use Plastics (SUP) Directive	28
3.10. Supplementary monitoring of total weight	30
3.11. Moving Averages	32
3.12 Special circumstances	32
3.12.1. Garbage bins on survey site	34
3.13 Sources of litter types	34
3.14 Discussion	35
3.14.1. Stricter international laws and developments of new directives in EU.	35
3.14.2. Increased public and political awareness	36
4 Conclusions	38
References	40
Appendix I OSPAR database exports of Dutch beach litter monitoring year 2018.	42
Appendix II Scans of OSPAR litter survey forms, year 2018.	42
Appendix III Litter Analyst evaluation tables of litter types, materials and sources period 2013-2018.	42
Appendix IV Recording the presence of “pollutants” on OSPAR Beach Litter Survey beaches	43
Appendix V Trends plots Top 5 Most Found Litter types	44
Appendix VI Data Statistics Netherlands (CBS)	46

List of figures

Figure 1: Fishing gear washing ashore, Terschelling	10
Figure 2 Marine litter collected, Noordwijk	10
Figure 3 Dutch monitoring beaches (map provided by RWS)	13
Figure 4 Walking pattern used for the beach litter monitoring.	14
Figure 5 Photograph of the Dutch reference beach Terschelling	14
Figure 6 Trendplot Total abundance period 2013- 2018	20
Figure 7 Trendplot Net & Ropes period 2013- 2018	21
Figure 8 Plastic bottles, Terschelling	22
Figure 10 Type of materials in period 2013-2018.	23
Figure 11. Number of paraffin like substances in period 2013-2018	25
Figure 12 Pieces of paraffin found in Veere	25
Figure 13 Pellets, Noordwijk	26
Figure 17 Exposed dune with marine litter in Veere	33

List of tables

Table 1 Contact information of local beach coordinators.	13
Table 2 Details of the 4 Dutch OSPAR Beach Litter reference beaches	15
Table 3 Average total item abundance, trend and significance of the trend for Bergen, Noordwijk, Terschelling and Veere and for all four beached aggregated for the period 2013-2018.	19
Table 4 Top 80% of most found litter types along the Dutch coast for the period 2013-2018.	20
Table 5 Material trend analysis of litter types for each material category	22
Table 6 Presence of pellets during quarterly measurements in 2017.....	26
Table 7: Drink packaging 2013 – 2018 and trend slopes and p-values.	28
Table 8: Single use plastic litter types 2013 – 2018 and trend slopes and p-values..	29
Table 8: Weight of marine litter recorded per survey in the period 2016-2018.....	30
Table 9: Six year moving of litter abundance in periods 2004 – 2018 and trend slopes and p-values.	32
Table 10 Dates of surveys conducted in 2018	33

List of abbreviations

OSPAR *the mechanism by which 15 Governments & the European Union cooperate to protect the marine environment of the North-East Atlantic.*

CBD *Center for Biological Diversity*

IUCN *International Union for Conservation of Nature and Natural Resources*

MSFD *European Marine Strategy Framework Directive (MSFD)*

DG *Descriptor Good Environmental Status*

RWS *Rijkswaterstaat – Department of Waterworks and Public Works*

CSV *Comma-separated values*

ICGML *OSPAR Intersessional Correspondence Group on Marine Litter*

NSF *The North Sea Foundation*

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 2013-2018. During the 2013-2018 period (January – December) 96 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 the four survey locations are displayed in this report. The number of specific litter types and total litter abundance is given using 6-year median and arithmetic averages. Significance of trends of abundance of specific and total litter types over time were assessed by non-parametric regression using untransformed data from item abundance set out against the monitoring date. Analysis of beach litter monitoring data was performed using the tool Litter Analyst.

The six-year data set suggests that the Dutch beaches are getting cleaner. On average 308 litter types were found per 100 meter beach during the period 2013-2018. The data show a decreasing trend in average item abundance per year for all beaches of -32,0 litter types per year. The trend has no statistical significance ($p\text{-value} = 0,0070$). Compared to last period 2012-2017, where it seemed the trend was stagnating, the trend slope has decreased again from -21,2 to -32,0. In 2018, on average 283 litter types were found each survey. The lowest count of litter types per survey was in Veere (37 litter types) and the highest count was in Noordwijk (1.539 litter types). 40 (Veere) and 1.121 (Bergen) litter types were found. Plastic is the most found material. It accounted for more than 90% of litter found.

The top-80% resulted in a top 15 of most found litter types on the four monitored beaches. The data show decreasing trends for 11 of the top 15 most found litter types; 6 of these trends are significant. The largest decreasing trend in average item abundance per year is from net and ropes (-15.2 abundance/year). In the period 2013-2018 net and ropes account for 37,6% of all litter types found (excluding tangled net & ropes). 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. In the period 2013-2018 the average count per year was 2.2 plastic bags per 100m beach and shows a decreasing trend of -0,7 abundance/year ($p\text{-value} = 0,000$) and is no longer included in the top 15 most found litter types.

In 2018, during 31% of the surveys conducted other pollutants such as paraffin was found. Paraffin was found less often than in 2017.

The North Sea is one of the most important fishing grounds in the world and has some of the busiest shipping lanes in the world. These economic activities on the North Sea of the fishing and shipping sector have a clear influence on the litter that is found on the Dutch North Sea beaches as Nets and ropes [300] and Tangled [33] constitute for 40 percent of the litter found. Single use plastics constitute for almost 25 percent of the litter found on the North Sea beaches. These plastics can originate from different land based sources such as littering of beaches and coastal areas (tourism); rivers and floodwaters and from an sea-based source namely illegal or accidental dumping at sea from shipping (e.g. transport, tourism).

1 Introduction

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).

It is estimated that more than 150 million tonnes of plastic have accumulated in the world's oceans and each year 12 million tonnes are added (Jambeck et al. 2016). Currently, the plastic production continues to increase. In 2017 the production grew from 335 to 348 million tonnes of plastic materials (Statista, 2019).

Marine litter is defined as: *"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"*. Marine litter travels long distances with oceans currents and is found all over the globe in marine environments, even in very remote areas (Werner et al. 2016). Research shows that large quantities of floating plastics from Europe and US end up in the Arctic Ocean and in the pristine Arctic ecosystem (Cózar et al. 2017).

Apart from the ecological impacts there are socioeconomic impacts such as costs for cleaning activities and reduced attractiveness for recreational activities. It was calculated that the potential costs across the EU for coastal and beach cleaning was assessed by almost €630 million per year (OSPAR, 2016). In addition, lost and discarded fishing nets can cause propeller issues and can consequently lead to shipping delays and lost fishing time.

Accumulation and dissemination of marine litter pose threats to the health of the world's oceans. In addition, possible effects on human health of especially micro and nano-plastics are being investigated.

1.1. The development of a standardized protocol and guideline

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.

In the year 2000, a standardized protocol for the 'OSPAR Pilot Project on Monitoring Marine Litter' was developed aimed at monitoring 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 Infrastructure and Water

Management to continue with the beach litter monitoring. With the installation of an Interseasonal Correspondence Group Marine Litter (ICGML) the project was embedded in OSPAR on an official basis.

A guideline for monitoring marine litter on beaches has been developed by as a tool to collect data on litter in the marine environment. OSPAR's Coordinated Environmental Monitoring Programme (CEMP) guideline for monitoring marine litter washed ashore and/or deposited on coastlines (beach litter)¹ 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 guidelines have been updated in 2018. The OSPAR guideline 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.

1.1.1 Developments baselines, threshold values and data analysis tool

The baselines and threshold values for beach litter are under development. It is expected that these will be approved in 2020 which can assist to evaluate trends and enable to assess if threshold values will be met according to the targets set by OSPAR. In addition, the Dutch government has been involved in the development of an improved data analysis tool called LitterR to perform i.e. statistical analysis for beach litter trends. This tool will be applied in the next year report 2014-2019 and the use of Litter Analyst will be phased out.

1.2. European Marine Strategy Framework Directive (MSFD)

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. At EU level, is the dedicated binding legal instrument for assessing, monitoring, setting targets and reaching good environmental status with regard to marine litter. The DG10 is defined as follows: *"Properties and quantities of marine litter do not cause harm to the coastal and marine environment by 2020"*. Monitoring marine litter is one of the obligations within this directive. Beach surveys performed according to the OSPAR protocol can be used to monitor trends in amounts (quantitative), materials (quantitative), and sources (qualitative) of marine litter washed ashore.

The Dutch Ministry of Infrastructure and Water Management has assigned the North Sea Foundation to monitor the beaches according to the OSPAR protocol in the Netherlands during 2013-2018. The North Sea Foundation (NSF) 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 2013-2018 beach surveys.

The current report aims to:

- provide an annual update of Dutch beach litter monitoring data of 2018;
- provide an overview of the Dutch beach litter data analysis results for 2013-2018 using Litter Analyst.

¹ <https://www.ospar.org/work-areas/cross-cutting-issues/cemp>



Figure 1: Fishing gear washing ashore, Terschelling



Figure 2 Marine litter collected, Noordwijk

1.3. Related macro-litter monitoring projects

A number of other monitoring projects where OSPAR methodology and survey forms are being conducted in The Netherlands. These projects, including a summary of their results, are included in the next sections.

1.3.1. Pilot monitoring Wadden Sea

In 2018 an OSPAR monitoring pilot was conducted in the Wadden Sea on three different locations namely the unhabituated sand flats 1) Steenplaat; 2) Griend; 3) Zuiderduintjes in assignment of the Department of Waterways and Public Works North - Netherlands. The methodology applied differs from the official OSPAR method. 100m and 1 kilometre surveys were conducted. Monitoring results of 3 surveys conducted in March, August and November 2018 are as follows: the total highest total abundance were on the south side of Griend (797 litter types – 214 litter types on 1 kilometre, 583 litter types on 100m). On the North side, the North Sea side, less litter types were counted (77 litter types; 32 litter types on 1 kilometre, 45 litter types on 100m), on both locations predominantly plastic litter types were found. On the Steenplaat and Zuiderduintjes less litter types were found. It was noted more wood litter types were found on the Steenplaat compared to Griend and Zuiderduintjes. On Zuiderduintjes the least litter types were counted and glass litter types were the most found (Department of Waterways and Public Works North - Netherlands, 2019). More survey data are needed to be able to compare the results of these surveys with the OSPAR monitoring on the North Sea coast.

1.3.2. The Clean River project

In 2017, the Institute for Nature Education, Plastic Soup Foundation and the North Sea Foundation initiated the Clean River project. In this project the OSPAR Beach Litter methodology is applied on river banks of the River Maas and Waal. The method was tested in 2017 and adjusted for river monitoring, resulting in slight modifications on the survey list, whilst keeping the data comparable to the beach litter monitoring data. In 2018 100m surveys were conducted. The project will run for the coming 5 years and will be extended to all rivers in the Netherlands. In 2018 a total of 76,959 litter types were registered along the riverbanks of the Maas and Waal during 209 surveys in the periods February – March and October-November 2018 (Clean River Project, 2019). More survey data will be collected to be able to detect trends and compare the results of these surveys with the OSPAR monitoring on the North Sea coast.

1.3.3 OSPAR Marine Litter Monitoring pilot on Bonaire

Starting in September 2018, an OSPAR monitoring pilot was initiated on the island of Bonaire, Caribbean Netherlands. Three locations were selected: 1) Boka Onima – a small, pocket beach on the north-eastern, windward side; 2) Piedra Pretu – a typical section of coastline along the south-eastern, windward side; 3) Te Amo Beach – a popular, recreational beach on the western, leeward side. Due to the extreme abundance of marine litter, OSPAR methodology was altered to reduce the sampling sites to 50m. The first surveys at each site served as training sessions, as well as an attempt to clear the sampling sites.

During the initial surveys, the following numbers of litter types were recorded: Boka Onima: 3,195, Piedra Pretu: 5,162 and Te Amo beach: 2,421 litter. The subsequent four surveys at Boka Onima yielded 16,502 litter types and Piedra Pretu yielded 14,783. On the leeward side, Te Amo

Beach had 6,582 in 3 surveys. With regards to composition - Boka Onima's total of 19,697 was 97% plastic/polystyrene; Piedra Pretu's 19,945 was 92% plastic/polystyrene and Te Amo Beach's 9,003 was 23% plastic/polystyrene (with an additional 52% of cigarette butts). The monitoring program is ongoing and currently supported by WWF-NL. The pilot results have been shared with the United Nations Environment Programme - Caribbean Environment Programme (UNEP-CEP) as part of the marine litter monitoring harmonization action plan for the Wider Caribbean Region.

2 Materials and methods

2.1 Selection of reference beaches

Within the OSPAR 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 easily 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 important. 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 2013-2018 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 selected. 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 types; 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 types. 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.

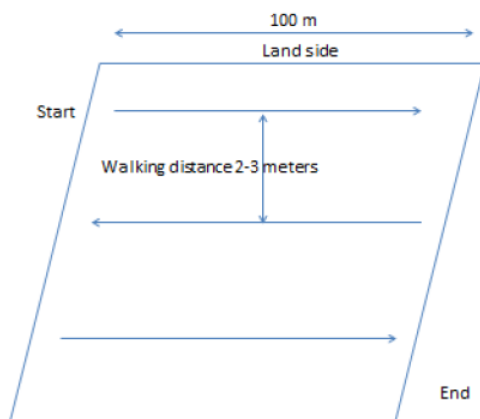


Figure 4 Walking pattern used for the beach litter monitoring. A monitoring strip is typically 2-3 m wide

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.

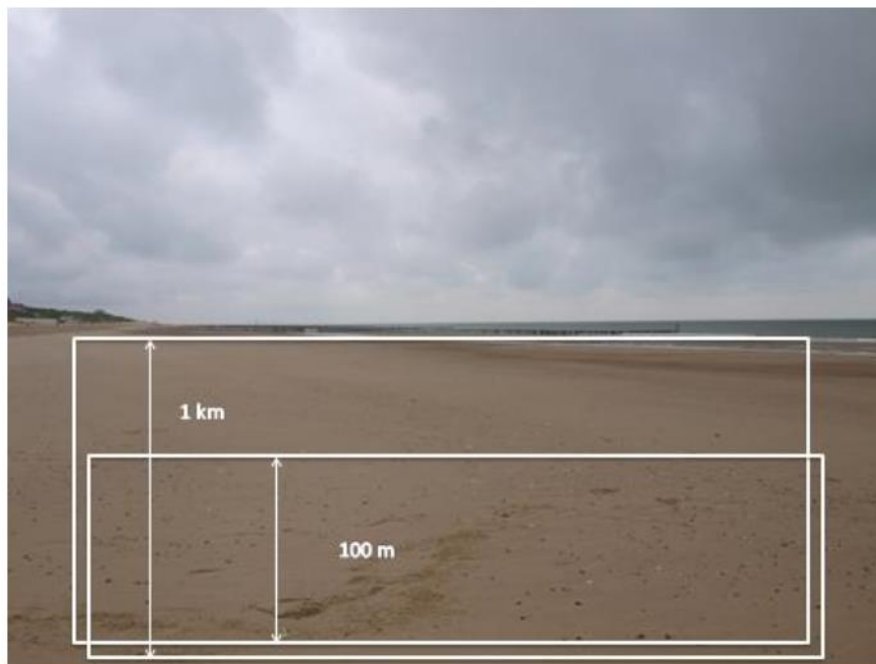


Figure 5 Photograph of the Dutch reference beach Terschelling

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	Number 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, the beached showed a highly significant decrease in larger litter types ($p < 0.001$). Factors such as increased effort by authorities, non-governmental organisations and the public in cleaning beaches, in which the larger litter types are most easily removed, play a role (OSPAR Commission, 2013). These efforts have continued the following years. It was therefore decided by OSPAR to stop 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

Litter types 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 litter types 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. Unknown litter or litter types 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 litter types in order for them to be identified later. The presence of recurring 'unknown' litter types 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). For the Netherlands, this is the North Sea Foundation. 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 were 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 database². In the near future, RWS CIV also stores 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 litter types) is performed by the 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 types and total litter types 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 Analyst³. Outputs of Litter Analyst are evaluation tables of litter types, sources, and materials, but also a data series plot, boxplots of item abundance 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:

- Aggregation condition 75%, minimum percentage of abundance of litter types in top-X list 80%.

²<http://www.mcsuk.org/ospar/home>

³<http://www.amo-nl.com/pdf/User%20manual%20Litter%20Analyst.pdf>

2.7.3 Trend analyses

In the annual report trend analyses are performed on the total item abundance and the top-80% litter types. The top-80% is defined as the list of most abundant litter types that during a six-year period constitutes on average at least 80% of the total abundance. Trends are analysed by non-parametric Mann Kendall trend analysis of specific item abundance against the year of the survey. In the current beach analysis, the dataset of 6 years (2013-2018) was used.

2.7.4 Calculation of total item abundance

The occurrence of considerable fluctuations in the total abundance 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 abundance, and not from annual averages.

2.7.5 Source analysis

The assignment of sources categories to litter types 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 allocation⁴. The method uses the so-called likelihood approach, whereby, for each litter type on the OSPAR protocol, it is assessed or estimated how likely it is that the litter type (e.g. plastic cleaner bottle, or cotton-bud-stick etc.) enters the marine environment from a given source (e.g. shipping, sewage outlets etc.). The following categories are used: very likely; likely; possible; unlikely; very unlikely and not possible.

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 litter types is of interest for MSFD policy makers, in light of the increased awareness of and attention for 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 litter types (period 2013-2018) which have been assigned with sufficient confidence to either of the following 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 Single Use Plastics

The European Commission published the Single Use Plastics Directive in 2019 (see paragraph 3.10). This directive aims to tackle marine litter coming from the 10 single-use plastic products most often found on European beaches. Single Use Plastics are defined as: “products that are made wholly or partly of plastic and are typically intended to be used just once or for a short period of time before they are thrown away”. Trend analysis is performed of the total abundances of the following single use litter types (period 2013-2018):

Plastic: Cutlery [22]; Plastic: Drinks [4]; Plastic: Caps [15]; Plastic: Food [6]; Plastic: Cups [21]; Plastic: Cutlery [22]; Rubber: Balloons [49]; Paper: Cig_stubs [64]; San: Buds [98]; San: Towels [99]; All cartons/tetrapacks [302]; Plastic: Crisp [19]; Plastic: Bags [2]; Plastic: Small_bags [3]; Nets and ropes [300]; Plastic: Tangled [33] and Plastic: Cutlery [22]

⁴ <http://publications.jrc.ec.europa.eu/repository/bitstream/JRC104038/lb-na-28309-en-n.pdf>

2.7.8 Unknown litter types

Photographs of unknown litter types 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.

2.7.9 Survey dates and special circumstances

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

2.7.10. Monitoring of other pollutants

Each monitoring, the presence of paraffine is registered under OSPAR code 108 size 0-1 cm, 109 size 1-10 cm and 110 size >10 cm. The frequency of how many pieces or lumps of paraffine are found is estimated per metre of strandline. Based on the experience of monitoring paraffine that has washed ashore, is that paraffine is spread in the entire sample area and normally concentrated along the flood lines. The method for estimated the number of pieces or lumps per metre strandline is the following:

- The number and sizes of lumps within three squares of 1 by 1 meter along the flood line are registered;
- The total amount of lumps per size category is calculated and divided by three;
- The average number of lumps per size category is registered on the OSPAR form for the estimated number of lumps found per metre strandline.

2.7.11. Monitoring of pellets

Each monitoring the presence of pellets is registered with an yes/ no on the OSPAR form. To get an better insight in the number of pellets washing ashore, an indication of the number of pellets found during each monitoring is recorded in the notes section. The following sizes categories are used: 1-50, 50-100 and 50-<500 pellets.

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

Exports from the OSPAR database containing all litter data from 2013- 2018 have been added in the digital Appendix II. A number of 96 surveys were performed. In the following sections, the total abundance 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.

3.1 Total abundance

The average total item abundance 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 litter types abundance for all beaches aggregated amounts to 308,3 litter types per 100 m beach. In 2018, the lowest count of litter types per survey was in Veere (37 litter types) and the highest count was in Noordwijk (1.539 litter types).

Table 3 Average total item abundance, trend and significance of the trend for Bergen, Noordwijk, Terschelling and Veere and for all four beached aggregated for the period 2013-2018. Significant trends are printed in bold.

<i>Location</i>	<i>Period</i>	<i>Litter abundance</i> <i>Average total abundance per survey</i>	<i>Median abundance per survey</i>	<i>Trend (abundance/year)</i>	<i>Significance of trend (p-value)</i>
Bergen	01/01/2013-31/12/2018	419,8	348,5	1,0	0,980
Noordwijk	01/01/2013-31/12/2018	360,5	244,0	-16,5	0,346
Terschelling	01/01/2013-31/12/2018	267,0	233,0	-46,5	0,009
Veere	01/01/2013-31/12/2018	186,1	123,5	-22,7	0,053
Ber Noo Ter Vee	01/01/2013-31/12/2018	308,3	288,5	-32,0	0,070

It appears that the decreasing trend of the total count trend found for the period 2013-2017 (-21,2) is again observed in the period 2013-2018 (-32,0). However, the significance of the aggregated trend is not very high (p-value 0.070).

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

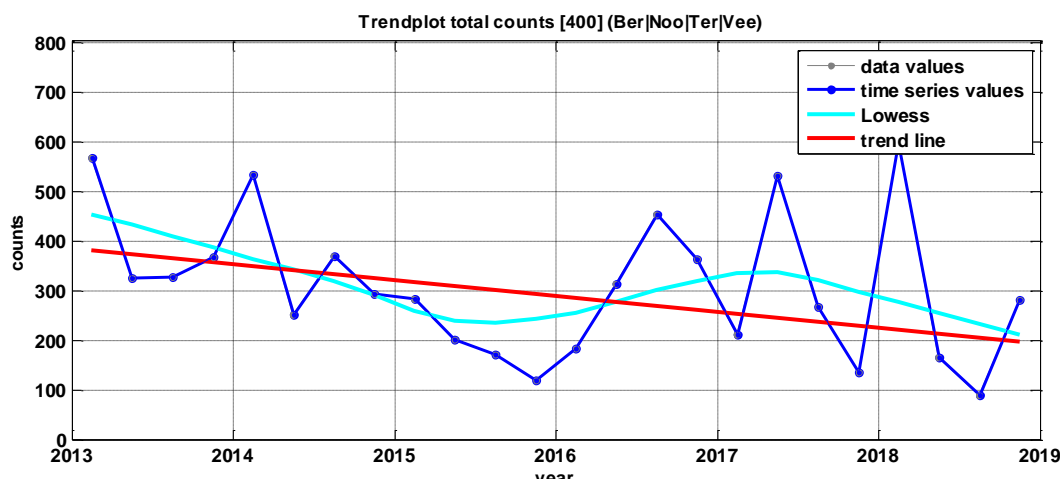


Figure 6 Trendplot Total abundance period 2013- 2018 with no statistical decreasing significant trend (p 0.070)

3.2 Top-80% Analysis

Top-80% analysis has resulted in a top-15 for all four beaches for the period 2013-2018. 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 4. Figure 6 shows the trend plot for the total abundance in the period 2013-2018. 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 2013-2018 are included in Appendix VII. Most found litter types, 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 abundance 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 types found (57,1%).

The data shows decreasing trends with a high ($p < 0.05$) significance for six of the top 15 litter types from the top 80% list. Litter types with high significance include: Net and ropes; balloons, small plastic bags, plastic drinks, plastic strapping bands and plastic food containers.

Table 4 Top 80% of most found litter types along the Dutch coast, including median and average count per 100 meter, percentage of total count, trend [abundance/year], and significance of trend for the period 2013-2018. 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 (abundance/ Year)	Significance of trend (p-value)
1	Nets and ropes [300]	104,1	116,0	37,6%	-15,2	0,035
2	Plastic polystyrene pieces < 50 cm [301]	59,1	60,0	19,5%	-6,9	0,092
3	Plastic: Caps [15]	14,4	19,2	6,2%	-1,6	0,214

4	Plastic: Crisp [19]	10,8	13,2	4,3%	0,2	0,785
5	Plastic: Foam_sponge [45]	11,4	12,6	4,1%	-0,3	0,747
6	Rubber: Balloons [49]	8,6	9,9	3,2%	-1,2	0,017
7	Plastic: Industrial [40]	8,0	9,1	3,0%	-0,6	0,487
8	Plastic: Tangled [33]	7,9	8,7	2,8%	-0,5	0,286
9	Plastic: Small_bags [3]	6,0	6,0	2,0%	-0,8	0,018
10	Plastic: Cutlery [22]	4,1	4,9	1,6%	-0,3	0,384
11	San: Buds [98]	3,5	4,4	1,4%	-0,6	0,106
12	Plastic: Other [48]	2,8	3,7	1,2%	-0,6	0,156
13	Plastic: Drinks [4]	3,6	3,5	1,1%	-0,8	0,002
14	Plastic: Strapping [39]	2,0	2,4	0,8%	-0,3	0,009
15	Plastic: Food [6]	2,3	2,3	0,7%	-0,4	0,035

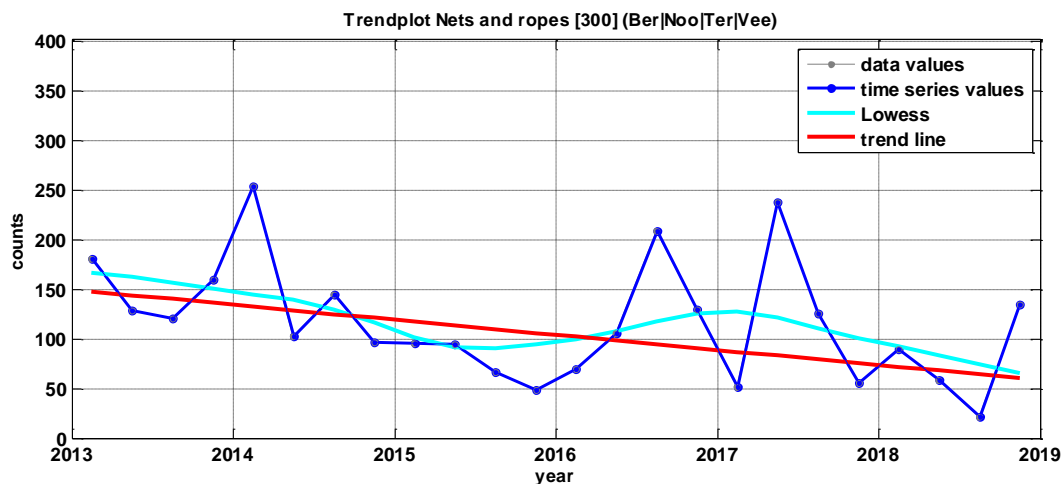


Figure 7 Trendplot Net & Ropes period 2013- 2018 with decreasing significant trend (p 0.035)

3.2.1. Differences between surveys sites

When comparing the results of the different surveys sites, the Top 15 most found litter types are very similar (see Appendix VII). Though, there are some differences in the type of litter types found and average abundance per 100m. In particular, the sanitary cotton bud sticks appear high on the Top 15 most found litter types list in Veere. Comparing total sanitary cotton bud sticks found, Veere (average count of 4,2 per 100m beach) scores higher on the top 15 list though on average Bergen was the highest score of 6,1 litter types per 100m beach. Shotgun cartridges only appear in the Top 15 litter types list in Veere (average count of 2,1 per 100m beach). Plastic strapping bands only occur in the top 15 list of Bergen (average count of 3,6 per 100m beach) and Terschelling (average count of 3,1 per 100m beach).



Figure 8 Plastic bottles, Terschelling

3.3 Materials of litter types

The data show decreasing trends for plastic/polystyrene, rubber, sanitary and metal material categories. The largest decreasing trend is from plastic/polystyrene material (-27.8 abundance/year). Small increasing trends are shown for the materials paper/ cardboard, wood and medical materials. Trend analyses of litter materials for the period 2013-2018 are provided in table 5.

In figure 10, the type of materials found are shown. Plastic/ polystyrene is the type of material found most with 89,4% followed by rubber (3,8%) and sanitary litter types (1,9%) and paper/ cardboard (1,2%) and wood (1,1%). The other materials are glass (0,9%), metal (0,7%), cloth/textile (0,5%), ceramic/pottery (0,3%) and medical (0,1%). Since the category rubber, sanitary and medical litter types included plastic litter types such as cotton bud sticks and balloons including plastic strings and sanitary containers, the percentage of plastic materials is higher. These categories together account for 5,8%. By applying this method, 95,2% is of the type of litter found is plastic.

Table 5 Material trend analysis of litter types for each material category at Bergen, Veere, Terschelling, and Noordwijk including trend in abundance/year and significance of trend for the period 2013-2018. Significant trends are printed in bold.

Aggregated results for Terschelling / Bergen / Noordwijk / Veere		
Material category	Trend [abundance/year]	Significance of trend (p-value)

plastic/polystyrene [406]	-27,8	0,066
rubber [407]	-1,0	0,066
sanitary [414]	-0,6	0,188
paper/cardboard [409]	0,1	0,619
wood [410]	0,2	0,426
glass [412]	0,0	0,980
metal [411]	-0,1	0,500
cloth/textile [408]	0,0	0,921
ceramic/pottery [413]	0,0	0,302
medical [415]	0,1	0,002

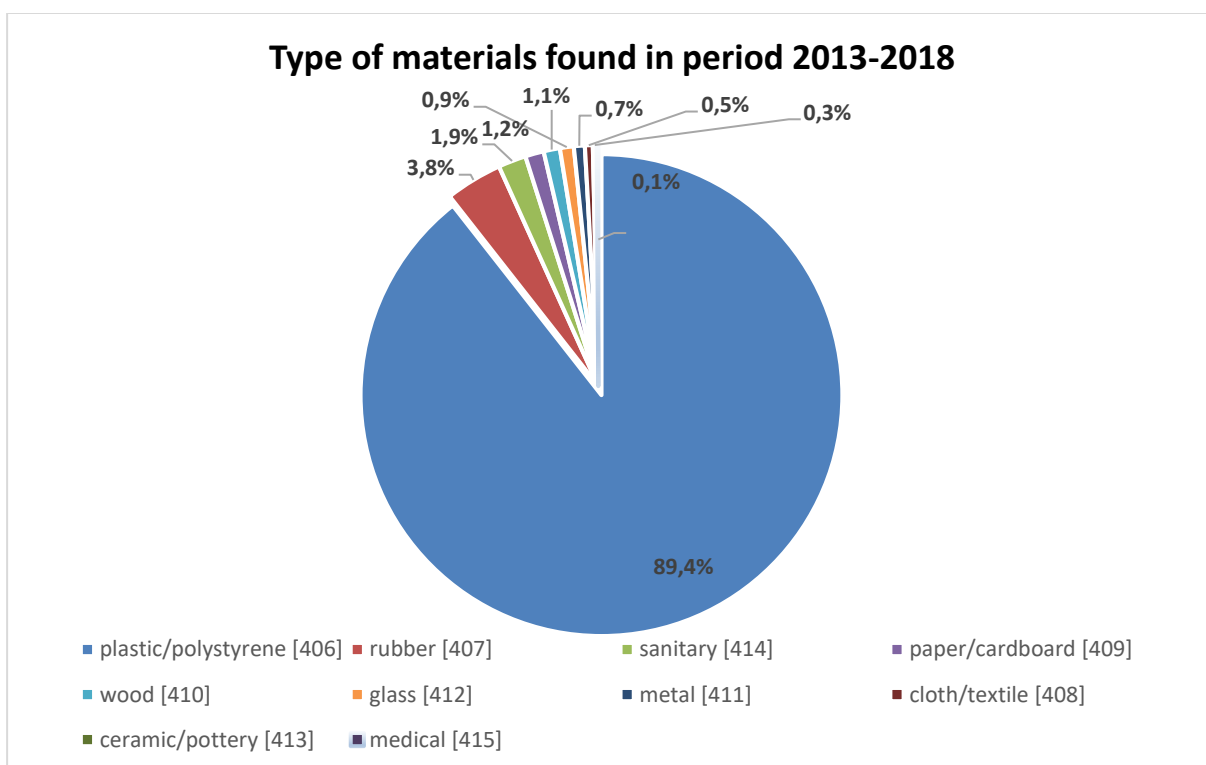


Figure 10 Type of materials in period 2013-2018.

3.4 Other plastics litter types found

A number of plastic litter types were found, that are not included on the OSPAR survey list. These include plastic (duck) tape, plastic plant pots and plastic cross for laying tiles that were found during various surveys in 2018.

3.5 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 (ranges 0-1cm, 1-10 cm and >10cm) 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 litter types 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 2013-2018 where 96 surveys were conducted, during 49 surveys, other pollutants such as paraffin were recorded. In 2018, during 31% of the surveys conducted other pollutants such as paraffin was found (figure 11). Paraffin was found less often than in 2017.

The average number of paraffin or wax pieces recorded for all sites in 2018* is presented below:

- size range 0-1cm 44 pieces/m²
- size range 1-10cm 44 pieces/m²
- size range >10cm 0 pieces/m²

*average of all surveys in 2018 where paraffin & wax was recorded as present in the given size range

3.5.1. The paraffin covenant

In 2018 a new agreement was signed to ensure that ships originating from Dutch ports no longer discharge tank washings containing paraffin such as candle wax into the sea. Ships transporting such substances to the Rotterdam and Moerdijk ports agreed to dispose of their tank washing containing these products in these ports. With immediate effect, under certain conditions, they will be compensated for such disposal. The agreement is signed by the Dutch government, carriers, shippers, Rotterdam Port Authority and the North Sea Foundation. Whether this agreement had led to the decrease of paraffin found during beach litter monitoring, is difficult to determine. More evidence is needed to evaluate the effect of the paraffin agreement.

Number of paraffin like substances found per 100m per size category in period 2013-2018

Year	Pollutants: Wax_small [108] 0-1 cm	Pollutants: Wax_medium [109] 1 - 10 cm	Pollutants: Wax_large [110] >10 cm
2013	10000	100	0
2014	0	100	0
2015	0	200	0
2016	3200	7200	100
2017	4500	5300	400
2018	700	700	0



25

3.6 Pellets

In 2018, during 6 (38%) of the 16 surveys conducted, plastic pellets were found. 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 6 the periods where plastic pellets were found are shown. Plastic pellets were mostly found in Q1 and Q4. In Bergen pellets were found during all surveys, and also the abundance of pellets was highest on the beach of Bergen.

Table 6 Presence of pellets during quarterly measurements in 2017.

Location	Period				
	Q1	Q2	Q3	Q4	Total number of times pellets found
Bergen	x	x	x	x	4
Noordwijk	x				1
Terschelling				x	1
Veere					
Total number of times pellets found per period	2	1	1	2	6



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 2013-2018 the average count per year was 2.2 plastic bags per 100m beach and shows a decreasing trend of -0,7 abundance/year (p-value = 0,000). Compared to the previous period, the average count per 100m decreased from 2,9 till 2,2 abundance per 100m beach and is no longer included in the top 15 most found litter types.

In figure 15 the trend plot for the period 2004-2018 is shown. The average count per year is 7.6 plastic bags per 100m of beach and shows a decreasing trend of -1,1 abundance/year (p-value = 0,000).

Since 2012, the trend is decreasing and it seems that the ban has possibly contributed to the already decreasing trend, future results must determine if the trend continues to decrease.

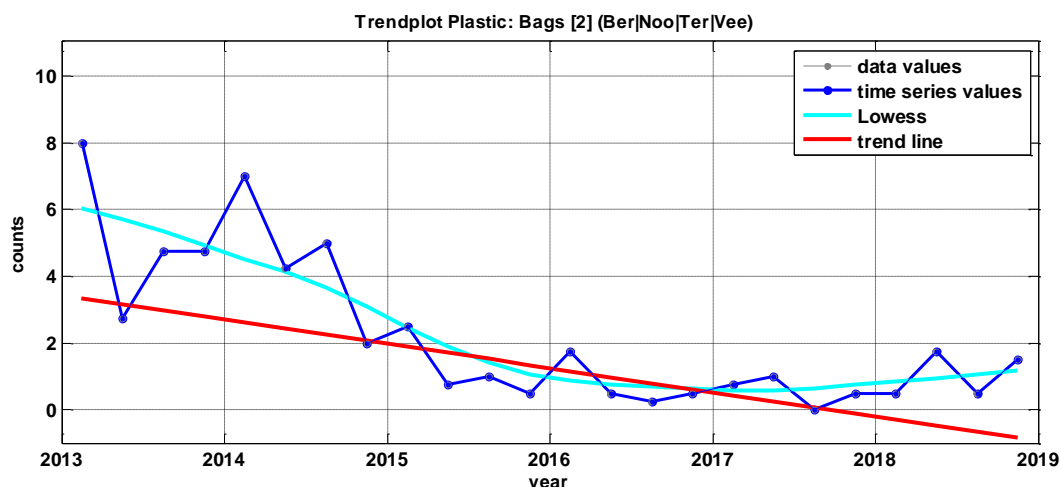


Figure 14 Trendplot Plastic bags in period 2013-2018 with decreasing significant trend (p 0.000)

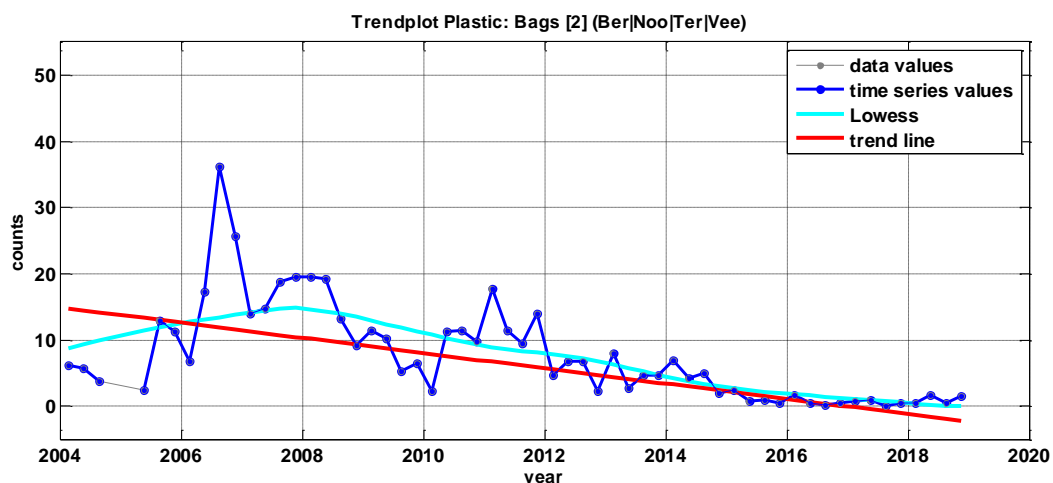


Figure 15 Trendplot Plastic bags in period 2004-2018 with decreasing significant trend (p 0.000)

3.8. 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 2013-2018 the average count per year was 3.5 plastic drinks per 100m beach and shows a decreasing significant trend of -0.8 abundance/year (p-value = 0.002).

3.8.1. Drink packaging

The trend plots for drink packaging litter types OSPAR litter types –[004],[302], [78] and [91] is included in table 7. Decreasing trends are present for plastic drink bottles, drink cartons/tetrapacks, and glass bottles.

Table 7: Drink packaging 2013 – 2018 and trend slopes and p-values. Significant trends are printed in bold.

Aggregated results for Terschelling / Bergen / Noordwijk / Veere						
	Litter category [OSPAR-100-ID]	Med. Count / 100 m	Aver. count/ 100 m	% of total count	Trend (abundance/ Year)	Significance of trend (p-value)
	Plastic: Drinks [4]	3,6	3,5	1,1%	-0,8	0,002
	All cartons/tetrapacks [302]	1,0	1,2	0,4%	-0,2	0,048
	Metal: Drink [78]	1,3	1,3	0,4%	-0,2	0,082
	Glass: Bottles [91]	0,8	0,9	0,3%	-0,2	0,047

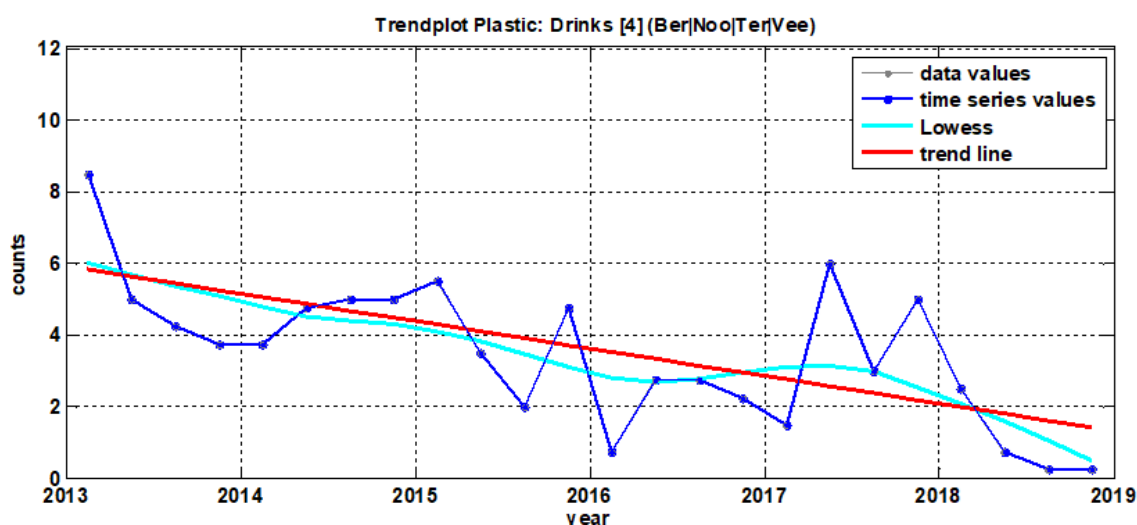


Figure 16 Trendplot Plastic Drinks in period 2013-2018 with decreasing significant trend (p 0.002)

3.9 Litter types included in the European Single Use Plastics (SUP) Directive

In 2018 the European SUP Directive was proposed by the European Commission and approved by the European Parliament in March 2019. This will mean that European countries will have two years to implement the directive. The directive contains measures to tackle marine litter coming from the 10 single-use plastic products most often found on European beaches, as well as abandoned fishing gear and oxo-degradable plastics.

The following measures are included:

- Measures to reduce consumption of food containers and beverage cups made of plastic and specific marking and labelling of certain products;
- Extended Producer Responsibility schemes covering the cost to clean-up litter, applied to products such as tobacco filters and fishing gear;
- A 90% separate collection target for plastic bottles by 2029 (77% by 2025) and the introduction of design requirements to connect caps to bottles, as well as target to incorporate 25% of recycled plastic in PET bottles as from 2025 and 30% in all plastic bottles as from 2030;
- The following single-use plastics will be banned by 2021: straws, cotton buds, drink stirrers, cutlery and plates, beverage cups and food and beverage containers made from expanded polystyrene, and the so-called oxo-degradable plastics.

In order to monitor the effectiveness of these measures, table 8 shows the single use plastic litter types that are included in the SUP Directive. The SUP litter types account for almost 24,5 percent, fishing SUP litter types account for 40,4 percent of litter found on Dutch North Sea beaches. Most litter types in table 8 show decreasing trends expect for cigarette buds, plastic cups, plastic crisp/sweet packets and lolly sticks and sanitary towels.

Table 8: Single use plastic litter types 2013 – 2018 and trend slopes and p-values. Significant trends are printed in bold.

Aggregated results for Terschelling / Bergen / Noordwijk / Veere						
	Litter category [OSPAR-100-ID]	Med. Count 100 m	Aver. count/ 100 m	% of total count	Trend (abundance/ Year)	Significance of trend (p-value)
	Plastic: Cutlery [22]	4,1	4,9	1,6%	-0,3	0,384
	Plastic: Drinks [4]	3,6	3,5	1,1%	-0,8	0,002
	Plastic: Caps [15]	14,4	19,2	6,2%	-1,6	0,214
	Plastic: Food [6]	2,3	2,3	0,7%	-0,4	0,035
	Plastic: Cups [21]	1,0	1,3	0,4%	0,0	0,861
	Plastic: Cutlery [22]	4,1	4,9	1,6%	-0,3	0,384
	Rubber: Balloons [49]	8,6	9,9	3,2%	-1,2	0,017
	Paper: Cig_stubs [64]	1,0	1,8	0,6%	0,2	0,155
	San: Buds [98]	3,5	4,4	1,4%	-0,6	0,106
	San: Towels [99]	0,5	0,6	0,2%	0,0	0,562
	All cartons/tetrapacks [302]	1,0	1,2	0,4%	-0,2	0,048
	Plastic: Crisp [19]	10,8	13,2	4,3%	0,2	0,785
	Plastic: Bags [2]	1,3	2,2	0,7%	-0,7	0,000
	Plastic: Small_bags [3]	6,0	6,0	2,0%	-0,8	0,018
	Nets and ropes [300]	104,1	116,0	37,6%	-15,2	0,035
	Plastic: Tangled [33]	7,9	8,7	2,8%	-0,5	0,286

3.10. Supplementary monitoring of total weight

Since 2016, supplementary research has been conducted by weighing the marine litter gathered after each survey. The aim is to get a better insight in the amount of kilograms of marine litter washing ashore. In 2018, marine litter was weighed at all 16 surveys.

All litter types 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 5,9 kilogram per survey. Compared to 2017, the weight decreased by 1,7 kilogram in 2018 from 7,6 kilogram to 5,9 kilogram. At two surveys in Bergen and Noordwijk, amounts of 12 and 21 kilogram were recorded. Based on data collected in past three years during 42 surveys, the average weight of marine litter per 100m is 6,5 kilogram (see table 8 for the overview). The weighing will be continued during 2019.

Table 8: Weight of marine litter recorded per survey in the period 2016-2018. Average yearly weights are printed in bold.

#	Survey beach	Year and date	Weight per survey in kg
1	NL003	28-4-2016	3,0
2	NL001	29-4-2016	10,5
3	NL002	22-6-2016	13,0
4	NL001	5-7-2016	8,0
5	NL004	7-7-2016	8,3
6	NL003	22-7-2016	2,3
7	NL002	10-10-2016	1,8
8	NL003	17-10-2016	2,0
9	NL004	22-10-2016	5,7
10	NL001	25-10-2016	4,9
		Average weight of marine litter in 2016 in kilogram	5,9
11	NL002	5-1-2017	5,0
12	NL003	6-1-2017	3,7
13	NL004	11-1-2017	3,7
14	NL001	19-2-2017	3,9
15	NL004	14-4-2017	8,0
16	NL002	20-4-2017	7,8
17	NL001	28-4-2017	20
18	NL003	27-4-2017	5,0
19	NL002	6-7-2017	7,8
20	NL004	11-7-2017	3,7
21	NL001	17-7-2017	8,9
22	NL003	18-7-2017	2,2
23	NL001	11-10-2017	14
24	NL003	12-10-2017	6,9
25	NL002	16-10-2017	18
26	NL004	18-10-2017	2,5
		Average weight of marine litter in 2017 in kilogram	7,6
27	NL001	12-1-2018	15,0

28	NL001	30-4-2018	10,5
29	NL001	23-7-2018	4,0
30	NL001	15-10-2018	12,0
31	NL002	8-1-2018	21,0
32	NL002	25-4-2018	2,8
33	NL002	28-7-2018	1,3
34	NL002	23-10-2018	2,0
35	NL003	31-1-2018	2,5
36	NL003	23-4-2018	0,2
37	NL003	22-7-2018	0,2
38	NL003	26-10-2018	8,0
39	NL004	24-1-2018	1,3
40	NL004	29-4-2018	4,2
41	NL004	27-7-2018	0,6
42	NL004	27-10-2018	8,0
		Average weight of marine litter in 2018 in kilogram	5,9

3.11. Moving Averages

The data of 2013-2018 show a decreasing trend without significance. Table 9 includes the moving averages, median, trend slope and p-values during six-year periods from 2004 – 2018. The total abundance of litter lies between 308- 447 litter types 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 seemed to be stagnating in the period 2012-2017 though in the period 2013-2018 the decreasing trend slope increased again. For the period 2004-2018 the total abundance is 362 litter types per 100m of beach with an p-value of 0,055.

Table 9: Six year moving of litter abundance in periods 2004 – 2018 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	2013-2018
6-year arithmetic averages	397	406	447	399	393	383	364	354	313	308
Median	352,4	404	430,6	408,8	368,9	368,6	366,6	345,9	303,1	288,5
Trend, slope	7,2	-4,3	-4,2	-3,0	25,7	2,0	-40,0	-42,1	-21,2	-32,0
Trend, p - value	0,573	0,712	0,901	0,823	0,785	0,941	0,011	0,011	0,157	0,070

3.12 Special circumstances

During the first survey at the beach in Veere in 2018, a storm had washed away part of the dunes at the survey site. The exposed soil layer showed a lot of marine litter stuck in the dune as shown in figure 17. Especially pieces of net and dolly rope were found. This reveals that marine litter that washed ashore and was collected during cleaning activities in the past gets and has possibly created dunes.



Figure 17 Exposed dune with marine litter in Veere

During all surveys in 2018, tractor and car tracks were visible in the survey areas. This indicates that there has been activity on the beach prior the monitoring and it is likely that marine litter types have been removed.

In table 10 the dates of surveys conducted in 2018 are presented.

Table 10 Dates of surveys conducted in 2018

<i>Beach ID</i>	<i>Location</i>	<i>Date of survey</i>
NL001	Bergen	12-1-2018
NL001	Bergen	30-4-2018
NL001	Bergen	23-7-2018
NL001	Bergen	15-10-2018
NL002	Noordwijk	8-1-2018
NL002	Noordwijk	25-4-2018
NL002	Noordwijk	28-7-2018
NL002	Noordwijk	23-10-2018
NL003	Veere	31-1-2018
NL003	Veere	23-4-2018
NL003	Veere	22-7-2018
NL003	Veere	26-10-2018
NL004	Terschelling	24-1-2018
NL004	Terschelling	29-4-2018

NL004	Terschelling	27-7-2018
NL004	Terschelling	27-10-2018

3.12.1. Garbage bins on survey site

During the surveys in Bergen and Noordwijk, garbage bins were present at the survey sites. It seems they are placed during the summer months or during occasions when large amounts of litter are washed ashore. The garbage bins were mostly filled with marine litter and litter from tourists. It is indicating that marine litter was collected by beach visitors near or at the survey site and that visitors use the bins to dispose their own litter.

Little information is available about when the garbage bins were emptied and how much litter was collected through them. The municipalities were not able to provide specific information on this.

3.13 Sources of litter types

The European Commission has identified the following main sources of marine litter and categorised in land- and sea based sources:

Land-based:

- land-fills and littering of beaches and coastal areas (tourism)
- rivers and floodwaters
- industrial emissions
- discharge from storm water drains
- untreated municipal sewerage

Sea-based:

- fishing and aquaculture
- illegal or accidental dumping at sea from shipping (e.g. transport, tourism)
- offshore mining and extraction (EU, 2019).

Although various methodologies for source allocation have been developed such as the Tudor & Williams method, the source of certain litter types to a particular source, way of release or pathway remains challenging. Though, there is no standard methodology available yet.

The challenge is that the location of the litter source can be located at sea, on the coast or further inland. At the same time, litter can be transported over long distances. Another challenge is that litter types can have an number of different potential sources. Ropes for example, often originate from fishing vessels, but can also originate from cargo vessels.

An general claim is that the majority of marine litter is linked to land-based sources. However, there is a lot of variation in the composition of litter depending on the location and should be used with caution (UNEP and GRID-Arendal, 2016). To determine the predominance of land- and/ or sea based sources various factors play a role; 1) distance and ratio of sources activities to where litter is accumulating and 2) local geography and physiography characteristics (UNEP and GRID-Arendal, 2016).

There are a number of important characteristics of the North Sea that should be taken in consideration when determining sources of marine litter related to economic activities taking place. The North Sea is one of the most important fishing grounds in the world and has some of the busiest shipping lanes in the world. Rotterdam is the largest port in Europe.

To illustrate that the shipping sector despite international and European regulations still contributes to marine litter, it was estimated by the European Commission that 60,000 up till 300,000 tonnes of ship-generated garbage (excluding oily- and sewage waste) end up in European sea waters every year (EC, 2019). A study conducted to estimate the contribution of shipping waste in the Mediterranean sea, shows a contribution of 20,000 tons of plastic marine debris per year (Liubartseva et al. 2018). Overall, the European Maritime Safety Agency states that shipping account for 20 percent of global discharge in the sea (EMSA, 2019).

Due to the important fishing grounds in the North Sea, there is an active fishing fleet operating on the North Sea. For European seas, it was estimated by a recent study that the loss of plastic waste from fishing and aquaculture lies between 9,888 – 32,770 tonnes per year (EC, 2018). Specific fishing gear that is used by the Dutch and Belgium fleet is dolly rope. It is estimated that the loss rate is around 50% (Bekaerd et al.;2015; Strietman et al., 2015).

These economic activities on the North Sea of the fishing and shipping sector have a clear influence on the litter that is found on the Dutch North Sea beaches as Nets and ropes [300] and Tangled [33] constitute for 40 percent of the litter found (see table 4).

As for plastic packaging, it constituted for almost 40 percent of the plastic demand in Europe (Plastics Europe, 2016). Especially single-use plastics have a higher chance to end up in the environment as they constitute for almost 25 percent of the litter found on the North Sea beaches (see table 8). These plastics can originate from different land based sources such as littering of beaches and coastal areas (tourism); rivers and floodwaters and from a sea-based source namely illegal or accidental dumping at sea from shipping (e.g. transport, tourism).

3.14 Discussion

The analysis of the aggregated data set for 2013-2018 shows a decreasing trend. The discussion below aims to provide background on possible causes based on expert opinion of the NSF for the decreasing trend.

The possible causes in short:

- Stricter international laws and developments of new directives in EU
- Increased public and political awareness
- Increased cleaning efforts

3.14.1. Stricter international laws and developments of new directives in EU.

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 at 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.

In 2018, the European Plastic Strategy was launched and the proposals of the European Single Use Plastic Directive and the revision of the Port Reception Facility Directive were sent to the European Parliament for approval.

3.14.2. Increased public and political awareness

The last years the public attention for marine litter and the “plastic soup” has grown considerably. In 2018 the European Commission launched the European Plastic Strategy which also contributed to the increased media and public attention for marine litter. Furthermore, the Ocean Cleanup received a lot of public attention when their second model was put in operation.

The proposal of the extension of the deposit scheme for small plastic bottles has received both political and public attention. Over 300 Dutch municipalities and 190 organisations and companies, the so called “deposit scheme alliance”, support the extension of a deposit scheme for small plastic bottles and drink cans.

Another example is the growing number of municipalities that have stopped or discouraged the release of balloons. More than 50% of the municipalities in the Netherlands discourage the release of balloons.

This increased awareness of the public, government and companies gradually led to improved policy measures and a growing number of (beach) cleaning initiatives.

3.14.3. Increased cleaning efforts

For coastal municipalities, a clean beach is high on the agenda, with tourism and the rise in (international) tourists as important drivers. Due to the good summer conditions in 2018, the absolute number of international guests to the Dutch coast increased by 9%. (NBTC Holland Marketing, 2019). 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 tourists to dispose their litter. 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 by the NSF for the sixth time in 2018. Reference beaches are also cleaned up during this beach cleanup. Furthermore beachcomber bins⁵ 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 cleanups have also been conducted at a larger scale than before.

During 2018 Rijkswaterstaat initiated a national arrangement “Zwerfafvalophaalregeling (ZOR)”. With this arrangement Rijkswaterstaat encourages to collect litter along the coast and river banks by third parties. The litter collected is collected and processed free of charge. Currently,

⁵ “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.

no information is available how many third parties have made use of the arrangement. It is difficult to assess how these developments and increased awareness and 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.

In addition, The Fulmar Litter monitoring report 2017 of The Netherlands concludes: "Stomach contents of fulmars beached in the Netherlands indicate that the marine litter situation off the Dutch coast is gradually slowly improving". Over the 5-year period 2013-2017, 92% of fulmars had ingested some plastic, with an average over all birds of 25 particles per stomach, weighing 0.26 gram. However, it is still far off international long-term targets for acceptable ecological quality. Within 10 year evaluation periods the trend is not consistently significant, but considered over longer periods it is, and indicates that at its current rate the long-term EcoQO target may be reached around the year 2060" (Franeker, 2017).

4 Conclusions

This report provides an annual update of Dutch beach litter monitoring data and an overview of the Dutch beach litter statistical data analysis results for 2013-2018.

The 2013-2018 beach litter monitoring data suggest that the Dutch beaches are getting cleaner though the 6 year trend has no statistical significance. On average 308 litter types were found per 100 meter beach during this period. In 2018, 283 litter types were found on average. The lowest count of litter types per survey was in Veere (37 litter types) and the highest count was in Noordwijk (1.539 litter types). 40 (Veere) and 1.121 (Bergen) litter types were found. There is a decreasing trend in total litter abundance (-32,0) with no statistical significance ($p=0.007$).

The beaches Noordwijk, Terschelling, Veere show a decreasing trend in average litter types abundance per year. Terschelling has the highest decreasing trend in average item abundance per year, namely -46.5. Bergen shows an increasing trend for average item abundance per year of +1,0.

The most three most found litter types are 1) nets and ropes; 2) plastic/polystyrene pieces smaller than 50 cm and 3) plastic caps. In the period 2013-2018 nets and ropes account for 37,6% of all litter types found (excluding tangled net & ropes). The data shows decreasing trends for 11 of the top 15 most found litter types; 6 of these trends are significant. The largest decreasing trend in average item abundance per year is from nets and ropes (-15.2 abundance /year).

Plastic is the most found material. It accounts for more than 90% of materials found. Decreasing trends in average abundance per year were found for plastic/polystyrene, rubber, sanitary and metal material categories. For glass, cloth/textile, ceramic/pottery materials no trends were found. For cardboard and medical materials small increasing trends were found. The largest decreasing trend in material categories is from plastic/polystyrene with -27.8 average item abundance per year.

In 2018, during 31% of the surveys conducted other pollutants such as paraffin was found. Paraffin was found less often than in 2017.

The North Sea is one of the most important fishing grounds in the world and has some of the busiest shipping lanes in the world. These economic activities on the North Sea of the fishing and shipping sector have a clear influence on the litter that is found on the Dutch North Sea beaches as Nets and ropes [300] and Tangled [33] constitute for 40 percent of the litter found. Single use plastics constitute for almost 25 percent of the litter found on the North Sea beaches. These plastics can originate from different land based sources such as littering of beaches and coastal areas (tourism); rivers and floodwaters and from an sea-based source namely illegal or accidental dumping at sea from shipping (e.g. transport, tourism).

Recommendations

For the development of the revision of the package of Dutch measures for the Dutch Marine Strategy Framework Directive (MSFD), the following actions are recommended:

- Collect data on amounts of litter collected by municipalities as well as litter collected during voluntary clean-ups to get a better understanding in the trends of amounts of litter washing ashore and insights whether clean-ups have an effect on the monitoring;

- Make an overview of all projects where the OSPAR beach litter monitoring methodology is applied and collect data to compare results in time to get insights in how litter disseminates and enters the North Sea.

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Appendix I OSPAR database exports of Dutch beach litter monitoring year 2018.

Appendix II Scans of OSPAR litter survey forms, year 2018.

Appendix III Litter Analyst evaluation tables of litter types, materials and sources period 2013-2018.

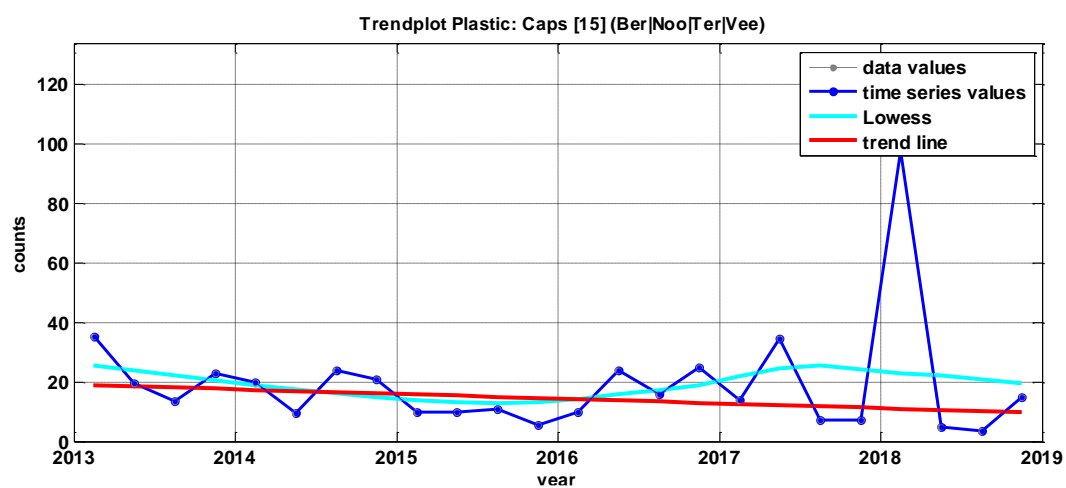
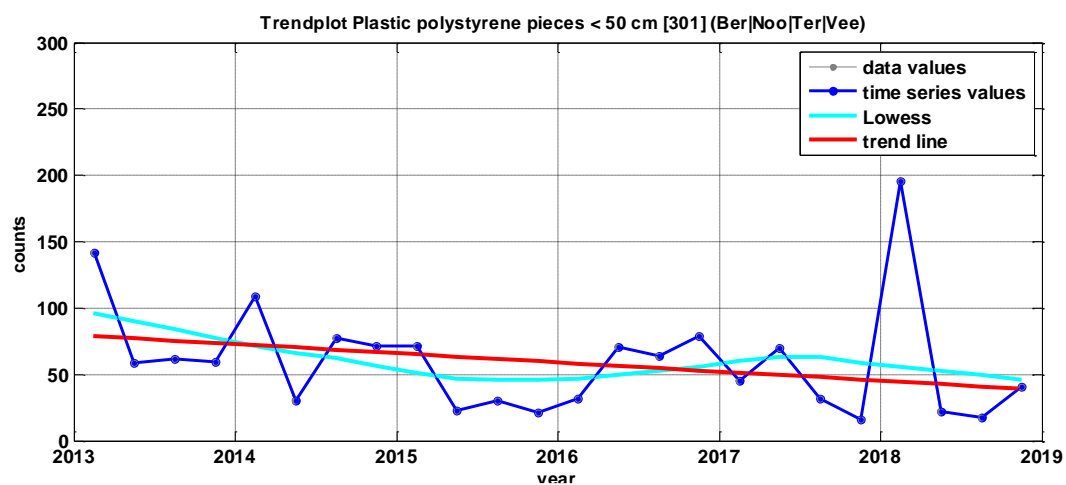
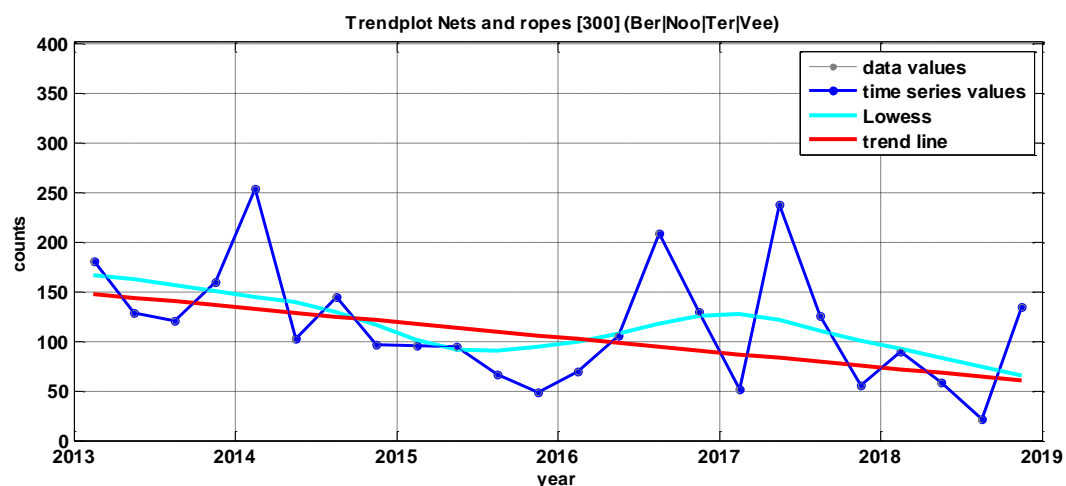
Appendix IV Recording the presence of “pollutants” on OSPAR Beach Litter Survey beaches

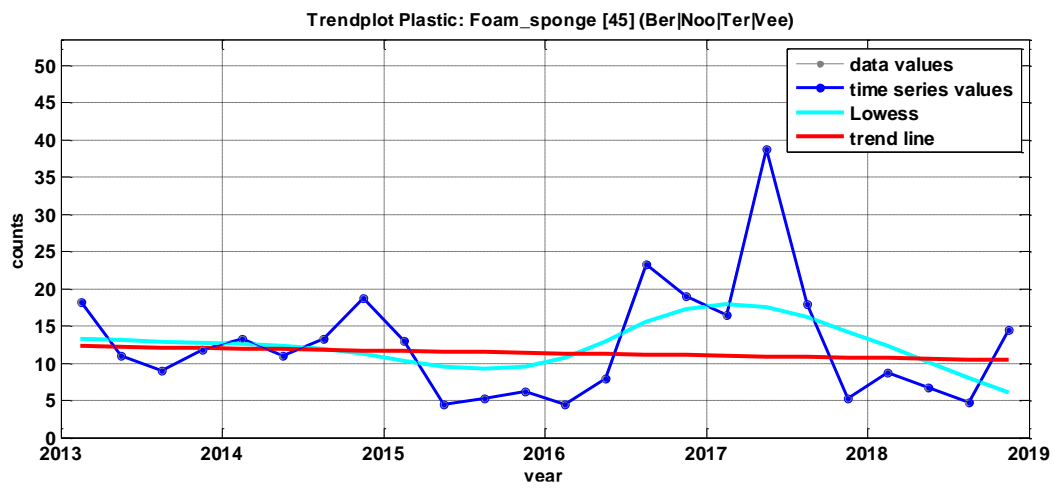
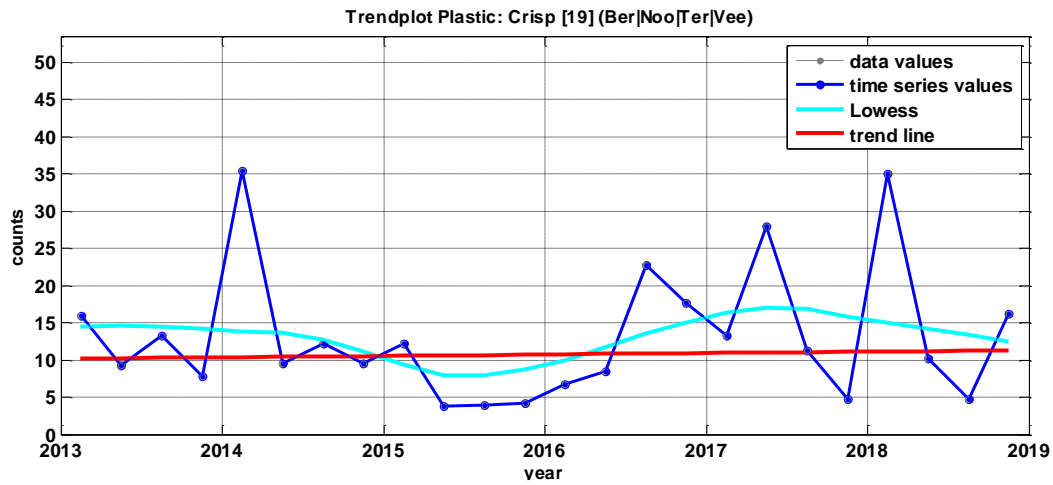
Agenda Item - OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic Meeting of the Environmental Impact of Human Activities Committee (EIHA - Cork (Ireland): 3 – 7 April 2017

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 V Trends plots Top 5 Most Found Litter types





Appendix VI Data Statistics Netherlands (CBS)

This appendix provides an overview of the Dutch beach litter monitoring analysis results for 2011-2018. This 8- year trend analysis is specially conducted for the agency Data Statistics Netherlands (CBS) and differs from the 6-year trend analysis period of the Dutch Beach Litter Monitoring report 2013-2018.

On average 337 items were found per 100 meter beach during the period 2011-2018. There is a decreasing trend in total litter abundance (-33,4) with statistical significance (p value 0,006). The beaches Noordwijk, Terschelling, Veere show a decreasing trend in average litter types abundance. Terschelling has the highest decreasing trend in average item abundance per year, namely -58.5. Bergen shows an increasing trend for average item abundance per year of +19,3. Table 1 shows the aggregated results for the period 2011-2018.

Tabel 1: Average total item abundance, trend and significance of the trend for Bergen, Noordwijk, Terschelling and Veere and for all four beached aggregated for the period 2011-2018. Significant trends are printed in bold.

Aggregated results for Terschelling / Bergen / Noordwijk / Veere 2011- 2018				
Location	Period	Average total abundance per survey	Trend	Significance of trend
			(abundance/year)	(p-value)
Bergen	01/01/2011-31/12/2018	376,5	19,3	0,307
Noordwijk	01/01/2011-31/12/2018	391,2	-33,2	0,032
Terschelling	01/01/2011-31/12/2018	331,8	-58,5	0,000
Veere	01/01/2011-31/12/2018	261,7	-51,8	0,000
Ber Noo Ter Vee	01/01/2011-31/12/2018	336,7	-33,4	0,006

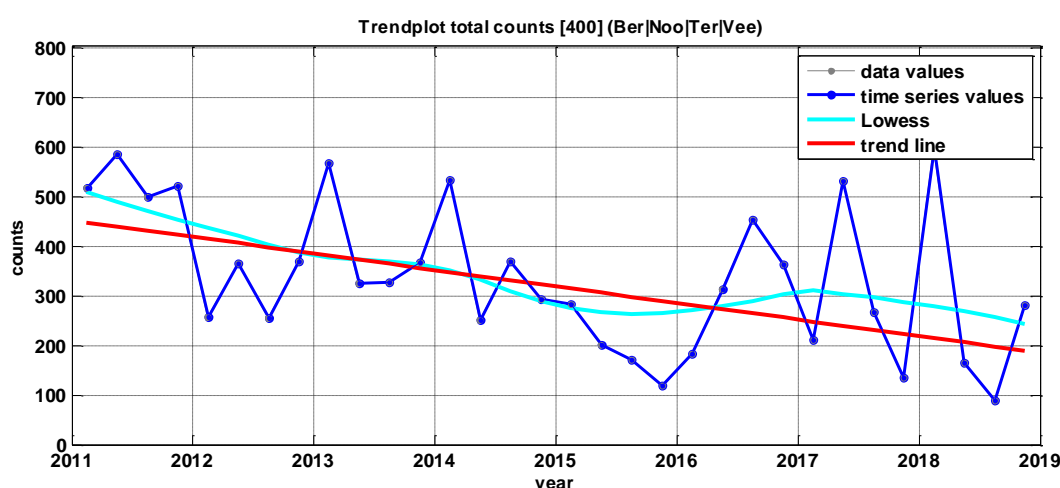


Figure 1 Trendplot total abundance in period 2011-2018 with significant trend (p value 0.006)