OSPAR Beach Litter Monitoring in the Netherlands

Update 2020

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Citation
Boonstra, M., Hougee, M. 2021. OSPAR Beach Litter Monitoring in the Netherlands. Update 2020. North Sea Foundation, Utrecht.

About
The North Sea Foundation is an independent non-governmental organization that provides knowledge necessary for an integrated sustainable protection, exploitation and spatial use of the North Sea and its coastal zones.

Contents

Summary

Marine litter, in particular the accumulation of plastic litter in the marine environment causing socio-economic and ecological harm, has been identified as a major global environmental problem. Due to ingestion and entanglement it is most likely harmful for many marine species. Qualitative and quantitative information about marine litter in the Dutch North Sea and coastline is required for setting up Dutch and OSPAR litter reduction measures, and to assess the effectiveness of these programmes of measures.

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 the periods 2018-2020 (state analysis) and 2015-2020 (trend analysis), respectively. The statistical analysis was conducted according the revised OSPAR CEMP guidelines and using the litteR software. One relevant update in the assessment is that the state assessment is now performed using primarily a three year period (OSPAR method). This shorter OSPAR period has the advantage that a more actual picture of the beach litter status is obtained. Another important update is that data analysis is now first performed at the beach level, and that subsequently the beach results are aggregated to the national level using the median beach results (blocking method) according to a statistically correct and published method.

The median total count for macrolitter for the period for the period 2018-2020 is 129 counts/100m beach. Trend analysis of the Dutch beach litter monitoring data (2015-2020) shows a significantly decreasing trend of -17 litter counts/100m, which shows that the Dutch beaches are getting cleaner in the period 2015-2020. On the beach level, all beaches show decreasing total count slopes, with the beaches Veere and Terschelling showing the largest significant trends

The median weight of litter per 100m beach for the period 2018-2020 is 2.5 kg litter/100m beach, and shows a significantly decreasing trend of −1.3 kg litter/100m per year in the period 2016-2020.

Material analysis shows that plastic remains the most found litter material (91%) with a median of 113 counts/100m in the period 2018-2020. The trend analysis results shows significantly decreasing trends for plastic/polystyrene (-18 counts/100m per year), rubber (-1 count/100m per year) and metal (-1.4 counts/100m per year). The other materials show no decreasing or increasing slopes.

The SUP litter group has a median of 29 counts/100m beach (22%, for the period 2018-2020) and shows a significantly decreasing trend of -4 counts/100m per year (period 2015-2020). The FISH litter group which mainly contains of fishing related items has a median of 66 counts/100m (50%, period 2018-2020) with a significantly decreasing trend of -7 counts/100m per year (period 2015-2020). The OTHER litter types have a median value of 37 (28%, period 2018-2020) and show a significantly decreasing trend of -6 counts/100m per year (period 2015-2020).

The top 10 for the period 2018-2020 is plastic: string [32], plastic: 2.5<>50cm [46], plastic: fishing net small [115], plastic: crisp [19], plastic: caps [15], plastic: tangled [33], plastic: foam sponge [45], rubber: balloons [49], plastic: industrial [40] and plastic: small bags [3]. The top 10 trend analysis (2015-2020) show mostly small but significantly decreasing trends slope for 8 types from the top 10 litter types. String [32] show a relatively large decreasing trend of -7.9 counts/100m year.

Indicative results for the presence of waxes and pellets on Dutch beaches are also presented in this report.

Although the total abundance of beach litter shows a significantly decreasing trend on Dutch beaches, the adopted beach litter threshold value (TV) of median 20 counts/100m beach is still far from being reached and the most recent forecast indicates that the TV could be reached around 2040. It is therefore important that current policies and measures are continued and expanded in order to reach the TV in the future.

List of abbreviations

BLM Beach Litter Monitoring
CEMP Coordinated Environmental Monitoring Programme
CSV Comma-separated values
D10 MSFD Descriptor 10, marine litter
FISH Fishing related litter types
GES Good Environmental Status
ICGML OSPAR Intersessional Correspondence Group on Marine Litter
JRC Joint Research Centre
MSFD European Marine Strategy Framework Directive (MSFD)
MSC Mediterranean Shipping Company
NL Netherlands
NSF North Sea Foundation
OSPAR the organization in which 15 Governments & the European Union cooperate to protect the marine environment of the North-East Atlantic.
RAP OSPAR Regional Action Plan for Marine Litter
RWS Rijkswaterstaat – Department of Waterworks and Public Works
SEA Sea related litter types
SUP Single Use Plastics
TV Threshold value
WAXPOL Other pollutants category

1. Introduction

1.1   General 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). Due to ingestion and entanglement it particularly harms marine life, at least 817 marine species are affected by marine litter (Kühn & Franeker, 2020). Millions of animals that live in the oceans are harmed, mutilated, and killed by marine litter each year (Butterworth et al., 2012).

It is estimated that more than 150 million metric tonnes of plastic have accumulated in the world's oceans and each year 12 million metric tonnes are added (Jambeck et al. 2016). Currently, 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 or abandoned in the marine and coastal environment. Marine litter consists of items that have been made or used by people and deliberately discarded into the sea or rivers or on beaches; brought indirectly to the sea with rivers, sewage, storm water or winds; accidentally lost, including material lost at sea in bad weather (fishing gear, cargo); or deliberately left by people on beaches and shores"* (United Nations, 2019).

Marine litter travels long distances with ocean 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 estimated at almost €630 million per year (OSPAR, 2016). Furthermore, lost, and discarded fishing nets can cause propeller issues and can consequently lead to shipping delays and lost fishing time.

The accumulation and dissemination of marine litter not only pose threats to the health of the world's oceans, but potentially also to human health, as the effects of plastic ingestion are being investigated.

1.2   Sources of marine litter

The European Commission has categorised the following main land and sea based sources. Land-based litter comes from landfills and littering of beaches and coastal areas (recreation), rivers and floodwaters, industrial emissions, discharge from storm water drains and untreated municipal sewerage. The main sea-based sources are fishing and aquaculture, illegal or accidental dumping at sea from ships (e.g. transport, tourism) and offshore mining and extraction (EU, 2019).

The European Commission estimates 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 an 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).

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 at sea. 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.

The North Sea is home to an active fishing fleet. 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 used by the Dutch and Belgium fleet to protect nets from wearing down is dolly rope. In the Netherlands, 100-200 tons of dolly rope is used annually (Tauw, 2018). It is estimated that the loss rate at sea is around 50%, which accounts for 50-100 tons of dolly

rope (Bekaerd et al., 2015; Tauw, 2018). During fishing operations or maintenance work, threads or bundles of dolly rope threads end up in the sea. The result is that this plastic material is commonly found on the beaches in Northern Europe. Apart from impacting wildlife, dolly rope floating at sea is also a safety hazard for the maritime sector.

1.3   European Marine Strategy Framework Directive (MSFD)
Within the European Marine Strategy Framework Directive (MSFD) marine litter is one of the descriptors (DG10) to assess the 'Good Environmental Status' of the marine environment. At EU level, the MSFD is the dedicated binding legal instrument for assessing, monitoring, setting targets and reaching good environmental status with regard to marine litter. The Directive obliges Member States to monitor marine litter.

The MSFD goal for DG10 for marine litter is defined as follows: <u>Properties and quantities of marine litter do not cause harm to the coastal and marine environment by 2020.</u>

The revised European Commission Decision 2017/848 requires EU Member States to establish threshold values (TVs) for criteria of Descriptor 10 on marine litter. TVs which are now mandatory through the new provisions, are intended to contribute to Member States determination of a set of characteristics for GES and enable their assessment of the extent to which GES is being achieved. The threshold value for marine litter has been set by the European Commission at a median of 20 litter types per 100 meter of beach. This excludes mesoplastic fragment 0.5-2.5cm and waxes.

1.4   OSPAR CEMP guidelines
Guidelines for the monitoring and assessment of marine litter on beaches have been developed by OSPAR and are currently updated with improved regional assessment methods (OSPAR, 2020).

The monitoring guidelines in the CEMP are based on the OSPAR (2010) monitoring guidance. 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 countries and 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 OSPAR beach litter assessment has been developed since 2013 (Schulz et al., 2017; Schulz et al., 2019), and has recently been updated with a statistically correct regional assessment method which has been implemented in the litteR software (Walvoort and Van Loon, 2021). In addition, OSPAR has developed a new asymptotic model to estimate more accurately when the beach litter threshold value could be reached (Walvoort et al., 2021; Van Loon et al., 2020).

1.4.1   Other litter monitoring projects
There are several other litter monitoring projects in The Netherlands which are 1) the Clean River project, initiated by the North Sea Foundation, Institute for Nature Education and Plastic Soup Foundation which includes large monitoring program on river banks (currently on more than 500 locations along the Meuse and the Rhine (Schone Rivieren, 2021); 2) a pilot monitoring in de Wadden Sea on unhabituated sand flats executed by Bureau Waardenburg on assignment of Rijkswaterstaat North Netherlands (RWS, 2019); 3) beach litter monitoring based on the OSPAR methodology on the island of Bonaire, Caribbean Netherlands executed by Clean Coast Bonaire, supported by World Wide Fund for Nature – Netherlands (Caporusso and Hougee, 2019).

1.5   Overview of policies and measures to reduce marine litter
The last years, policies have been developed and implemented to address marine litter. In the following paragraphs relevant legislation and measures taken are described in short.

1.5.1   OSPAR Regional Action Plan
OSPAR's marine litter objective is "to substantially reduce marine litter in the OSPAR Maritime Area to levels where properties and quantities do not cause harm to the marine environment". The North-East Atlantic Environment Strategy (2010 – 2020) commits to "develop appropriate programmes and measures to reduce amounts of litter in the marine environment and to stop litter entering the marine environment, both from sea-based and land-based sources".

To fulfil this objective the OSPAR Contracting Parties agreed on [a Regional Action Plan (RAP) for Marine Litter](#) for the period 2014-2021. The RAP contains 23 national actions and 32 collective actions which aim to address both land-based and sea-based sources, as well as education and outreach and removal actions. Each of the actions is driven by specific Contracting Parties or groups of Contracting Parties, and progress on actions is assessed each year at the meeting of the ICG-ML. Currently, the RAP for the period 2022-2030 is under development.

1.5.2   Objectives and measures in the Netherlands

The Dutch government has set a target for 2020 to reduce the amount of litter on the coast (beach litter) and the impact in marine organisms (plastic particles in stomachs of Northern Fulmars). The Dutch MSFD goals set for 2020 are (a) the amount of visible litter on the coast has decreased and (b) there is a decreasing trend in the amount of litter in marine organisms.

In reducing litter, the Netherlands focuses on prevention by means of an integrated source approach, communication and awareness campaigns, and closing product chains (through e.g. Green Deals, product requirements- and waste management policies). The Netherlands is also supporting the cleaning of beaches and the Fishing for Litter and DollyropeFree project (DollyropeFreeproject, 2016). The policy approach of the Dutch implementation of the MSFD by initiating Green Deals aimed to reduce litter from fisheries, shipping and tourism in 2015, was evaluated in 2019 (Witteveen + Bos, 2019). The Green Deal approach in the Netherlands is a policy instrument to stimulate companies, regional and local government, stakeholder organizations, civil society organizations and interest groups to work together to accomplish green growth. It was concluded that these specific Green Deals contributed to awareness, actions, and measures to reduce marine litter. In the policy document "Ontwerp Programma Noordzee", it was stated that the pollution of the marine environment in the last 10 years has reduced (Ministry of Infrastructure and Water Management, 2021). Currently the package of MSFD measures for the period 2022-2027 is under development.

Examples of additional policy efforts are: a) implementation of the European Plastic Bag Directive to reduce the consumption of lightweight plastic carrier bags and reduce street- and marine litter. Therefore, a ban on free plastic bags in shops was introduced on January 1st, 2016; b) national arrangement "Zwerfafvalophaalregeling (ZOR)" that was initiated in 2018. With this arrangement Rijkswaterstaat encourages to collect litter along the coast and river banks by third parties. The litter collected by volunteers is collected and processed free of charge; c) the Dutch Plastic Pact (Plastic Pact NL) was launched in the Netherlands by the Ministry of Infrastructure and Water Management. The goal of the pact is to make single-use plastic products and packaging more sustainable and suitable for reuse. Ninety-seven parties have signed the pact, including producers and retailers (RWS, 2021).

1.5.3   European Single Use Plastic (SUP) and fishing gear Directive

In 2018 the European SUP Directive was proposed by the European Commission and approved by the European Parliament in March 2019 (European Parliament, 2019). This year, it was officially implemented on July 1st 2020 in The Netherlands. The directive contains measures to address marine litter originating from the 10 single-use plastic products most often found on European beaches, as well as abandoned fishing gear and oxo-degradable plastics. 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".* Fishing gear is defined as: *"any item or piece of equipment that is used in fishing and aquaculture to target and capture or rear marine biological resources, or that floats on the surface of the sea and is deployed with the objective of attracting and capturing or rearing such marine biological resources".*

The following measures are included in the Directive: a) Measures to reduce consumption of food containers and beverage cups made of plastic, and specific marking and labelling of certain products; b) extended Producer Responsibility schemes covering the cost to clean-up litter, applied to products such as tobacco filters and fishing gear; c) 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 a target to incorporate 25% of recycled plastic in PET bottles as from 2025 and 30% in all plastic bottles as from 2030; d) the following single-use plastics are banned by July 3rd 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. Currently, the implementation of the

extended producer responsibility (EPR) schemes for various single use plastics and fishing gear is in development.

1.6   Aims of the report

Quantitative and qualitative information about marine litter entering our seas and oceans is required for the development and evaluation of Dutch and regional measures to reduce marine litter. Therefore, the aims of this report are (a) to provide an annual update of the Dutch beach litter monitoring data of 2020; (b) to calculate and present state analysis results (for 2018-2020) and trend analysis results (for 2015-2020) using the Dutch beach litter data. This year report is prepared according the specifications for data analysis specified in the currently revised CEMP guidelines (2022) and with some additional specifications from Rijkswaterstaat and NSF, respectively.

2. Methods

2.1   Selection of reference beaches

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.

Four reference beaches have been selected in the Netherlands (see figure 1). 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, are free of buildings all year round and comply with the OSPAR criteria a, b, c, d, e.

Additional information in regards to physical and geographical characteristics e.g. proximity of shipping lanes, river mouths, waste water outlets of each beach are available and updated when changes occur.

The compliance of criteria (f), 'no collection of any other litter activities', does not apply to all the beaches. The reference beach Bergen is cleaned on a weekly basis all year round. Volunteers and/ 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 the period 2015-2020 all local beach coordinator and/or municipalities 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. In addition, not all organised cleaning activities are announced publicly

or are known by the municipalities (see results and discussion). This accounts especially for individuals who clean up when visiting the beach.

2.2   Monitoring method

Each reference beach 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. Within the OSPAR area, the standard survey unit is 100 meters long from the water's edge to the back of the beach. Litter types are classified according to the 'CEMP Guidelines for marine monitoring and assessment of beach litter' using the adjusted OSPAR scoring lists (OSPAR Commission, 2020).

The monitoring session starts at the back of the beach on the landside. All visible litter (>0.5 cm) on the beach surface is counted and registered on the OSPAR beach litter monitoring form. 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 meter monitoring area and draw a line in the sand during monitoring of the litter types. After reaching the 100-meter 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 figure 2).
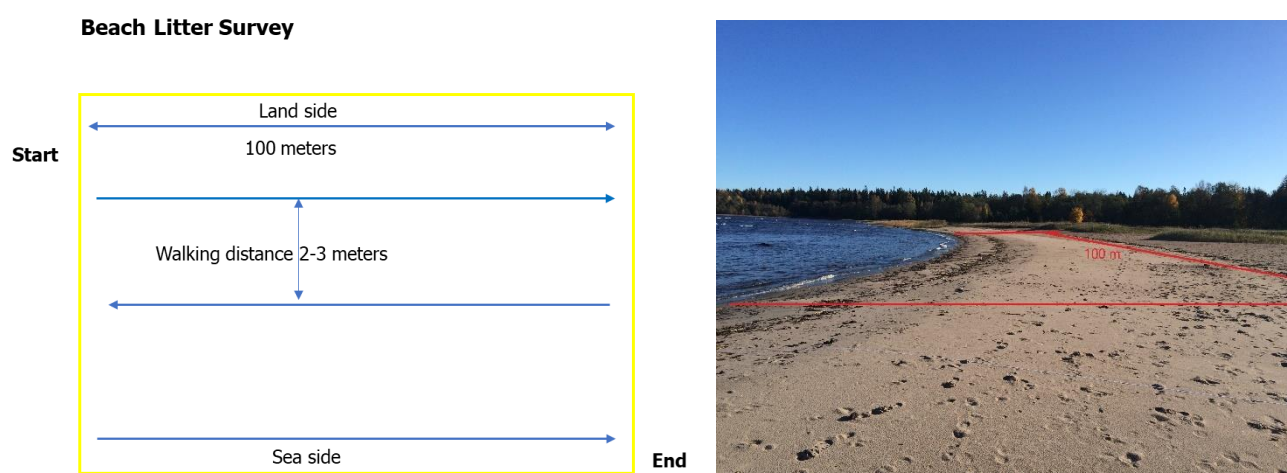
Figure 2 Walking pattern used for the beach litter monitoring and survey area.

The current 100m-survey form contains 126 litter types (marked by item-codes). This includes identifiable litter types and associated pieces of these items, unknown items and unknown litter fragments. 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 for them to be identified later. The presence and number of Wax and other pollutants, as well as industrial plastic pellets are counted and reported separately.

Permanent reference points (marked by beach poles) are used to ensure that the same site will be monitored for all surveys. The Dutch Beach Litter reference beaches are:

Table 1 Metadata of the 4 Dutch OSPAR Beach Litter reference beaches.

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

2.3   Monitoring frequency and period

The reference beaches are surveyed four 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 unexpected events such as container loss may result in a postponed or cancelled beach survey. The survey periods

are as follows: 1) winter: mid-December – mid-January; 2) spring: April; 3) summer: mid-June – mid-July; and 4) autumn: mid-September – mid-October.

2.4   Reporting period

The Dutch Ministry of Infrastructure and Water Management has assigned the North Sea Foundation (NSF) to monitor the beaches according to the OSPAR protocol in the Netherlands during 2015-2020. During this period, 95 surveys were performed by the BLM survey team of the NSF.

2.5   Data Management

The beach litter monitoring data are entered in the OSPAR database within three working days after the monitoring took place, 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. 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 OSPAR Beach Litter Database online database. Until 2020, the Marine Conservation Society (MCS) hosted the database. In 2020 the database was transferred to and hosted by the OSPAR commission. RWS CIV also stores the beach litter data in the RWS DONAR database.

2.5.1   Unknown litter types

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

2.5.2   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.

2.5.3   Data clean-up

After downloading the survey results from the OSPAR database, the OSPAR beach litter data files are cleaned by removing the wax types (types 108-110) and other pollutants (type 111), presence of pellets from the datafile and comments columns and prepared for analysis with LitteR software. This removal is also automatically performed via the litteR type file, because these types are excluded (not selected) in the Total Count and the other groups. The presence of waxes, pellets, weights comments are analysed separately (see sections 2.8, 2.9.6-2.9.8).

2.6   LitteR software

Rijkswaterstaat has developed a new tool to perform statistical analysis of litter data (e.g. beach, river, seafloor litter). This software package is based on robust statistics, such as the use of median values and Theil-Sen and Mann-Kendall trend analysis. These robust statistics are very suitable for the skewed (non-normal) litter data distributions, and have been develop for application in OSPAR beach litter data analysis. The software is freely available on the CRAN website.

2.7   Overview of analyses performed

In the table 2, the overview of analyses performed for this report are presented. These analyses are performed on MFSD and OSPAR and country assessment level. To give clarity in the differences of the assessments, the table gives the overview of the analysis groups, type of analysis, periods and on which level the analyses are performed. The descriptive statistics are explained in more detail in section 2.9. The threshold value (TV) assessment and trend analysis are explained in section 2.10 and 2.11.

2.8   Outlier analysis

For data quality control purposes, the outlier analysis is performed with LitteR. This analysis detects outliers in the surveys selected for the data analysis. In statistics, an outlier is a data point that differs significantly from other observations. The outliers are presented in box- and whisker plots. These surveys are checked by the lead surveyor to ensure the registration of the surveys is correct and whether there were special circumstances that could explain the outlier. These explanations are included in the report.

Table 2 Overview of analyses performed in this annual report

Overview of analyses performed				
Analysis group	Analysis performed	Information need	Period	Spatial level
State analysis	Outlier analysis	OSPAR, MSFD	2015-2020	Beach
	Total count (median)	OSPAR, MSFD	2018-2020 2015-2020	NL, beach
	Total weight (median)	NL	2018-2020	NL
	Material groups (medians, median-based percentages)*	OSPAR (all) MSFD (plastic)	2018-2020 2015-2020	NL
	SUP, FISH and OTHER groups	OSPAR/MSFD	2018-2020	NL
	Top 10 (median-based)	OSPAR	2018-2020	NL
	Mesoplastics (0.5-2.5cm)	NL	2018-2020	NL
	Presence of Waxes	NL	2018-2020	NL
	Presence of Pellets	NL	2018-2020	NL
	Threshold value assessment	MSFD	2018-2020	NL
Trend analysis	Total count trend	OSPAR, MSFD	2015-2020	NL, beach
	Total weight trend	NL	2016-2020	NL
	Material group trends	OSPAR, MSFD	2015-2020	NL
	SUP-trend	OSPAR, MSFD	2015-2020	NL
`	FISH trend	MSFD	2015-2020	NL
	Top-10 trends	OSPAR	2015-2020	NL
	Mesoplastics (0.5-2.5cm)	NL	2015-2020	NL

2.9   State analysis

The following descriptive statistics are performed by LitteR software 1) median count, i.e., the median of the counts for each litter type 2) Theil-Sen slope (slope): a robust non-parametric estimator of slope (litter counts/100m per year) 3) p-value to show if a slope presents a significant trend. The descriptive statistics that are included in Results & Discussion chapter are further explained in the sections below.

2.9.1   Median total litter count

The median total litter count is calculated for 3 years (OSPAR period) and 6 years (MSFD period), respectively. The medians are first calculated at the beach level using the indicated periods, and then aggregated to the country level using the median beach value (blocking method, see CEMP guidelines (OSPAR, 2022). The litter type mesoplastic fragments 0.5-2.5 cm [117] is excluded from the total count calculation and is analysed separately.

2.9.2   Material analysis

A material analysis is performed for a 3 and 6-year period of the total abundances of litter groups which have been assigned to any of the following categories: Plastic/polystyrene, Rubber, Paper/cardboard, Wood, Glass, Cloth/textile, Metal and Ceramic/pottery.

The litter composition percentages are calculated based on the calculated medians of each material type.

2.9.3   Functional group analysis

A specific litter group analysis is performed for a 3-year period using the combined total counts for following material group types:

- Single Use Plastics (SUP)

- Fishing related items (FISH)
- All other items (OTHER)

The categorisation of the OSPAR litter types per specific litter group is included in Appendix V.

2.9.4 Top 10 litter types
The top 10 most found litter types is calculated for a 3-year period. A top-20 list of most found litter types on individual beaches is constructed. These top-20 litter types per beach are then aggregated at the country level and the top 10 list with the highest aggregated median values are selected.

2.9.5 Indicative assessment of mesoplastics fragments
All beach litter items >5mm are surveyed. However, meso-plastic fragments (0-2.5 cm) are not included in the total count calculation. The CEMP guidelines prescribe they are monitored less comparably within the OSPAR area due to their small size and the occurrence of very high numbers on some beaches. A separate monitoring method is currently under development. Due to the fact that the beach litter monitoring in the Netherlands is conducted by the same organisation and professional surveyors team for many years now, the quality of the monitoring data for mesoplastic fragments can be considered to be useful. In this report, these fragments are descriptively analysed at the country level for a 3-year period.

2.9.6 Indication of waxes presence
During each monitoring, the presence of paraffin 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 meter of strandline. Waxes are monitored along the flood line with the assumption based on experience that all waxes are gather there. The total number per size category within three squares of 1 by 1 meter along the flood line is registered. If the waxes are found along the entire flood line then for three squares of 1 meter by meter all lump waxes are counted for each size category and divided by three and recorded on the OSPAR form.

The presence analysis is performed for each wax size group separately. First, within a size class, for each beach the mean presence (as percentage) of waxes is calculated. Then the median beach presence (percentage) per size class is calculated.

2.9.7 Indication of pellets presence
Each monitoring the presence of pellets is registered with a yes/no on the OSPAR form. The median presence percentage of pellets for the period 2018-2020, analysed using the blocking method (first beach aggregation for 2018-2020, then calculate median beach result) is included in the report.

2.9.8 Indicative monitoring of total weight
Since 2016, supplementary research has been conducted by weighing the marine litter gathered after each survey. From 2017 on, during all surveys marine litter weighted and recorded. All litter types were collected in a plastic bag after the sand was manually removed by shaking off the sand as much as possible. The bag was weighed with a digital balance (see Appendix IV for the overview). The aim is to get a better insight in the weight of marine litter washing ashore. The weights per survey are reported and the average and median weight for the five year period 2016-2020 and the three year period 2018-2020 is calculated and included in the report.

2.10 Threshold value
The threshold value is calculated based on the period 2018-2020 , mesoplastic fragments 0.5-2.5cm. and waxes/other pollutants [117] are excluded. The median value is calculated of these 47 surveys to calculate the median assessment value. This value is compared to the threshold value of the median of 20 litter counts per 100 meter coastline.

2.11 Trend analysis
In the annual report trend analyses are performed on the total count (TC) of all litter items, all material groups, the SUP, FISH and OTHER groups, and the top 10 types. The trend period used is 6 years, in order to show relatively recent trends. Trends are analysed by non-parametric Theil-Sen analysis, and p-values are calculated using the Mann Kendall analysis.

3. Results & Discussion

This chapter includes the beach litter monitoring results of the 3- year descriptive statistics and 6-year trend analysis. Both analyses included the aggregated total count on country level and beach level, material analysis on country and beach level, specific litter group analysis on country and beach level, top 10 most found litter types on country level and top 5 trend plots, trend plots on country and beach level on total count, materials and specific litter groups on country. In addition, 3- year descriptive statistics and 6-year trend analysis plots are presented.

The results of the country and local beach level of the 6- year trend analysis will be elaborated on in more detail.

Due to the further development of LitteR and the changes of the application of statistical methods and choices made at OSPAR level for analysis periods, the data presentation differs with previous annuals report. Therefore no comparisons are made with the previous 6- year trend analysis results.

Exports from the OSPAR database containing all litter data have been added in Appendix I. The scanned field forms are included in Appendix II. The LitteR files and reports are provided in Appendix III and the survey dates and weights overview are included in Appendix IV.

3.1   Outlier analysis

The outlier analysis was performed for the 6- year period 2015-2020. The boxplot of the outlier analysis is presented in figure 3 and table 3 includes the overview of specific outlier per location. All outliers were checked before further analysis.

All survey registrations were checked and no errors were detected. The variability between the locations are considered to be consistent by the lead surveyors. Veere is the location where more often fewer litter types are found. This is also is the case for Noordwijk, this location seems to have high variabilities. Bergen and Noordwijk are the two locations where after a periods of Westerly winds, more often large amounts of litter are found.

The outlier for Bergen in 2020 in April could be explained by heavy winds that hit our coast in February. According to the KNMI there was one heavy storm (Ciara) in 2020 in February with windspeed 10 Beaufort (24.5 m/s) (KNMI, 2021). Heavy winds hit our coast in later in February and August. There were no other specific extreme weather conditions which seems that have influenced the results of the surveys conducted in 2020.
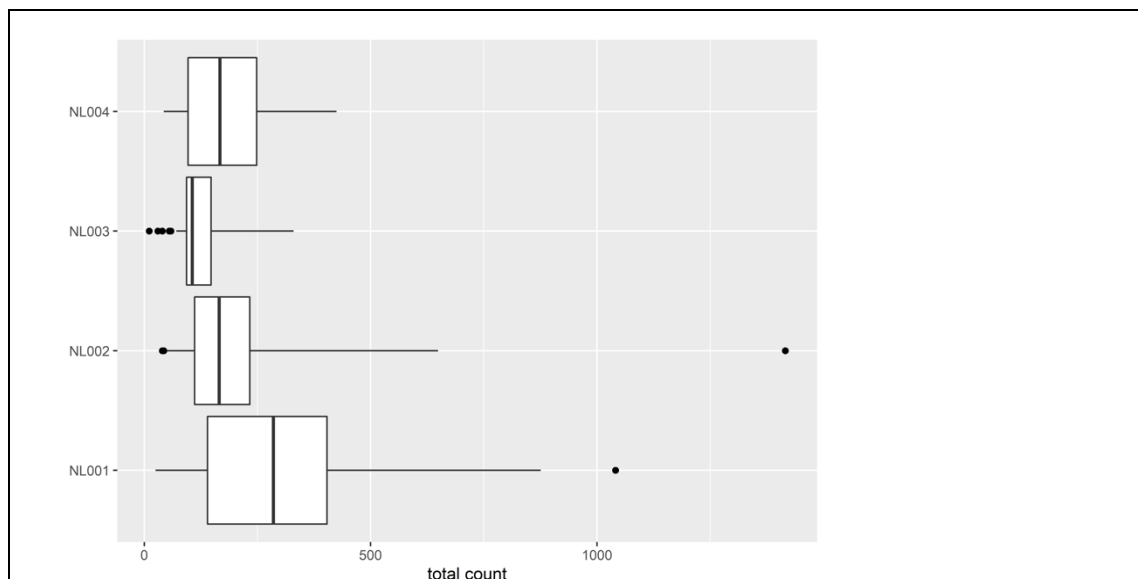
Figure 3 Outlier boxplot 2015-2020 per location. Outliers are given as dots.

Table 3 Overview of outlier in the period 2015-2020.

6- year outlier analysis			
Location	**date**	**n**	**total count**
Bergen	28-4-2017	24	1041
Noordwijk	10-7-2020	24	40
Noordwijk	14-1-2016	24	43
Noordwijk	8-1-2018	24	1416
Veere	19-4-2020	24	11
Veere	23-4-2019	24	30
Veere	12-10-2017	24	40
Veere	2-1-2020	24	55
Veere	23-4-2018	24	59

3.1.1   Other special circumstances

In 2020 the world wide COVID-19 pandemic begun and is still ongoing. In the general discussion section, developments that could have been an influence on the beach litter monitoring results are explained in more detail.

3.2   State analysis (2018-2020)

This section includes the three year analysis of the aggregated total count on regional and local beach level, material analysis on regional and local beach level, specific litter group analysis on regional and local beach level, the top 10 most found litter types on regional level and trend plots on regional and local beach level on total count, materials and specific litter groups.

3.2.1   Overview results and trend plots

The results of the descriptive analysis are included in table 4.

Table 4 Overview state analysis results for the period 2018-2020.
Note that material and SUP/FISH percentages are reported using this recent period.
The trends for all the groups and types in this table are presented in Table 5.

Total count on country level			
Region	Name/ group code	n	median
Netherlands	TC	47	129
Location	type name/ group code	n	median
Bergen (NL001)	TC	12	251
Noordwijk (NL002)	TC	12	146
Veere (NL003)	TC	12	100
Terschelling (NL004)	TC	11	116

Region	type name/ group code	n	median	%
Netherlands	PLASTIC	47	113	91%
Netherlands	RUBBER	47	4	3%
Netherlands	WOOD	47	3	2%
Netherlands	GLASS	47	2	2%
Netherlands	PAPER	47	1	1%
Netherlands	METAL	47	1	1%
Netherlands	CLOTH	47	0	0%
Netherlands	POTTERY	47	0	0%

Region	type name/ group code	n	median	%
Netherlands	SUP	47	29	22
Netherlands	FISH	47	66	50
Netherlands	OTHER	47	37	28

Region	type name/ group code	n	median
Netherlands	PLASTIC: STRING [32]	47	53
Netherlands	PLASTIC: 2.5 <>50cm [46]	47	11
Netherlands	PLASTIC: FISHING_NET_SMALL [115]	47	6
Netherlands	PLASTIC: CRISP [19]	47	6
Netherlands	PLASTIC: CAPS [15]	47	5
Netherlands	PLASTIC: TANGLED [33]	47	4
Netherlands	PLASTIC: FOAM_SPONGE [45]	47	3
Netherlands	RUBBER: BALLOONS [49]	47	3
Netherlands	PLASTIC: INDUSTRIAL [40]	47	2
Netherlands	PLASTIC: SMALL_BAGS [3]	47	2

Total weight on country level				
Region	type name/ group code	n	mean	median
Netherlands	Total weight	47	4.0	2.5

3.3   Trend analysis

This section includes the 6-year trend analysis (2015-2020) of the aggregated total count on country and local beach level, material analysis on country and local beach level, specific litter group analysis on country and local beach level, top-10 most found litter types on country level and trend plots on country and local beach level on total count, materials and specific litter groups on country level and top 5 most found litter types.

3.3.1   Overview results and trend plots

The results of trend analysis for 2015-2020 are included in table 5. In figures 8, 9, 10, and 11. Trend analysis plots are presented for total count and the specific litter groups for PLASTIC, SUP and FISH. The trend plots for the top 5 litter types are presented in figures 12, 13, 14, 15 and 16.

In each plot, the black dots are the observations, the thin gray line segments connect the dots and guide the eye, and the red line is the Theil-Sen slope.

Table 5 Overview of trend analysis results for the period 2015-2020
Note that material and SUP/FISH percentages, respectively, are reported using a three year period
(Table 4). Further note small differences in the order of the top using three or six year periods (Table
4 and 5), respectively. p-values of significant trends are printed fat.

Total count at country level					
Region	type name/ group code	n	median	slope	p value
Netherlands	TC	95	166	-17.0	**0.004**

Total count at beach level					
Location	type name/ group code	n	median	slope	p value
Bergen (NL001)	TC	24	285	-13.5	0.301
Noordwijk (NL002)	TC	24	166	-9.05	0.238
Veere (NL003)	TC	24	106	-20.6	**0.014**
Terschelling (NL004)	TC	23	167	-26.3	**0.029**

Material trends at country level					
Region	type name/ group code	n	median	slope	p value
Netherlands	PLASTIC	95	148	-17.8	**0.003**
Netherlands	RUBBER	95	5	-1.0	**<0.001**
Netherlands	WOOD	95	2	0.1	0.112
Netherlands	GLASS	95	2	0	0.413
Netherlands	METAL	95	2	-1.4	**0.003**
Netherlands	CLOTH	95	1	0	0.148
Netherlands	PAPER	95	1	0	0.437
Netherlands	POTTERY	95	0	0	0.327

Functional group trends at country level					
Region	type name/ group code	n	median	slope	p value
Netherlands	SUP	95	35	-3.9	**0.007**
Netherlands	FISH	95	83	-7.4	**0.004**
Netherlands	OTHER	95	49	-6.0	**<0.001**

Top 10 trends country level					
Region	type name/ group code	n	median	slope	p value
Netherlands	PLASTIC: STRING [32]	95	60	-7.9	**0.001**
Netherlands	PLASTIC: LARGE 2.5 <>50cm [46]	95	12	-0.7	0.050
Netherlands	PLASTIC: CRISP [19]	95	7	-0.2	0.259
Netherlands	PLASTIC: FOAM_SPONGE [45]	95	6	-0.8	**0.002**
Netherlands	PLASTIC: CAPS [15]	95	6	-0.9	**0.003**
Netherlands	PLASTIC: INDUSTRIAL [40]	95	5	-1.3	**0.000**
Netherlands	PLASTIC: FISHING_NET_SMALL [115]	95	4	0.7	**0.002**
Netherlands	PLASTIC: TANGLED [33]	95	4	-0.9	**0.001**
Netherlands	RUBBER: BALLOONS [49]	95	4	-0.8	**0.000**
Netherlands	PLASTIC: SMALL_BAGS [3]	95	3	-0.4	**0.011**

Total weight on country level					
Region	type name/ group code	n	mean	median	slope	p value
Netherlands	Total weight	73	5.1	3.4	-1.3	**0.000**
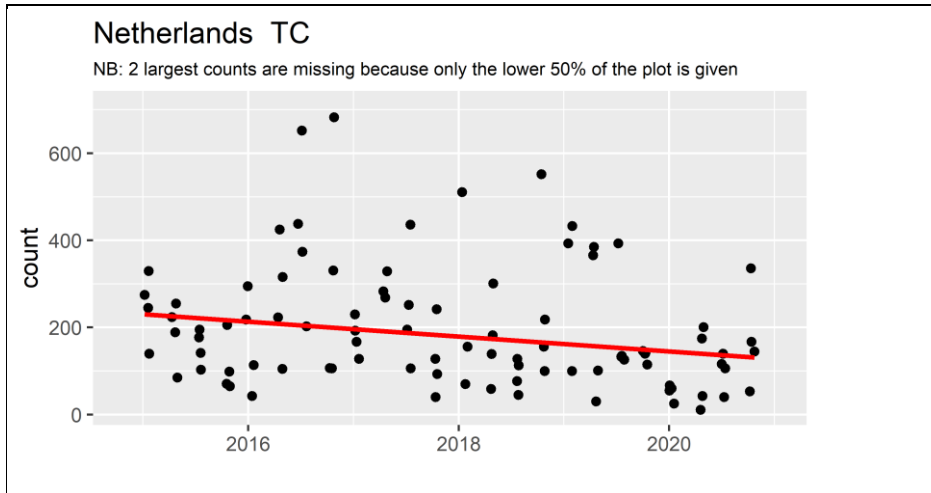
Figure 8 Trend plot 2015-2020: six year plot total count aggregated results for all Dutch beaches with p value 0.004 (exclusively small plastic [117])
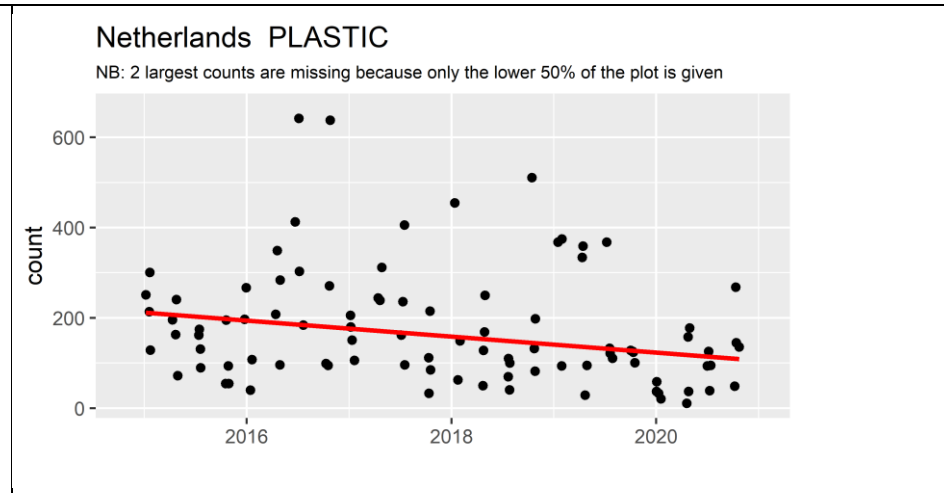
Figure 9 Trend plot 2015-2020: six year plot litter group "Plastics" aggregated results for all Dutch beaches with p value 0.003 (exclusively small plastic [117])
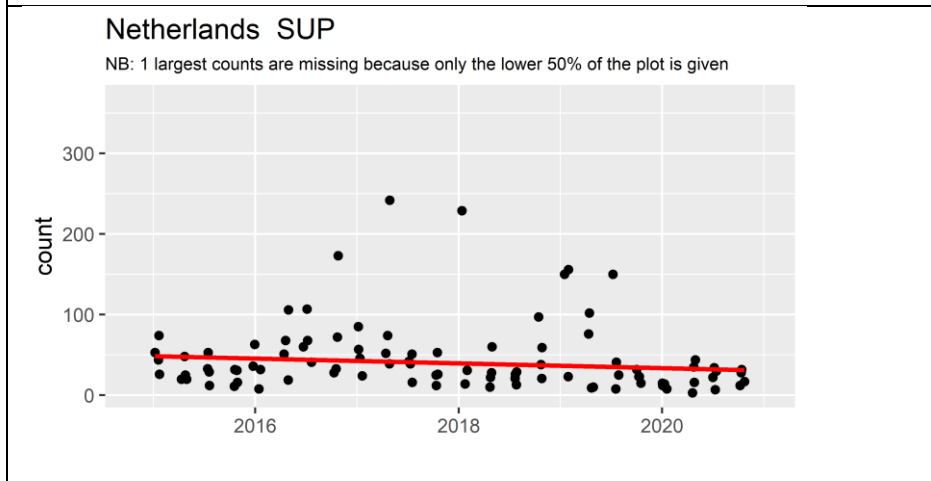
Figure 10 Trend plot 2015-2020: six year plot specific SUP litter group aggregated results for all Dutch beaches with p value 0.009
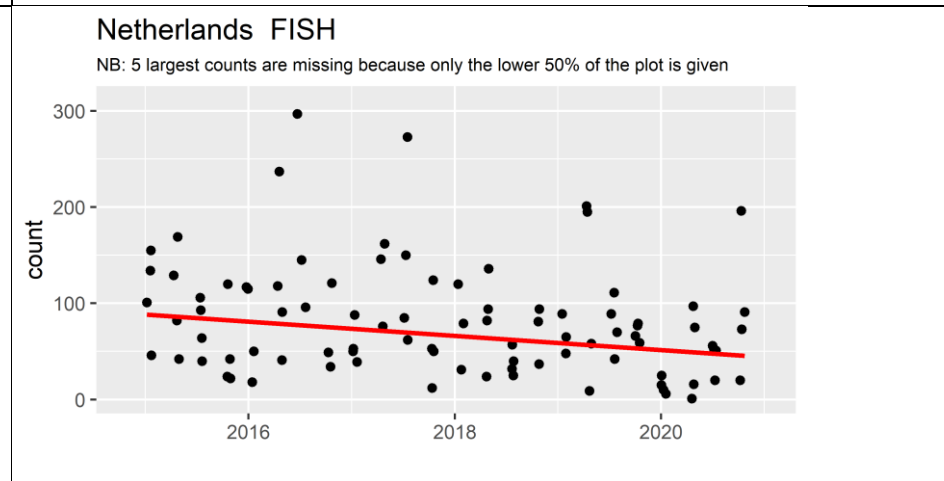
Figure 11 Trend plot 2015-2020: six year plot specific FISH litter group aggregated results for all Dutch beaches with p value 0.004
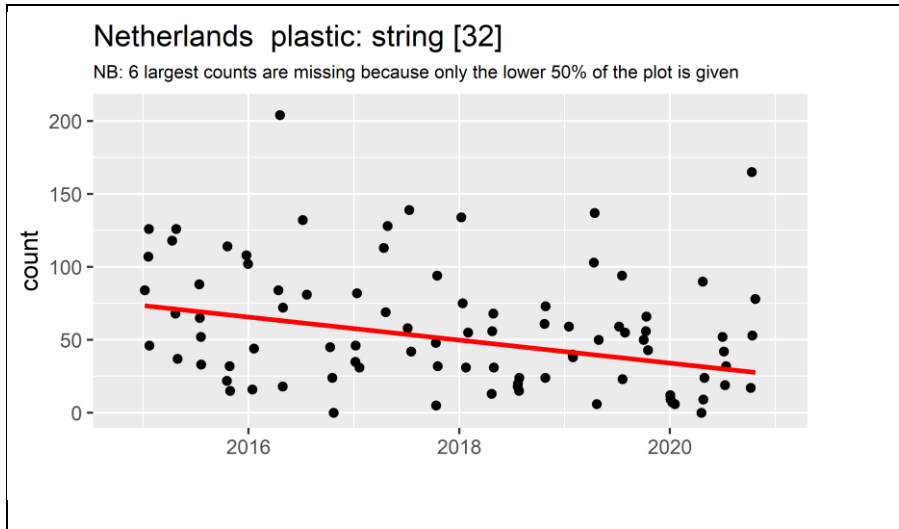
Figure 12 Trend plot plastic: string [32] 2015-2020: six year plot litter aggregated results for all Dutch beaches with p value 0.001
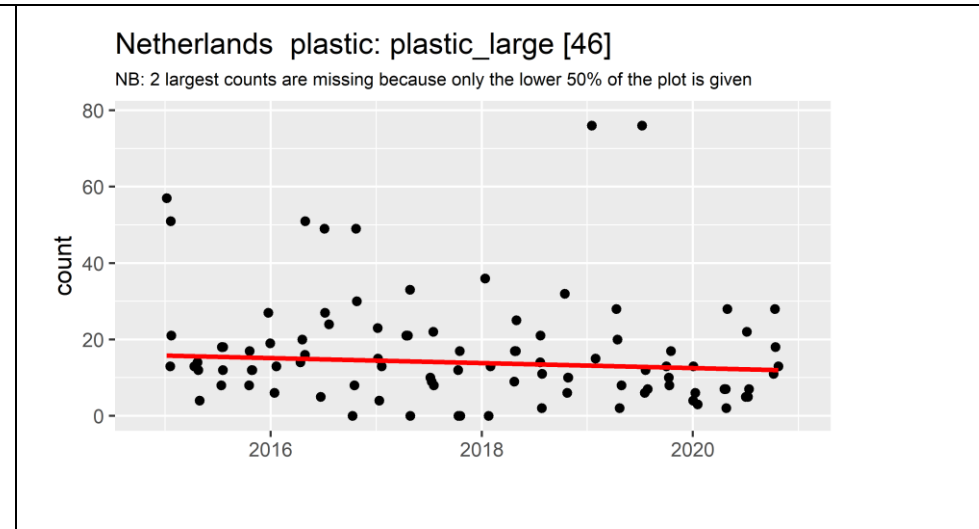
Figure 13 Trend plot Plastic/polystyrene pieces 2.5 cm >< 50 cm [46] 2015-2020: six year plot litter aggregated results for all Dutch beaches with p value 0.050
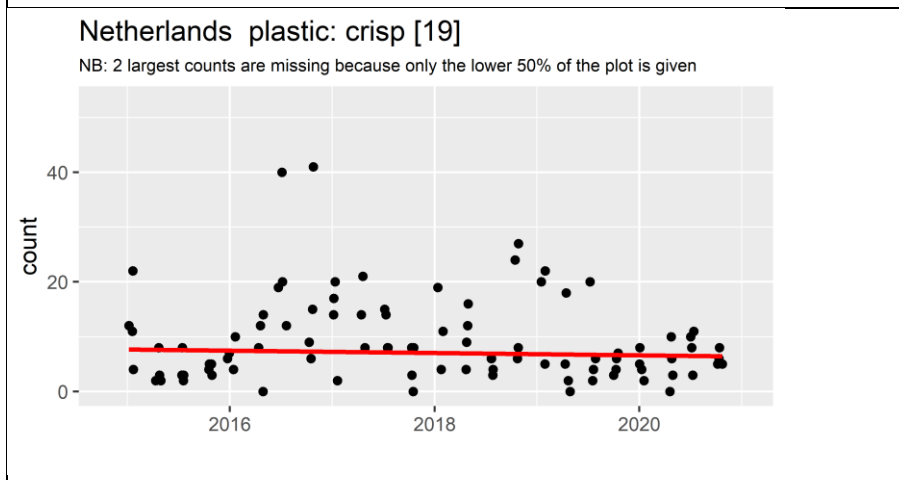
Figure 14 Trend plot Plastic crisp/sweet packets and lolly sticks [19] 2015-2020: six year plot litter aggregated results for all Dutch beaches with p value 0.259
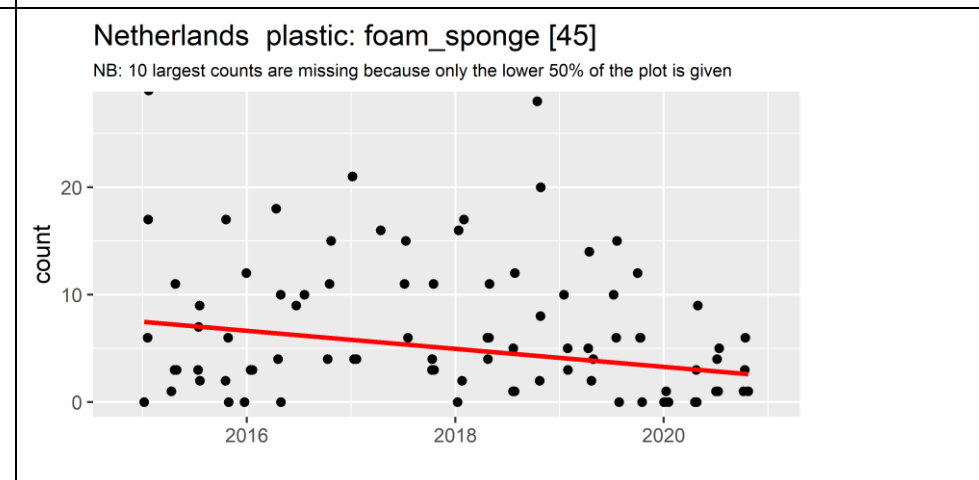
Figure 15 Trend plot plastic foam sponge [45] 2015-2020: six year plot litter aggregated results for all Dutch beaches with p value 0.002
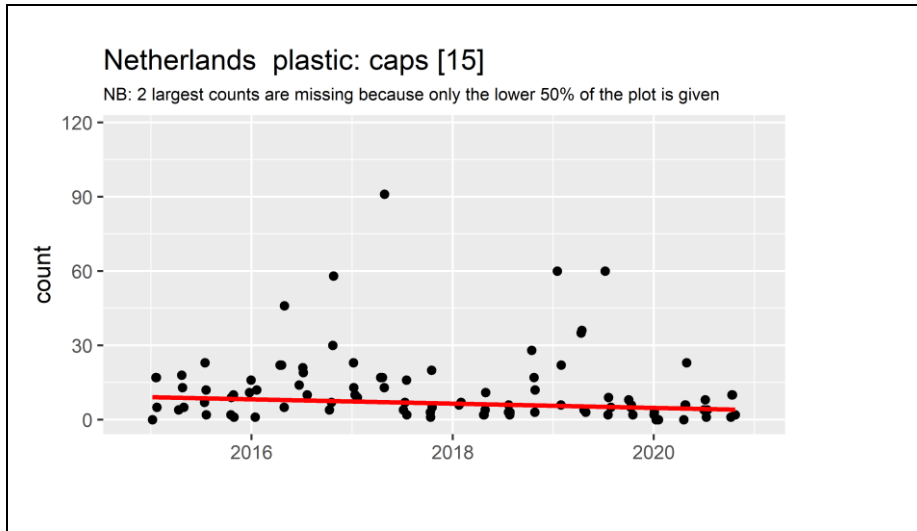
Figure 16 Trend plot plastic: caps & lids [15] 2015-2020: six year plot litter aggregated results for all Dutch beaches with p value 0.003

Figure 17 Indicative 6- year trend plot 2015-2020 small plastic fragments [117] six year plot litter aggregated results for all Dutch beaches with p value 0.182
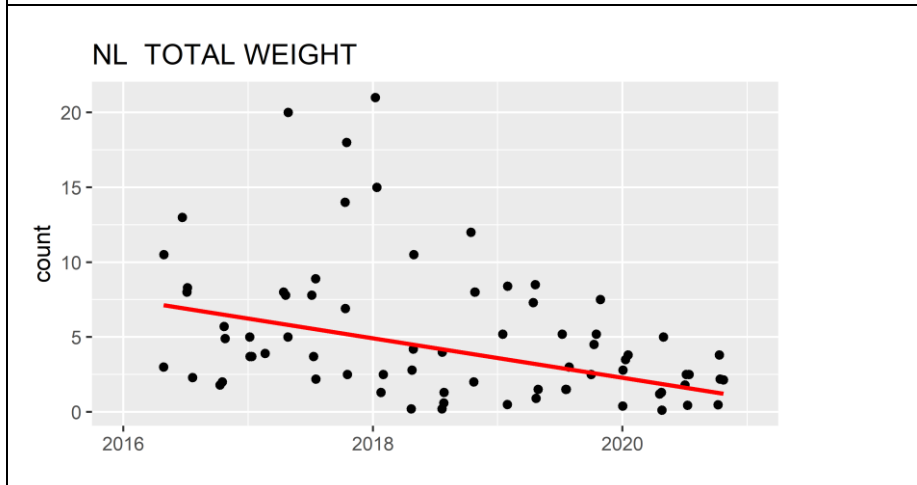
Figure 18 Trend analysis 2016-2020: five- year trend analysis plot total weight aggregated results for all Dutch beaches with p value 0.000
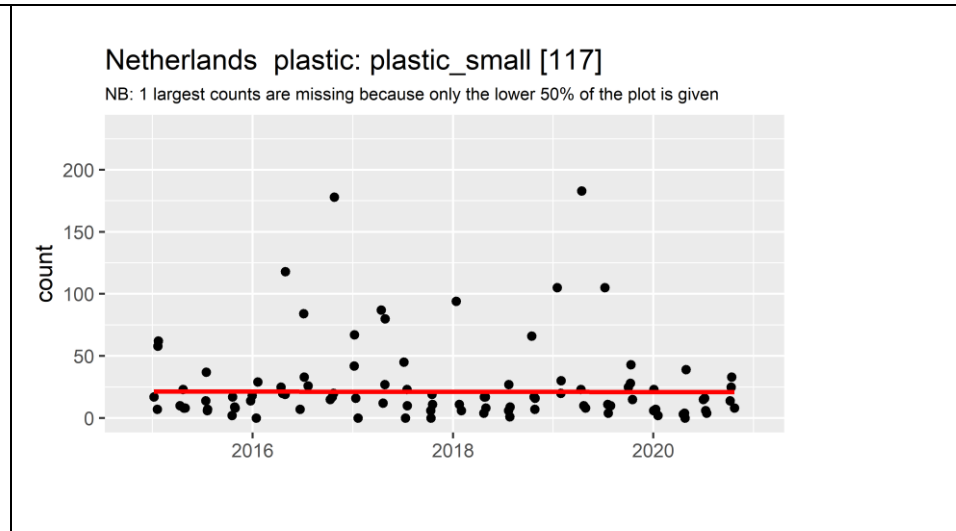
3.3.2   Total count
The aggregated country total count for the period 2015-2020 shows a significant decreasing trend of -17 counts/100m per year. The median total count for the period 2015-2020 is 166 counts/100m. On individual beach level, all four beaches show decreasing slopes with the highest decreasing slope of – 26 counts/100m per year on Terschelling.

3.3.2   Material group analysis
The litter types are categorized in following material categories: plastic/polystyrene [406], rubber [407], wood [410], paper/cardboard [409], glass [412], ceramic/pottery [413], metal [411] and cloth/textile [408].

In the period 2015-2020, plastic is the most found type of material (89%) followed by rubber (3%), wood (1%) and glass (1%). The other materials are metal, paper, cloth and pottery. Plastic/polystyrene has a median value of 148 counts per 100 meter beach. The trend analysis results shows significantly decreasing trends for plastic/polystyrene (-18 counts/year), rubber (-1 count/year) and metal (-0.1 count/year) . The other materials show no decreasing or increasing slopes.

3.3.3   Functional group analysis
The litter types are categorized in the specific litter group types: SUP, SEA, FISH and OTHER. All specific litter groups show decreasing slopes with significant decreasing trends. The SUP litter group has a median value of 29 counts per 100 meter beach and shows a significantly decreasing trend of -3 litter counts/100m per year. The SEA litter group has a median value of 83 counts per 100 meter beach with a significantly decreasing trend of -7 litter counts/100m per year.

3.3.4   Top 10 litter types
The Dutch top 10 most found litter types for the period 2015-2020 shows that plastic string [32] is the most found litter type, this litter type mainly consists of plastic dolly rope. Plastic string has a median of 60 litter counts per 100 meter of beach with a decreasing trend slope of -8 counts/100m per year. Plastic/polystyrene pieces 2.5 cm >< 50 cm [46] ranks as the number two most found litter type with a median of 12 counts per 100 meter beach and decreasing trend slope of -0.7 counts/100m per year. Plastic crisp/sweet packets and lolly sticks ranks is third most found litter type with a median value of 7 counts per 100 meter beach and decreasing slope of -0.2 counts/100 m per year. The other litter types in top 10 all show significantly decreasing trends.

The top 10 most found litter types the state analysis period (2018-2020) show the same top 10 litter types though the ranking. The trend plots for the top 5 most found litter type are included in figure 12, 13, 14, 15 and 16.

Figure 19 Various plastic caps found during survey in Bergen, 2020

Figure 20 Lead surveyor Marijke Boonstra on beach of Bergen, 2020.

Figure 21 Single use plastic cutlery found on beach of Bergen, 2020

Figure 22 Single use mask found on beach of Noordwijk, 2020

Figure 23 Dental floss brush found on beach of Bergen, 2020	Figure 24 Species of net found on the beach of Bergen, 2020
Figure 25 Plastic food packaging found on beach of Veere, 2020	Figure 26 Belt from MSC Zoe container disaster found near survey site on Terschelling, 2020

3.5   Indicative assessment of mesoplastics fragments

The category mesoplastic fragments 0.5-2.5cm [117] has been analyzed separately. The indicative 6-year trend analysis shows a small non-significant decreasing trend slope (-0.045 counts/100m per year). The median count for this period is 15 litter types per 100 meter beach and account for 8% of the litter recorded in the period 2015-2020. The trend plot is shown in figure 24.

3.6   Threshold value

The threshold value (TV) is calculated based on 3-year analysis period (2018-2020) and is based on 47 surveys, small plastic fragments 0-2.5cm [117] and waxes/other pollutants are excluded. The median total count for this period is 129 litter counts per 100 meter beach. The threshold value of a median value of 20 litter items per 100 coastline is not yet met. Based on new asymptotic trend model of Walvoort et al. (2021) and the Dutch beach litter data from 2011-2019, the TV on Dutch beaches could be reached around 2047.

3.7   Indication of waxes presence

Since the beginning of the beach litter monitoring (2002), the presence of pollutants, such as paraffin, has been separately recorded on the OSPAR Marine Litter Monitoring Survey Form. This included three waxes size categories. Paraffin waxes are recorded per size category which are 0-1 cm [108], 1-10 cm [109] and >10cm [110] and the frequency of paraffin per 100m (estimated number per meter of strandline) is recorded.

In the period 2018-2020 medium and small wax pieces (size 0- 1cm and 1-10cm) were most found. The median presence in the period 2018-2020 for small pieces was 7%, for medium pieces 7% and large pieces 1%. In table 5 the median presence of waxes per size and in period 2018-2020 is presented.

3.8   Indication of pellets presence

An analysis was conducted on the median presence of pellets for the period 2018-2020. The results are included in table 6. In the period 2018-2020, the median presence of pellets was that a 56% of surveys conducted pellets were found. Bergen is the location where in 2018, 2019 and 2020 in each survey pellets were found.

3.9   Indicative monitoring of total weight

The state analysis results of indicative monitoring of total weight in period 2018-2020 is included in table 4. The median indicative weight for the period 2018-2020 is 2.5 kg.

Based on trend analysis conducted with data collected in past five years during 73 surveys, the median weight of marine litter per 100 meter beach is 3.4 kg and shows decreasing trend slope of -1.3 kg/year (see table 5). Based on the data collected in the past five years, there appears to be a correlation between the number of litter types found and the average weight of marine litter recorded (see figure 8 and 18). Both show a decreasing trend, and an average relation between these two beach litter indicators can logically be expected.

Table 6 State analysis indication of waxes presence per size in period 2018-2020

Beach	2018			2019			2020			median presence per size category for period 2018-2020		
	Presence of Pollutants: Wax_small [108]	Presence Wax_medium [109] presence	Presence Wax_large [110] presence	Presence Wax_small [108] presence	Presence Wax_medium [109] presence	Presence Wax_large [110] presence	Presence Wax_small [108] presence	Presence Wax_medium [109] presence	Presence Wax_large [110] presence	Wax_small 0-1 cm [108]	Wax_medium 1-10 cm [109]	Wax_large >10 cm [110]
Bergen	3	1	0	2	2	1	3	1	0	17%	9%	2%
Noordwijk	1	0	0	2	3	1	0	0	0	6%	6%	2%
Terschelling	2	2	0	2	3	0	0	1	0	9%	13%	0%
Veere	0	1	0	1	1	0	0	1	0	2%	6%	0%
% of surveys where paraffin per size category was found per year										8%	8%	1%

Table 7 State analysis of indication of pellets presence in period 2018-2020

State analysis Presence of pellets 2018-2020				
Location	2018	2019	2020	% of surveys where pellets were found per location in period 2018-2020
Bergen	4	4	4	100%
Noordwijk	1	4	2	58%
Terschelling	1	3	2	55%
Veere	0	2	0	17%
% of surveys where pellets were found per year				57%

3.10   General discussion

The beach litter monitoring aims to gain insight into the quantities and types of litter that wash up on the Dutch North Sea beaches. This provides insight into the presence of (floating) litter in the sea and the degree of pollution in the North Sea.

The trend analysis of the aggregated data set for 2015-2020 shows a decreasing significant trend, which is good news. This is the result of increased public and political awareness, successful public campaigns and projects by various NGO's, implementation of international, European, national laws and policies. The increased awareness has also led to a growing number of (beach) cleaning initiatives and individual cleaning efforts during beach visits. However, the beach litter threshold value is not yet reached. A new asymptotic model, applied to Dutch beach litter data, shows that the beach litter TV could be reached around 2047, if the current decreasing trend is maintained. This requires at least that the current measures are maintained, and additional beach litter reduction measures are probably needed (Walvoort et al., 2021). When the most recent data period (including 2020 data) is used in this model, it is forecasted that the TV could be reached around 2040.

The year of 2020 is a special year with the start of the worldwide COVID pandemic which resulted in various national lockdown periods in order to limit contact between people. This meant that i.e. that the government advised to work from home and not travel abroad, closed schools, universities, public venues, shops and restaurants. Also some periods during the lockdown beaches were closed off. The pandemic had a worldwide impact on economic activities, also the shipping and fishing industry were affected in various ways. It difficult to estimate the effect of the pandemic on the possible reduced input of litter into the seas worldwide. At the same time, new types of litter were found on streets, roads and beaches etc. due to the increased widespread use of personal protective gear such as (often single-use plastic) masks, gloves, wet wipes and bottles of sanitizers). Due to improper discharge or poor behaviour this type of litter ended up in the environment. Though single use masks have not found in large quantities at beaches, this is more the case in urban areas.

The pandemic also had another effect. After lockdown periods, beach visits became even more popular. During the summer periods, some beach roads were closed off due to large amount of people wanted to visit the beach. Also more Dutch people spend their summer holidays in The Netherlands with coastal destinations being popular. At the same time, the large clean-up campaigns such as the Boskalis Beach Cleanup Tour and river clean-ups were cancelled due to COVID restrictions. A number of environmental organisations at the same time report an increase of individuals who are cleaning up their local environment increased national wide.

Fishermen part of the Fishing For Litter scheme continued to collect debris that gets stuck in their nets during normal fishing activities. The debris is stored in big bags onboard and delivered in ports for processing. In 2020, a record amount of 644 tons of debris was collected which also included lost container goods of the MSC Zoe (KIMO, 2021). It is likely that operational fishing waste is also collected in these bags. Currently, 140 fishing boats participate in Fishing for Litter.

Coastal municipalities participate in "Clean Beach Elections" that are organised since 2003. In the year 2020, there seem to be no indications of increased litter on recreational beaches. However, no exact information is available on litter amounts and types collected by municipalities and coastal cleaning initiatives on an annual basis. There is a concern in the entire OSPAR region that these cleaning efforts have an influence on the monitoring results. The quantification of cleaning activities and to evaluate its effect on trends remains challenging.

The long term trend of the fulmar litter monitoring shows a decreasing trend of litter found in the stomachs of Northern Fulmars. Combined with the results of the six year beach litter monitoring trend analysis, there are indications that the abundance of litter in the North Sea is decreasing. The five year trend analysis of the total weights confirms this. At the same time the threshold value for beach litter of 20 litter counts per 100 meter of beach and the fulmar threshold value "a period of at least five consecutive years, no more than 10% of northern fulmars (Fulmarus glacialis) in samples of at least 100 birds may exceed the level of 0.1 g of plastic particles in the stomach" are not yet met. Political, public and governmental efforts should continue to prevent the input of litter in our seas.

4. Conclusions and recommendations

This report provides an annual update of Dutch beach litter monitoring data and an overview of the Dutch beach litter statistical results for the period 2018-2020 (state analysis) and 2015-2020 (trend analysis). The statistical analysis was conducted according the revised CEMP guidelines, implemented in the litter software, for conducting beach litter data analysis. This meant that some changes were made on the analysis and presentation of the data, compared to previous years. The most important change it that the calculated medians are now leading in presenting the results of the 3- year state results and 6- year trend results for Dutch beach litter.

The 6-year trend analysis (period 2015-2020) of beach litter monitoring data shows a significant decreasing trend of -17 counts/100m per year and shows that the Dutch beaches are currently getting cleaner. The total count median for this period is 166 litter types per 100 meter of beach (excluding small mesoplastic fragments and waxes). Based on data collected in past five years during 73 surveys, the median weight of marine litter per 100 meter beach is 3.4 kilogram and shows a significant decreasing trend. Although the Dutch beaches are getting cleaner, a new asymptotic trend model indicates that the beach litter TV could be reached after 2040. To reach this TV sooner, additional marine and riverine litter reduction measures would be needed.

The functional litter groups SUP and FISH show significantly decreasing trends. The SUP litter group has a median of 29 counts per 100 meter beach and shows a significantly decreasing trend of -3 counts/100m per year. The FISH litter group which mainly contains of fishing related items has a median of 83 counts/100m with a significantly decreasing trend of -7 counts/100m year.

Plastic remains the most found material (91%) with a median of 113 counts/100m in the period 2018-2020. The trend analysis results shows significantly decreasing trends for plastic/polystyrene (-18 counts/100m per year), rubber (-1 count/100m per year) and metal (-0.1 count/100m per year). The other materials show no decreasing or increasing slopes.

On beach level, all beaches show decreasing trend slopes with Veere and Terschelling showing significant trends.

The top 10 for the period 2018-2020 consists of plastic: string [32], plastic: 2.5<>50cm [46], plastic: fishing net small [115], plastic: crisp [19], plastic: caps [15], plastic: tangled [33], plastic: foam sponge [45], rubber: balloons [49], plastic: industrial [40] and plastic: small bags [3].

The top 10 trend analysis show mostly small but decreasing trends slopes for most found litter types in the top 10. String and cord show a relatively large decreasing trend of -8 counts/100m per year.

In the period 2018-2020, the median presence of pellets was that a 56% of surveys conducted pellets were found. On the beach of Bergen each survey pellets were found. In the period 2018-2020 medium and small wax pieces (size 0-1cm and 1 -10cm) were most found. The median presence in the period 2018-2020 for small and medium pieces was 7% and large pieces 1%. Bergen has the highest presence of small was pieces (17%).

Although the total abundance of beach litter shows a significantly decreasing trend on Dutch beaches, the EU beach litter threshold value (TV) of median 20 counts/100m beach is still far from being reached. It is therefore important that current policies and measures in place are evaluated and further improved in such a way that it can maintain a continued reduction of marine litter entering the North Sea. Especially the measures that target the reduction of plastic dolly rope. These efforts and measures are needed to further reduce the impact of plastic pollution of our seas and oceans.

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Appendixes

Appendix I OSPAR database exports of Dutch beach litter monitoring year 2020 (separate file)

Appendix II Scans of OSPAR litter survey forms, year 2020 (separate files)

Appendix III LitteR reports and files 2018-2020 and 2015-2020 (separate folder)

Appendix IV Survey dates and weights

#	Survey beach	Year	Weight (kg) per 100m
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
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
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
43	NL001	16-1-2019	5.2
44	NL001	12-4-2019	8.5
45	NL001	9-7-2019	5.2
46	NL001	10-10-2019	4.5
47	NL002	30-1-2019	8.4
48	NL002	15-4-2019	7.3
49	NL002	19-7-2019	1.5
50	NL002	2-10-2019	2.5
51	NL003	29-1-2019	0.5
52	NL003	23-4-2019	0.9
53	NL003	21-7-2019	1.5
54	NL003	17-10-2019	5.2
55	NL004	29-4-2019	1.5
56	NL004	29-7-2019	3.0
57	NL004	29-10-2019	7.5
58	NL003	2-1-2020	0.4
59	NL004	3-1-2020	2.8
60	NL002	10-1-2020	3.5
61	NL001	18-1-2020	3.8
62	NL003	19-4-2020	1.2
63	NL002	24-4-2020	1.3
64	NL004	26-4-2020	0.12
65	NL001	30-4-2020	5.0
66	NL004	2-7-2020	1.8
67	NL001	6-7-2020	2.5
68	NL002	10-7-2020	0.45
69	NL003	14-7-2020	2.5
70	NL002	7-10-2020	0.48
71	NL004	11-10-2020	3.8
72	NL001	13-10-2020	2.2
73	NL003	23-10-2020	2.15

Appendix V List of OSPAR litter types and assignment litter groups

Source: TGML beach litter photo guide.
https://mcc.jrc.ec.europa.eu/main/photocatalogue.py?N=41&O=457&cat=all
Note: with some interpretation in the conversion of the Joint list codes to the OSPAR codes

type_name	included	SUP	FISH	OTHER
Plastic: Yokes [1]	x	x		x
Plastic: Bags [2]	x	x		
Plastic: Small_bags [3]	x	x		x
Plastic: Bag_ends [112]	x	x		x
Plastic: Drinks [4]	x	x		
Plastic: Cleaner [5]	x			x
Plastic: Food [6]	x	x		
Plastic: Toiletries [7]	x			x
Plastic: Oil_small [8]	x			x
Plastic: Oil_large [9]	x			x
Plastic: Jerry_cans [10]	x			x
Plastic: Injection_gun [11]	x			x
Plastic: Other_bottles [12]	x			x
Plastic: Crates [13]	x			x
Plastic: Car_parts [14]	x			x
Plastic: Caps [15]	x	x		
Plastic: Cigarettelighters [16]	x			x
Plastic: Pens [17]	x			x
Plastic: Combs [18]	x			x
Plastic: Crisp [19]	x	x		

Plastic: Toys [20]	x			x
Plastic: Cups [21]	x	x		
Plastic: Cutlery [22]	x	x		
Plastic: Fertiliser [23]	x			x
Plastic: Meshbags [24]	x			x
Plastic: Gloves [25]	x			x
Plastic: Gloves_pro [113]	x			x
Plastic: Lobsterpots [26]	x		x	
Plastic: Fish_tags [114]	x		x	
Plastic: Octopus_pots [27]	x		x	
Plastic: Oyster_nets [28]	x		x	
Plastic: Oyster_trays [29]	x		x	
Plastic: Mussel_sheeting [30]	x		x	
Plastic: Rope [31]	x		x	
Plastic: String [32]	x		x	
Plastic: Fishing_net_small [115]	x		x	
Plastic: Fishing_net_large [116]	x		x	
Plastic: Tangled [33]	x		x	
Plastic: Fishboxes [34]	x		x	
Plastic: Fishing_line [35]	x		x	
Plastic: Light_sticks [36]	x		x	
Plastic: Floats [37]	x		x	
Plastic: Buckets [38]	x			x
Plastic: Strapping [39]	x			x
Plastic: Industrial [40]	x			x

Plastic: Fibre_glass [41]	x			x
Plastic: Hard_hats [42]	x			x
Plastic: Shotgun [43]	x			x
Plastic: Shoes [44]	x			x
Plastic: Foam_sponge [45]	x			x
Plastic: Plastic_small [117]				
Plastic: Plastic_large [46]	x			x
Plastic: Plastic_vlarge [47]	x			x
Plastic: Other [48]	x			x
Rubber: Balloons [49]	x	x		
Rubber: Boots [50]	x			x
Rubber: Tyres [52]	x			x
Rubber: Other [53]	x			x
Cloth: Clothing [54]	x			x
Cloth: Furnishings [55]	x			x
Cloth: Sacking [56]	x			x
Cloth: Shoes [57]	x			x
Cloth: Other [59]	x			x
Paper: Bags [60]	x			x
Paper: Cardboard [61]	x			x
Paper: Purepak [118]	x			x
Paper: Tetrapak [62]	x			x
Paper: Cig_packets [63]	x			x
Paper: Cig_stubs [64]	x	x		
Paper: Cups [65]	x			x

Paper: Newspapers [66]	x			x
Paper: Other [67]	x			x
Wood: Corks [68]	x			x
Wood: Pallets [69]	x			x
Wood: Crates [70]	x			x
Wood: Lobsterpots [71]	x			x
Wood: Fish_boxes [119]	x			x
Wood: Lolly [72]	x			x
Wood: Brushes [73]	x			x
Wood: Other_small [74]	x			x
Wood: Other_large [75]	x			x
Metal: Aerosol [76]	x			x
Metal: Caps [77]	x			x
Metal: Drink [78]	x			x
Metal: Bbqs [120]	x			x
Metal: Electrical [79]	x			x
Metal: Fishing [80]	x			x
Metal: Foil [81]	x			x
Metal: Food [82]	x			x
Metal: Scrap [83]	x			x
Metal: Oil [84]	x			x
Metal: Paint_tins [86]	x			x
Metal: Lobsterpots [87]	x		x	
Metal: Wire [88]	x			x
Metal: Other_small [89]	x			x

Metal: Other_large [90]	x			x
Glass: Bottles [91]	x			x
Glass: Bulbs [92]	x			x
Glass: Other [93]	x			x
Pottery: Construction [94]	x			x
Pottery: Octopus_pots [95]	x		x	
Pottery: Other [96]	x			x
San: Condoms [97]	x			x
San: Buds [98]	x	x		
San: Towels [99]	x	x		
San: Tampons [100]	x	x		
San: Toilet [101]	x			x
San: Other [102]	x			x
Med: Containers [103]	x			x
Med: Syringes [104]	x			x
Med: Other [105]	x			x
Faeces: In_bags [121]	x			x
Pollutants: Wax_small [108]				
Pollutants: Wax_medium [109]				
Pollutants: Wax_large [110]				
Pollutants: Other [111]				
Plastic: Food_plastic [610]				
Plastic: Food_eps [620]				
Plastic: Cups_plastic [211]				
Plastic: Cups_eps [212]				

Plastic: Fishboxes_plastic [341]				
Plastic: Fishboxes_eps [342]				
Plastic: Plastic_s [1171]				
Plastic: Eps_s [1172]				
Plastic: Plastic_m [461]				
Plastic: Eps_m [462]				
Plastic: Plastic_l [471]				
Plastic: Eps_l [472]				
Plastic: String_cord [321]				
Plastic: Dolly_rope [322]				
Plastic: Tangled_string [331]				
Plastic: Tangled_dolly_rope [332]				
San: Buds_plastic [981]				
San: Buds_cardboard [982]				
Plastic: Biofilm [481]				
Glass: Jars [931]				
Survey: Old_rope_small [200]				
Survey: Old_rope_large [201]				
Survey: Old_plastic_pieces [202]				
Survey: Old_gloves [203]				
Survey: Old_cartons [204]				
Survey: Old_oildrums_new [205]				
Survey: Old_oildrums_old [206]				

Survey: Old_human_faeces [207]				
Survey: Old_animal_faeces [208]				
Survey: Old_cloth_rope [210]				