# OSPAR Beach Litter Monitoring In the Netherlands
# First annual report 2002-2012

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Merijn Hougee of North Sea Foundation (Stichting De Noordzee) during a beach litter monitoring survey.

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## Summary

**Conclusions**

The available Dutch OSPAR beach litter monitoring data appear to be effective for the detection of a range of significant trends in the beach litter abundances; using the statistical methods recently developed for beach litter by Van Franeker (2013). More specifically, significant trends in total abundance in the 1000m-data; and in 6 of the 10 top-10 items from the 100m data, were found (see table below). The Top-10 contains 81% of the total item abundance. Differences (non-significant) between the development of total abundance could be observed between the different beaches. These promising results give several options for the effective assessment of Dutch beach litter; and for waste management measures.

*Top 10 most frequently counted items in the Dutch 100m beach surveys during the period 2002-2012 and trends over this time frame (4 reference beaches, each usually surveyed 4 times per year: in total now available 154 surveys; 60839 items counted, average 395 per 100m survey). Trends over time are tested for significance by linear regression of log transformed data of individual counts against the year of survey. A significance level of p<0.05 is used, all values higher considered as non-significant (ns), p<0.05 marked *, p<0.01 marked **, and the highest significance level of p<0.001 marked as ***. Increases indicated by ↑ and decreases by ↓ up to probabilities of p=0.25. The symbol ↕ indicates uncertainty of direction of trend for probabilities greater than p=0.25.*

| RANK | Item or item cluster | % of total | n / 100m | trend |
|---|---|---|---|---|
| ***1*** | All Nets & ropes etc | 38% | 147.3 | ↑*ns* |
| ***2*** | All Plastic/Polystyrene pieces | 19% | 72.6 | ↕*ns* |
| ***3*** | All plastic bags | 6% | 23.6 | ↕*ns* |
| ***4*** | Plastic Caps/lids | 5% | 20.2 | ↑** |
| ***5*** | Plastic Crisp/sweet packets and lolly sticks | 4% | 15.1 | ↓ns |
| ***6*** | Rubber Balloons, incl valves ribbons, strings etc | 3% | 12.7 | ↑*** |
| ***7*** | Plastic Drinks Bottles, containers, drums | 2% | 8.4 | ↓** |
| ***8*** | Wood Other < 50 cm | 2% | 7.9 | ↓*** |
| ***9*** | Plastic Food Bottles, container incl fast food | 2% | 7.1 | ↓** |
| ***10*** | Plastic Industrial packaging, sheeting | 2% | 7.0 | ↑** |
| | **ALL Debris** | **100%** | **395** | ↕***ns*** |

**Recommendations**

1. In future assessments, it is proposed to describe numbers of debris items on the beaches on the basis of 5-year arithmetic average values with associated standard errors.
2. It is proposed to assess significance of trends over time by linear regression of log transformed data from individual counts against year of survey. For 'recent trends' it is recommended to use data from last 10 years of surveys. The same approach of 5-year averages and tests for trends is used in the Fulmar plastic particle EcoQO monitoring by OSPAR.
3. To define targets for EcoQO in OSPAR or Good Environmental Status in the MSFD, policy makers may use either (changes in) 5-year average values or significance levels of trends over time. The desired baselines and targets are a choice for policy makers.
4. It is recommended to set the Dutch EcoQO or GES target on the basis of abundance of ALL beach debris on the combined data for the four Dutch reference beaches. Underlying analyses of

specific beaches, particular items, or clusters of items of materials, sources etc. can be used to assist in decisions on priorities of policy actions and measurements of the effect of those actions

5. From the recent study of Van Franeker (2013), it appears that it is not necessary, and even unwise, to discontinue the monitoring of the Bergen beach.
6. The beach at the south point of Texel (*) may be used occasional additional study.
7. It is recommended that RWS Zee and Delta organize the installation of clear signposts on the reference beaches, with texts explaining the research and the request not to remove or deposit litter. Furthermore, no litter bins should be available near these reference beaches.
8. It is recommended to perform a source (land, sea, unknown/uncertain) analysis study; and a material analysis study (plastic and other materials), in 2014. The results of this additional study must be added to the available IMARES Report (Van Franeker, 2013), and finalized into a complete IMARES Beach litter analysis report.
9. It is recommended to start with the occasional monitoring by SDN of the weight of total plastics in 2014 as follows: collect the plastic debris of all net/rope/cord materials in a plastic bag, all other plastics in a second one, and remaining debris in a third, and weigh these on a spring scale.
10. Plastic pellets, also called mermaid tears, are not counted within the BLM protocol. Only the presence of the pellets is recorded. In 2014 a pilot is planned to obtain semi-quantitative pellet data with an efficient method, which has to be defined then. Sieving of pellets will probably be a useful method.

# 1. Introduction

Marine litter in the sea – in particular plastic litter – is a major problem, denominated by various scientists and conservation organizations as 'the new environmental challenge'. All over the world, large quantities of marine litter are washed ashore. Marine litter causes unwanted effects on sealife and is gives economic costs for society. For policy development with the aim to reduce marine litter and/or to assess effectiveness of existing policies, qualitative and quantitative information is needed about the sources and amounts of marine litter that enters the seas and oceans. "Marine litter (marine debris) is any persistent, manufactured or processed solid material discarded, disposed of, abandoned or lost in the marine and coastal environment". This also includes such items entering the marine environment via rivers, sewage outlets, storm water outlets or winds.

In the year 2000, a standardized protocol for the 'OSPAR Pilot Project on Monitoring Marine Litter' was developed with the aim to monitor the amounts and sources of marine litter in the North East Atlantic region. started in 2000 with Sweden as the coordinator. The protocols for 100-metres and 1-km surveys were developed, tested and used during fieldwork over from 2000 onwards. The initial pilot project was executed for a period of six years (2000-2006) in nine countries: the Netherlands, Belgium, Germany, the 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 together coordinated this programme. The Dutch Ministry of Environment and Infrastructure (IenM) decided to continue with the beach litter monitoring. With the instalment of the Intercessional Correspondence Group Marine Litter (ICGML) the project was embedded in OSPAR on an official basis.

**Beach Litter Monitoring: a tool for assessing marine litter in the North Sea**

Within the European Marine Strategy Framework Directive (MSFD) marine litter is one of the descriptors (DG10) in order to determine 'Good Environmental Status' of the marine environment. Monitoring beached litter is one of the obligations within this directive. Beach surveys performed according to the protocol can be used to monitor trends in amounts (quantitative) and sources (qualitative) of marine litter washed ashore.

The Ministry of Transport and Environment (RWS Waterdienst) has assigned the North Sea Foundation to monitor the beaches according to the OSPAR protocol in the Netherlands in 2012.This report provides an overview of the field results from the 2012 beach surveys. The results are analysed in relation to the results in previous years in order to identify trends.

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

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

**Aims of this annual report**

1. To give a complete overview of the Dutch beach monitoring and assessment results, including data tables and trend analyses, from 2002 up till now.
2. To provide an annual update of this overview report.

## 2. Materials and methods

### 2.1 Selection of reference beaches

Within OSPAR (OSPAR BLM Guide) 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 reference beaches are composed of sand, are accessible all year round, are easy accessible for marine litter removal, have a length of 100 metres and 1 km, are free of buildings all year round and comply with the OSPAR criteria a, b, c, d, e. The compliance of criteria (f), 'no collection of any other litter activities', does not apply to the beaches. The reference beach Bergen is cleaned on a regular basis all year round. The other beaches are incidentally cleaned by volunteers or local government authorities. Therefore contact with local beach authorities is essential. Before a monitoring on a reference beach is executed, the local beach coordinator is contacted. The main reason to do this is because of the knowledge of local activities which can influence the monitoring session, like a local cleanup, an accident with cargo, a storm, etc.. In 2012 there was contact with all local beach coordinators on a regular basis.

**Table 1: Contact information local beach managers**

| | |
|---|---|
| **Gemeente Veere**<br>Strand exploitatie Walcheren (SSW)<br>Lucas Fransen<br>Tel. 0118 586275<br>fransenssw@zeelandnet.nl<br>Gemeente:<br>David Wisse, 06 51882966 | **Gemeente Noordwijk**<br>Petri Biegstraaten<br>Tel. 071 3660370 |
| **Gemeente Bergen**<br>Leo Doppenberg<br>Tel. 072 8880320<br>L.Doppenberg@bergen-nh.nl | **Gemeente Terschelling**<br>Evert Van Leunen,<br>e.v.leunen@terschelling.nl<br>Leo Boumen milieu<br>Tel: 0562 446251 |

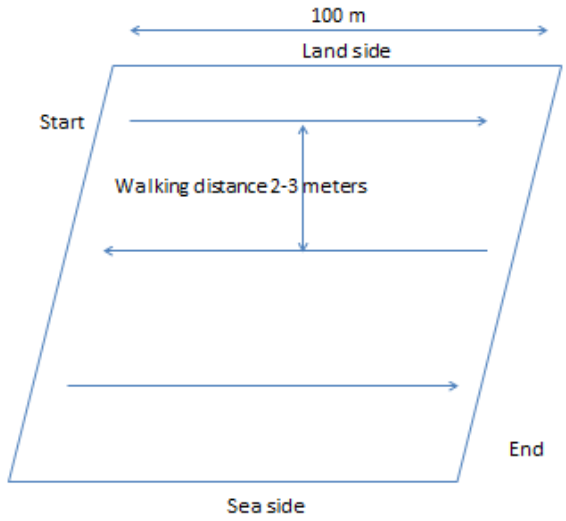
*Figure 1: Dutch monitoring beaches for marine litter at Veere, Noordwijk, Bergen and Terschelling. (With courtesy to RWS CIV for providing this figure)*

## 2.2 Sampling areas

Once sampling areas have been identified a beach is chosen. A sampling unit is a fixed section of beach covering the whole area between the water edge to the back of the beach. Two sampling units are used within the OSPAR area: 100-metres: for identifying all marine litter items; and 1-km: for identifying objects larger than 50 cm.

The monitoring sessions start at the back of the beach on the landside. A small strip of about 2-3 meters is monitored, walking distance between the two surveyors is about 2-3 meters. Two surveyors walk parallel with the beach towards the end of the 100 metre monitoring area and draw a line in the sand during monitoring of the litter items. After reaching the 100 meter border of the monitoring area, the surveyors make a turn and proceed with the next strip. 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 2: 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 used a fixed part of the 1-km. An example is given in Figure 3.

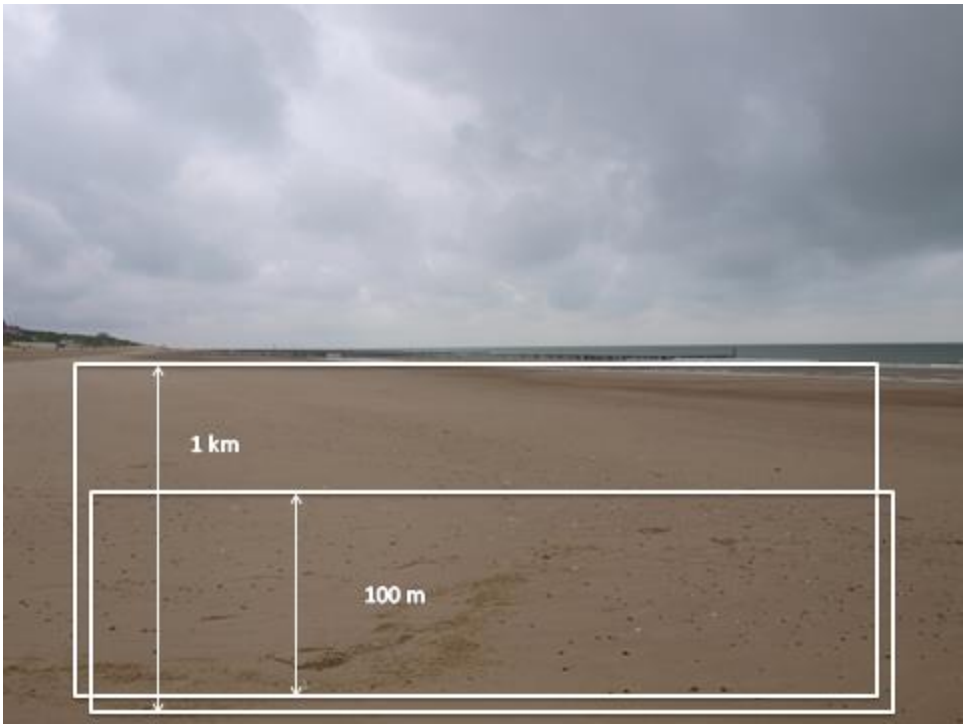



*Figure 3: Photograph of the Dutch reference beach Terschelling.*
*Vraag: duidelijkere foto van de duinvoet maken en toevoegen.*

Permanent reference points must be 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 mainly located by marked beach poles.

Action 1: In 2014, the choice of starting points (beach pole or special poles; and the measuring of length of the monitoring path (using measurement rope or GPS) will be checked and if necessary optimized.
Action 2: in 2014, it will be investigated if monitoring signs can be placed on the reference beaches.

Details of the 4 Dutch OSPAR Beach Litter reference beaches. In addition to beach pole descriptions, details GPS positions for start point, endpoint of 100m section and endpoint of 1km section will be assessed.

| nr | Beach name | Access point | Start Beach Pole (start of 100m and 1km survey) | Endpoint of 1km survey |
|---|---|---|---|---|
| **NL1** | Bergen | Boulevard Noord Egmond aan Zee | 35.250 | South to 36.250 |
| **NL2** | Noordwijk | Langevelderslag | 72.250 | South to 73.250 |
| **NL3** | Oostkapelle/Veere | Oranjezon | 10.3 | North in direction beach access Oranje zon |
| **NL4** | Terschelling | Oosterend Badweg | 18.200 | West to 19.200 |

### 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, slippery rocks 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: Mid-December–mid-January
- Spring: April
- Summer: Mid-June–mid-July
- Autumn: Mid-September–mid-October

### 2.4 Item classification

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

### 2.5 Collection, identification and registration of litter

All items found on the sampling unit should be entered on the survey forms provided (OSPAR, version 2010). On the survey forms, each item is given a unique OSPAR identification number. The survey forms also provide a box for a UNEP identification number. This is for UNEP use only. Unknown litter or items that are not on the survey form should be noted in the appropriate "other item box".

A short description of the item should then be included on the survey form. If possible, digital photos should be taken of unknown items so that they can be identified later and if necessary be added to the survey form.

Following the advice from Van Franeker (2013), SDN will continue to monitor OSPAR Item nr 117 (plastic/polystyrene pieces < 25mm); since this is absolutely essential for data continuity and statistical tests of trends over time.

It is proposed to occasionally monitor the mass of plastic debris, starting in 2014, as follows. Collect the plastic debris of all net/rope/cord materials in a plastic bag, all other plastics in a second one, and remaining debris in a third, and weigh these on a spring scale.

Plastic pellets, also called mermaid tears, are not counted within the BLM protocol. Only the presence of the pellets is recorded. In 2014 a pilot is planned to obtain semi-quantitative pellet data with an efficient method, which has to be defined then. Sieving of pellets will probably be a useful method.

### 2.6 Data Management

For each reference beach a questionnaire must be completed by the national coordinator (OSPAR, version 2010). The questionnaire includes information on the location and the physical and geographical characteristics of each beach, including the proximity of possible sources of marine litter. Also included are questions regarding factors that could help explain the amounts, types, and composition of marine litter found on that beach, for example, cleaning schemes. The questionnaire provides background information for the analysis of beach survey data. The coordinator is asked to gather as much relevant information as possible. 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. please use official data from authorities responsible only. When circumstances change, for example, the development of a new residential area nearby, the questionnaire must be updated. Photographs of unknown litter items are stored in the database and an associated photograph folder.

The field survey forms are archived by SDN.and transcribed by SDN to fresh paper survey forms at the office desk shortly after the monitoring.

The transcribed survey forms and photos of unknown items are scanned and digitally stored by SDN and RWS-WVL as a backup of the basic monitoring data.

New monitoring data are added to the validated dataset in Excel recently produced by Van Franeker (2013). This dataset is protected in a work sheet in the Excel file using password protection. In the coarse of a monitoring year, collected datasets are added to a separate datasheet for that year; by first deprotecting the work sheet; then adding the new data, and then reprotecting the datasheet. When a monitoring year has been finished and the data have been validated, the year-sheet is copied into the mastersheet. The mastersheet is first deprotected, than the data year is copied into the mastersheet, and then the mastersheet is password protected again.

The known special circumstances and limitations of the present dataset are described in the BLM database (Excel) in a separate worksheet. Special circumstances are in principle not a reason to exclude data from statistical analysis, because these are natural and realistic events.

### 2.7 Data validation

The data collected by Stichting De Noordzee will be validated by RWS Zee and Delta with respect to the following points:

a. Check of the correct use of the data registration forms
b. Check of the correct transfer of the monitoring data from the (a) field data forms into (b) the transcribed data forms into (c) the monitoring database (Excel file).

### 2.7 Data analysis procedures

#### 2.7.1 Data preparation: item clustering

The OSPAR/UNEP monitoring lists are given in Appendices I and II). The current 100m survey form contains 116 categories. However, the database holds 11 additional categories that were used before 2010. Changes made to the categories in 2010 represent a serious complication in data analyses. Details were given in Van Franeker (2013). For analyses that include data from before and after the changes in 2010, it is essential that clusters of items are used that contain both the old and the new categories. Usage of separate categories in these cases would lead to biased analytical results. Details were given in van Franeker 2013.

The item clusterings which are performed are listed in Table 2 (van Franeker, 2013):

| CLUSTER description | OSPAR 100m categories included | remarks |
|---|---|---|
| **All Nets & ropes etc** | =31+32+33+115+116+200+201 | In 2010, main changes concerned a switch in categories for ropes/cords based on diameter rather than length |
| **All Plastic/Polystyrene pieces** | =46+47+48+202 | In 2010, a new category for pieces < than 25mm was introduced, which was previously included in the others |
| **All plastic bags** | =002+003 | Categories combined because distinction often unclear, and addition/split of a category for ' bag ends nr 112' As it is unclear where such items were listed before 2010 (other?) but are numerically hardly relevant, category 112 is not included in the cluster |
| **All Tetrapacks** | =062+118+204 | After 2010, milk tetrapacks were separated from other tetrapacks |
| **All other cloth-textile** | =059+210 | In 2010, the category for textile/cloth rope or string was deleted, with such items now included in the 'other' textile-cloth category |
| **All synthetic work gloves (rubber, plastic)** | = 025+113+203 | Changes were made in the descriptions of household and industrial glove types |
| **All Metal Oil drums** | 084+205+206 | Drums were split into new and old before 2010, but no longer after |

In the 1 km dataset, changes introduced in 2010 have even more complicated consequences, and for any use of data that combine years from before and after 2010, it is recommended to simply look at the cluster of all items recorded.

### 2.7.2 Top 10 analysis

Determine the top 10 most abundant items using the item clustering rules from Paragraph 2.7.1 for the data period 2002 – 2012. Report the percentage of items that is covered by this top-10 list. Note: this action only has to be performed once, and this top 10 list is used for further and future analysis.

### 2.7.3 Trend analyses

First trend analyses are performed on the total number of items and the top-10 items. More specifically, the following trend analyses were performed:

a. Total number of items monitored on 100 m; average of 4 beaches and individual beaches
b. Total number of items monitored on 1 km; average of 4 beaches and individual beaches
c. Top-10 items on 100 m; average of 4 beaches

Trends are analysed by linear regression of ln-transformed data (*) of individual counts of the number of litter items against the year of the survey. In the current beach analysis, the full dataset of 11 years (2002-2012) was used. For future work it is recommended to calculate recent trends over the most recent 10-year period. The same approach is used in the OSPAR EcoQO on plastic particles ingested by the Fulmar

** Background information*
Beach litter data show a skewed distribution, which is not permissible for many statistical analyses. Data transformation by log transformation (natural logarithm plus 1) resulted in normal data distribution, suitable for statistical tests as in for example linear regressions (Van Franeker, 2013).

### 2.7.4 Calculation of assessment values of total abundance

To avoid that annual fluctuations dominate the perception of beach litter surveys, it is proposed to use 5-year arithmetic averages, with standard errors to describe total abundance. This approach smoothes incidental annual variations. The average is calculated from individual counts, and not from annual averages.

Another, and potential additional way to smooth data for abundance into balanced integrated figures, is the use of geometric means, based on calculations of log transformed data. However, for the beach litter data from the Netherlands, Van Franeker (2013) assessed that log transformation for 5-year averages had no additional merit. In that case the direct arithmetic average is a more easy to understand figure to use for abundances.

This report makes no direct proposal for OSPAR EcoQO or MSFD GES target definitions. Such targets could be base on both the signicance level of trends, or on the absolute values for total abundance. Definition of such targets is a policy issue. Here we only propose to base such targets on either linear regression trend analysis or on 5-year averaged absolute abundances.

It is recommended however, to base an EcoQO or GES policy target on the combined data for ALL debris. The underlying data for specific beaches, particular items, or clusters of items of materials, sources etc. are essential to assist in decisions on priorities of policy actions and to measure the effect of those actions, but their inclusion into the EcoQO or GES target would make assessments highly complicated.

### 2.7.5 Material analysis

This type of analysis has not yet been fully implemented; but will be in 2014. Especially the fraction of plastic/synthetic items appears to be of interest for MSFD policy makers.

### 2.7.6 Source analysis

This type of analysis has not yet been implemented; but will be in 2014. It is essential for the MSFD to connect monitoring results to probable sources and pathways; leading to possible water management measures. It is proposed to perform trend analyses of total abundances of items which have been assigned with sufficient confidence to (a) sea sources (shipping, fisheries, off shore); (b) land sources (tourism; sanitary; rivers and channels; or (c) unknown or uncertain sources.

## 2.8 Reporting

### 2.8.1 Annual report

SDN produces an annual report, which contains an update of the state and trend analyses of Dutch beach litter using the new and existing data. This report is finished within 4 months after the last monitoring activity.

### 2.8.2 OSPAR

RWS Zee and Delta will report the new annual beach litter data in the OSPAR Access format, using the digital scans of the transcribed field forms.

## 3. Results and discussion

### 3.1 Item clustering

Data surveys by van Franeker (2013) made it clear that changes made to the OSPAR litter categories in 2010 had serious consequences for data analysis. As long as data reports include data from before and after 2010, it is essential that analyses for overall debris and specific categories use the clusters identified in chapter 2.7.1, in which proper account is taken of categories that were made redundant in the current forms. Usage of just the categories that are listed in the current data forms would lead to biased results

### 3.2 Top-10 analysis

The complete list of relative abundances of beach litter items, calculated for the period 2002-2012 and using the new item clustering rules, is given in Table 3. A more detailed insight in the composition of the new item clusters is given in Van Franeker (2013) Table 5.

It appears that 81% of all items is covered by the top-10 list, which can be considered an acceptably high percentage. It is proposed to use this top-10 list for further trend analysis, in order to get a more detailed insight in the developments of specific item classes. This information can be useful for possible waste management measures.

*Table 3 Ranking of items after initial clustering. (data from full 2002-2012 period of 100m surveys in the Netherlands, total number of surveys 154, total nr of counted items 60389)..*

| RANK | Item or item cluster | OSPAR-100-ID | count | % of total | n / 100m | Cumula-tive % |
|---|---|---|---|---|---|---|
| 1 | All Nets & ropes etc | =31+32+33+115+116+200+201 | 22677 | 38% | 147.3 | |
| 2 | All Plastic/Polystyrene pieces | =46+47+48+202 | 11180 | 19% | 72.6 | |
| 3 | All plastic bags | =002+003 | 3632 | 6% | 23.6 | |
| 4 | Plastic Caps/lids | OSPAR100_015 | 3114 | 5% | 20.2 | |
| 5 | Plastic Crisp/sweet packets and lolly sticks | OSPAR100_019 | 2318 | 4% | 15.1 | |
| 6 | Rubber Balloons, incl valves ribbons, strings etc | OSPAR100_049 | 1949 | 3% | 12.7 | |
| 7 | Plastic Drinks Bottles, containers, drums | OSPAR100_004 | 1295 | 2% | 8.4 | |
| 8 | Wood Other < 50 cm | OSPAR100_074 | 1214 | 2% | 7.9 | |
| 9 | Plastic Food Bottles, container incl fast food | OSPAR100_006 | 1101 | 2% | 7.1 | |
| 10 | Plastic Industrial packaging, sheeting | OSPAR100_040 | 1074 | 2% | 7.0 | 81% |
| 11 | Plastic Foam sponge | OSPAR100_045 | 937 | 2% | 6.1 | |
| 12 | Sanitary - Cotton bud sticks | OSPAR100_098 | 833 | 1% | 5.4 | |
| 13 | Plastic Strapping bands | OSPAR100_039 | 761 | 1% | 4.9 | |
| 14 | Plastic Cutlery/trays/straws | OSPAR100_022 | 675 | 1% | 4.4 | |
| 15 | Glass Other items | OSPAR100_093 | 558 | 1% | 3.6 | |
| 16 | All Tetrapacks | =062+118+204 | 426 | 1% | 2.8 | |
| 17 | Glass Bottles | OSPAR100_091 | 400 | 1% | 2.6 | |
| 18 | Wood Other > 50 cm | OSPAR100_075 | 387 | 1% | 2.5 | |
| 19 | Plastic Cups | OSPAR100_021 | 379 | 1% | 2.5 | |
| 20 | Metal Drink cans | OSPAR100_078 | 367 | 1% | 2.4 | 91% |
| 21 | Plastic Cleaner Bottles, containers, drums | OSPAR100_005 | 274 | 0% | 1.8 | |
| 22 | All other cloth-textile | =059+210 | 270 | 0% | 1.8 | |
| 23 | Metal Other pieces < 50 cm | OSPAR100_089 | 269 | 0% | 1.7 | |
| 24 | Plastic other bottle/container/drum | OSPAR100_012 | 215 | 0% | 1.4 | |
| 25 | Plastic Shotgun cartridges | OSPAR100_043 | 212 | 0% | 1.4 | |
| 26 | Plastic Cosmetics bottles and containers | OSPAR100_007 | 203 | 0% | 1.3 | |
| 27 | All synthetic work gloves (rubber, plastic) | = 025+113+203 | 193 | 0% | 1.3 | |

| RANK | Item or item cluster | OSPAR-100-ID | count | % of total | n / 100m | Cumula-tive % |
|---|---|---|---|---|---|---|
| *28* | Paper Cigarette butts | OSPAR100_064 | 190 | 0% | 1.2 | |
| *29* | Plastic Mesh vegetable bags | OSPAR100_024 | 188 | 0% | 1.2 | |
| *30* | Cloth-Textile - Clothing | OSPAR100_054 | 175 | 0% | 1.1 | |
| *31* | Plastic Cigarette lighters | OSPAR100_016 | 172 | 0% | 1.1 | |
| *32* | Rubber other pieces | OSPAR100_053 | 156 | 0% | 1.0 | |
| *33* | Rubber Tyres and belts | OSPAR100_052 | 150 | 0% | 1.0 | |
| *34* | Plastic Toys & party poppers | OSPAR100_020 | 149 | 0% | 1.0 | |
| *35* | Plastic Fishing line (angling) | OSPAR100_035 | 124 | 0% | 0.8 | |
| *36* | Metal Aerosol/Spray cans | OSPAR100_076 | 123 | 0% | 0.8 | |
| *37* | Cloth-Textile - Shoes (leather) | OSPAR100_057 | 120 | 0% | 0.8 | |
| *38* | Wood - Corks | OSPAR100_068 | 112 | 0% | 0.7 | |
| *39* | Plastic Oyster nets and Mussel bags incl stoppers | OSPAR100_028 | 111 | 0% | 0.7 | |
| *40* | Plastic Fertiliser/animal feed bags | OSPAR100_023 | 104 | 0% | 0.7 | |
| *41* | Plastic Jerry cans (square containers with handle) | OSPAR100_010 | 103 | 0% | 0.7 | |
| *42* | Plastic sheeting from mussel culture (Tahitians) | OSPAR100_030 | 99 | 0% | 0.6 | |
| *43* | Plastic Buckets | OSPAR100_038 | 99 | 0% | 0.6 | |
| *44* | Plastic Injection gun containers | OSPAR100_011 | 87 | 0% | 0.6 | |
| *45* | Plastic Floats/Buoys | OSPAR100_037 | 85 | 0% | 0.6 | |
| *46* | Paper Other items | OSPAR100_067 | 85 | 0% | 0.6 | |
| *47* | Plastic Pens | OSPAR100_017 | 83 | 0% | 0.5 | |
| *48* | Plastic Shoes/sandals | OSPAR100_044 | 82 | 0% | 0.5 | |
| *49* | Glass Light bulbs/tubes | OSPAR100_092 | 81 | 0% | 0.5 | |
| *50* | Metal Foil wrappers | OSPAR100_081 | 79 | 0% | 0.5 | |
| *51* | Sanitary - towels/panty liners/backing strips | OSPAR100_099 | 63 | 0% | 0.4 | |
| *52* | Metal Industrial scrap | OSPAR100_083 | 62 | 0% | 0.4 | |
| *53* | Stone Construction material e.g. tiles | OSPAR100_094 | 51 | 0% | 0.3 | |
| *54* | Plastic Lobster and cod tags | OSPAR100_114 | 50 | 0% | 0.3 | |
| *55* | Plastic Fish boxes | OSPAR100_034 | 49 | 0% | 0.3 | |
| *56* | Wood Pallets | OSPAR100_069 | 47 | 0% | 0.3 | |
| *57* | Sanitary - Other items | OSPAR100_102 | 46 | 0% | 0.3 | |
| *58* | Paper Cardboard | OSPAR100_061 | 44 | 0% | 0.3 | |
| *59* | Plastic bag ends | OSPAR100_112 | 42 | 0% | 0.3 | |
| *60* | Metal Bottle caps | OSPAR100_077 | 42 | 0% | 0.3 | |
| *61* | Cloth-Textile - Furnishing | OSPAR100_055 | 41 | 0% | 0.3 | |
| *62* | Plastic container: Engine oil <50 cm | OSPAR100_008 | 40 | 0% | 0.3 | |
| *63* | Sanitary - Tampons and tampon applicators | OSPAR100_100 | 40 | 0% | 0.3 | |
| *64* | Plastic 4/6-pack yokes | OSPAR100_001 | 37 | 0% | 0.2 | |
| *65* | Paper Cigarette packets | OSPAR100_063 | 36 | 0% | 0.2 | |
| *66* | Sanitary - Toilet fresheners | OSPAR100_101 | 36 | 0% | 0.2 | |
| *67* | Cloth-Textile - Sacking | OSPAR100_056 | 32 | 0% | 0.2 | |
| *68* | Plastic Crab/lobster pots | OSPAR100_026 | 27 | 0% | 0.2 | |
| *69* | Plastic Light sticks (tubes with fluid) | OSPAR100_036 | 26 | 0% | 0.2 | |
| *70* | Wooden Ice lolly sticks/chip forks | OSPAR100_072 | 26 | 0% | 0.2 | |
| *71* | Paper Newspapers & magazines | OSPAR100_066 | 25 | 0% | 0.2 | |
| *72* | Wooden Paint brushes | OSPAR100_073 | 25 | 0% | 0.2 | |
| *73* | Plastic Car parts | OSPAR100_014 | 24 | 0% | 0.2 | |
| *74* | Metal Food cans | OSPAR100_082 | 23 | 0% | 0.1 | |
| *75* | Medical - Containers/tubes | OSPAR100_103 | 22 | 0% | 0.1 | |

| RANK | Item or item cluster | OSPAR-100-ID | count | % of total | n / 100m | Cumula-tive % |
|---|---|---|---|---|---|---|
| *76* | Plastic Crates (not fishboxes see OSPAR100-ID 034) | OSPAR100_013 | 18 | 0% | 0.1 | |
| *77* | Plastic Combs/hair brushes | OSPAR100_018 | 18 | 0% | 0.1 | |
| *78* | Wooden Crates | OSPAR100_070 | 15 | 0% | 0.1 | |
| *79* | Metal Paint tins | OSPAR100_086 | 15 | 0% | 0.1 | |
| *80* | Medical - Other items (swabs, bandaging etc.) | OSPAR100_105 | 15 | 0% | 0.1 | |
| *81* | Rubber Boots | OSPAR100_050 | 13 | 0% | 0.1 | |
| *82* | Stone Other ceramic/pottery items | OSPAR100_096 | 13 | 0% | 0.1 | |
| *83* | Plastic container: Engine oil > 50 cm | OSPAR100_009 | 12 | 0% | 0.1 | |
| *84* | Sanitary - Condoms | OSPAR100_097 | 12 | 0% | 0.1 | |
| *85* | Plastic Oyster trays (round from oyster cultures) | OSPAR100_029 | 11 | 0% | 0.1 | |
| *86* | All Metal Oil drums | 084+205+206 | 10 | 0% | 0.1 | |
| *87* | Metal Wire, wire mesh, barbed wire | OSPAR100_088 | 10 | 0% | 0.1 | |
| *88* | Metal Other pieces > 50 cm | OSPAR100_090 | 9 | 0% | 0.1 | |
| *89* | Stone Octopus pots | OSPAR100_095 | 9 | 0% | 0.1 | |
| *90* | Plastic Hard hats | OSPAR100_042 | 8 | 0% | 0.1 | |
| *91* | Metal Electric appliances | OSPAR100_079 | 7 | 0% | 0.0 | |
| *92* | Paper Cups | OSPAR100_065 | 4 | 0% | 0.0 | |
| *93* | Paper Bags | OSPAR100_060 | 3 | 0% | 0.0 | |
| *94* | Medical -Syringes | OSPAR100_104 | 3 | 0% | 0.0 | |
| *95* | Plastic Octopus pots | OSPAR100_027 | 2 | 0% | 0.0 | |
| *96* | Plastic Fibre glass | OSPAR100_041 | 2 | 0% | 0.0 | |
| *97* | Wooden Fish boxes | OSPAR100_119 | 2 | 0% | 0.0 | |
| *98* | Metal Fishing weights | OSPAR100_080 | 1 | 0% | 0.0 | |
| *99* | Metal Lobster/crab pots and tops | OSPAR100_087 | 1 | 0% | 0.0 | |
| *100* | Wooden Crab/lobster pots | OSPAR100_071 | 0 | 0% | 0.0 | |
| *101* | Metal Disposable BBQ's | OSPAR100_120 | 0 | 0% | 0.0 | |
| | | **totals** | **60839** | **100 %** | **395** | *100%* |
| | | | | | | |
| | **Items Not used in analysis** | | | | | |
| | Faeces Bagged dog poo | OSPAR100_121 | 1 | | | |
| | Old Category human faeces | OSPAR100_207 | 0 | | | |
| | Old Category dog faeces | OSPAR100_208 | 27 | | | |
| | Paraffin or wax pieces Size range 0–1 cm number/m | OSPAR100_108 | 121 | | | |
| | Paraffin or wax pieces Size range 1–10 cm number/m | OSPAR100_109 | 67 | | | |
| | Paraffin or wax pieces Size range > 10 cm number/m | OSPAR100_110 | 23 | | | |
| | Other pollutant | OSPAR100_111 | 40 | | | |
| | Industrial plastic pellets | OSPAR100_209 | x | | | |
| | | | | | | |

The dominance of synthetic materials is shown in Figure 4 for proportional abundance of the Top-20 items for all items found in all 154 100m-surveys over the full 2002-2012 period. The Top-10 list contains 81% of all items; the top-20 list contains 91%. The non-synthetic items have been drawn a bit out of the main pie, which for the remainder is all synthetic debris. The dominant role of net and rope remains as unquestioned sea based sources is also immediately evident.

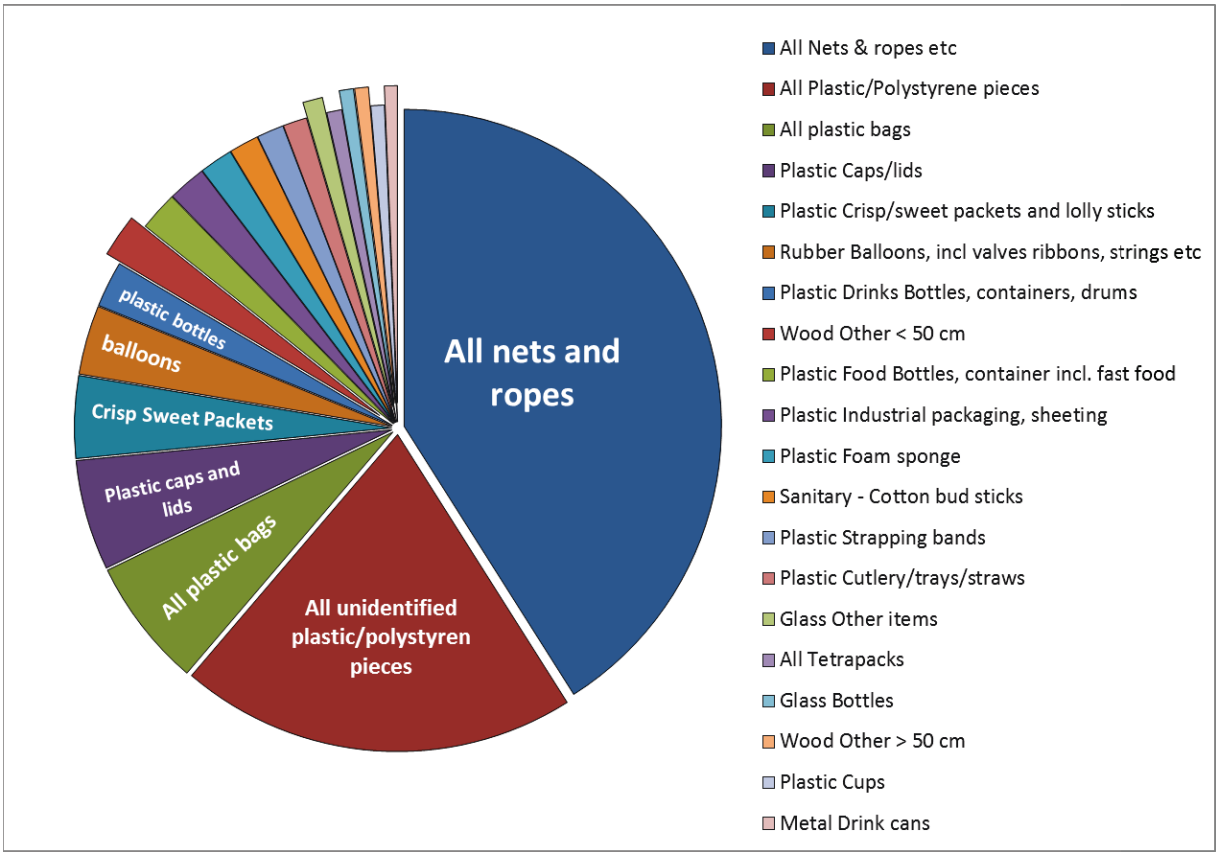



*Figure 4 Proportional abundance by number of Top-20 debris types. (from Table 3; the Top-20 list holds 91% of the number of all 60839 litter items found in during all 154 Dutch 100m-surveys over the monitoring period 2002-2012; pie pieces of non-synthetic materials slightly shifted outward)*

### 3.3 Trend analyses

#### 3.3.1 Total number of items monitored on 100 m; individual beaches and average

The results for trend analyses for total number of items are shown in Table 4. The trend results for the individual beaches are shown; and the average trend result of the four beaches is shown.

*Table 4 Results of linear regressions on the All Debris counts in the 100m OSPAR survey beaches in the Netherlands 2002-2012 (n=154). Constant and Estimate define the regression line, with se representing confidence limits. The t column shows the value for the test statistic, followed by the probability that this result indicates a significant correlation. A significance level of p<0.05 is used, all values higher considered as non-significant (ns), p<0.05 marked *, p<0.01 marked **, and the highly significance level of p<0.001 marked as ***. Increases indicated by ↑ and decreases by ↓ up to probabilities of p=0.25 with symbol ↕ indicating uncertain trends for probabilities greater than p=0.25.*

| **Linear regression results for ALL DEBRIS counts in the Dutch 100m OSPAR survey beaches** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Trends analysed by linear regression of **log transformed individual count data** against year of count | | | | | | | | |
| | items | ***n counts*** | **Constant** | **est** | **se** | **t** | **t pr.** | |
| NL all 4 beaches | All debris | *154* | -6.9 | 0.0063 | 0.0201 | 0.31 | 0.755 | ↕ns |
| all exc Bergen | All debris | *115* | -13.6 | 0.0097 | 0.0219 | 0.44 | 0.659 | ↕ns |
| NL1 Bergen | All debris | *39* | 12.3 | -0.0035 | 0.0366 | -0.10 | 0.924 | ↕ns |
| NL2 Noordwijk | All debris | *38* | -38.8 | 0.0222 | 0.0330 | 0.67 | 0.505 | ↕ns |
| NL3 Veere | All debris | *38* | -139.2 | 0.0723 | 0.0364 | 1.99 | 0.054 | ↑*ns* |
| NL4 Terschellling | All debris | *39* | 138.7 | -0.0661 | 0.0413 | -1.60 | 0.117 | ↓*ns* |

Table 4 clearly show that for the combination of the 4 OSPAR reference beaches in the Netherlands (100m sections) there have been little changes in the total abundance of marine litter averaged for all beaches since 2002. This matches results from monitoring plastics in stomachs of Fulmars from the North Sea (Van Franeker, J.A. & the SNS Fulmar Study Group 2013). However, the table also shows that the situation is not the same on the individual beaches. The two central beaches show indeed no change, but the southern Veere beach has a near significant increase of marine debris (p=0.054) but the northern Terschelling beach tends to a decreasing level of litter (p=0.117).

As a check on validity of these differentiated beach specific trends within the fairly limited distances in the Netherlands, also the 1km all large debris data were tested by linear regressions, with a strongly surprising result of strong declines in large debris items in most places, except for Veere (see Table 5). Proportionally this seems in line with the small 100m debris surveys, in which Veere was the only beach with a near significant increase (see Table 4). A hypothetical explanation for the differences between rates of change of smaller items in the 100m surveys (overall no change since 2002) and larger items in the 1km survey (significant decrease since 2002) could be the increasing level of beach clean activities, in which usually the larger items are removed first. If so, beach cleaning activities are apparently not seriously affecting the amounts of smaller debris recorded in the 100m surveys as the impact from cleaning shortly before a survey is not much different from the variations caused by the many other factors involved (spring tides, variable wind directions and forces, seasonally variable beach activities, sand accumulation/replacement by wind and water etc. Undoubtedly all of these have serious impact on individual count results, but apparently cleaning activity is not dominating over the other factors.

### 3.3.2 Total number of items monitored on 1 km; individual beaches and average

The results for the monitoring of the items >50 cm on 1 km are shown in Table 5 en Figure 5.

*Table 5: Results of linear regressions on the All Large Debris counts in the 1km OSPAR survey beaches in the Netherlands 2002-2012 (n=154).*

| **Linear regression results for ALL LARGE DEBRIS counts in the Dutch 1km OSPAR survey beaches** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Trends analysed by linear regression of **log transformed individual count data** against year of count | | | | | | | | |
| | items | ***n counts*** | **Constant** | **est** | **se** | **t** | **t pr.** | |
| NL all 4 beaches | All large debris | *149* | 175.4 | -0.0854 | 0.0216 | -3.96 | <0.001 | ↓*** |
| all exc Bergen | All large debris | *112* | 153.4 | -0.0743 | 0.0254 | -2.93 | 0.004 | ↓** |
| NL1 Bergen | All large debris | *37* | 233.9 | -0.1146 | 0.0388 | -2.95 | 0.006 | ↓** |
| NL2 Noordwijk | All large debris | *38* | 177.8 | -0.0866 | 0.0432 | -2.01 | 0.052 | ↓ns |
| NL3 Veere | All large debris | *35* | 3.7 | 0.0002 | 0.038 | 0.01 | 0.995 | ↕*ns* |
| NL4 Terschelling | All large debris | *39* | 277 | -0.1358 | 0.0441 | -3.08 | 0.004 | ↓** |

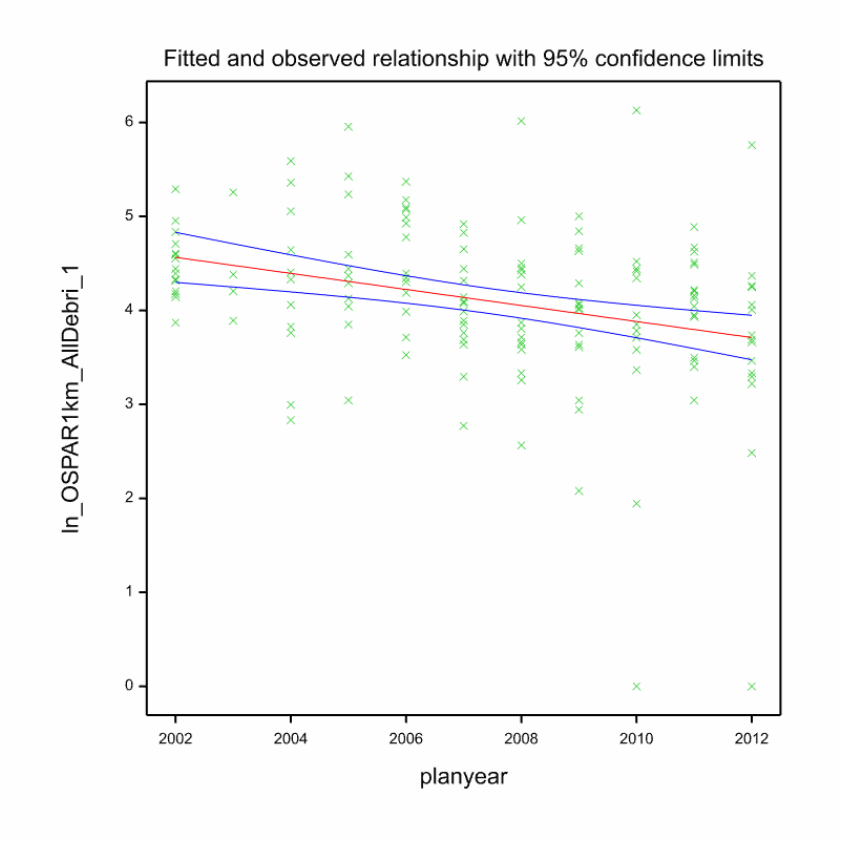



*Figure 5 Dataplot and regression line for all large debris counted in the 1km OSPAR surveys, all beaches 2002-2012 (149 km surveys). The downward trend is highly significant (p<0.001). See Table 5 for details.*

### 3.3.3 Top-10 items on 100 m; average of 4 beaches

The results of the trend analyses of the top-10 analyses are shown in Table 6. Six of the ten top-10 items show significant changes. This confirms the suitability of this monitoring programme to detect changes in specifi litter items; which is very useful for waste management purposes. For example, analysis of trends for abundance of balloons (see Table 6; Figure 6) over this period show a highly significant increase ($p<0.001$). This information sheds new light on the use of balloon releases during festivities on a local and national level.

*Table 6. Trends in Top-10 items or clusters at Dutch beaches over period 2002-2012*

| **Trends analysed by linear regression of log transformed individual count data against year of count (TopTen categories, representing 81% of litter items; Netherlands, 2002-2012; n=154 OSPAR 100m counts)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **item description** | **Constant** | **est** | **se** | **t** | **t pr.** | | ***n/100m*** |
| TopTen_ 01 | All nets and ropes | -86.5 | 0.0454 | 0.0256 | 1.77 | 0.079 | ↑*ns* | *147* |
| TopTen_ 02 | All plastic pieces | -9.5 | 0.0067 | 0.0215 | 0.31 | 0.755 | ↕*ns* | *73* |
| TopTen_ 03 | All plastic bags | 41.4 | -0.0192 | 0.0234 | -0.82 | 0.414 | ↕*ns* | *24* |
| TopTen_ 04 | Plastic caps lids | -133.4 | 0.0677 | 0.0291 | 2.32 | 0.021 | ↑** | *20* |
| TopTen_ 05 | Plastic crips lolly | 92.0 | -0.0447 | 0.0243 | -1.84 | 0.068 | ↓ns | *15* |
| TopTen_ 06 | Balloons | -188.2 | 0.0949 | 0.023 | 4.12 | <.001 | ↑*** | *13* |
| TopTen_ 07 | Plastic Drink Bottles | 125.2 | -0.0614 | 0.0214 | -2.88 | 0.005 | ↓** | *8* |
| TopTen_ 08 | Wood other < 50cm | 293.9 | -0.1455 | 0.0237 | -6.15 | <.001 | ↓*** | *8* |
| TopTen_ 09 | Plastic food bottles | 116.9 | -0.0574 | 0.0228 | -2.52 | 0.013 | ↓** | *7* |
| TopTen_ 10 | Plastic ind pack & sheets | -109.7 | 0.0555 | 0.0264 | 2.10 | 0.037 | ↑** | *7* |
| | **TopTen combined** | **-16.6** | **0.011** | **0.0205** | **0.54** | **0.591** | ↕**ns** | ***322*** |

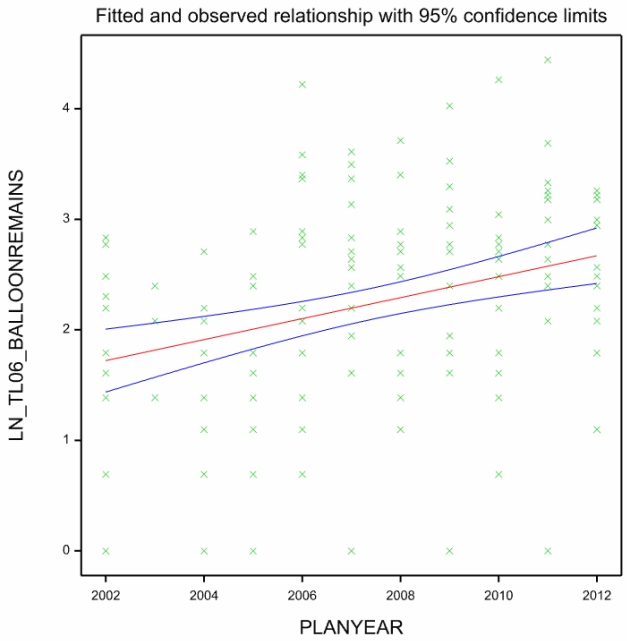



*Figure 6 Example of Top-10 item trend: balloon abundance on Dutch beaches (100m surveys 2002-2012; 154 counts), showing a highly significant increase (p<0.001)..*

### 3.4 Total abundance analyses; 5-year moving average

Erratic inter-annual variations complicate the usage of annual averages (Fig.7A), which is reason to propose the usage of averages based on more data points over longer time periods, such as 5 years. Averaged data over such a period could be used as a reference, or target for EcoQO or GES in terms of absolute abundance.

To nevertheless illustrate changes by year on the basis of 5-year averages, graphs may use 'running' averages for 5 years, each time shifting one year. Subsequent data points thus are based on 4 years of overlapping data, and should only be used as a visual aid to illustrate presence or absence of trends and not as the basis for calculations. As discussed in paragraphs above, statistical significance of trends is assessed on the basis of linear regression of ln-transformed count data from individual surveys, against the year of the surveys.

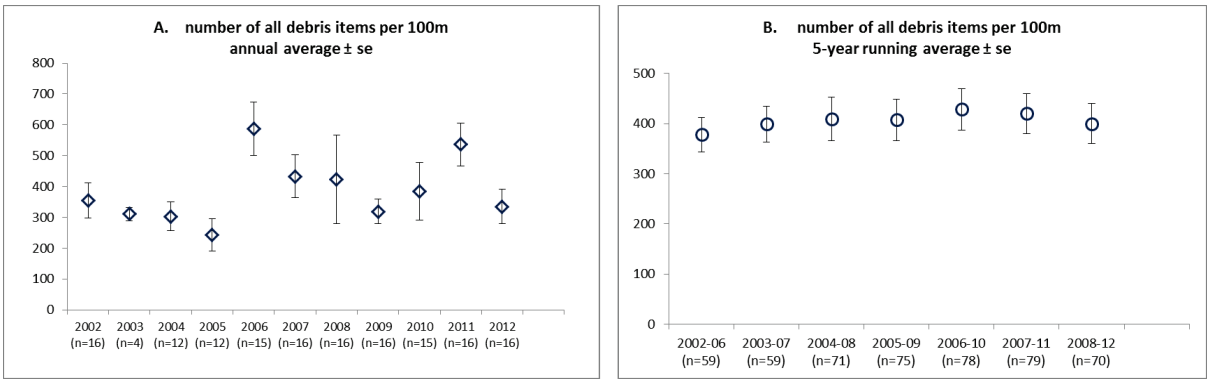
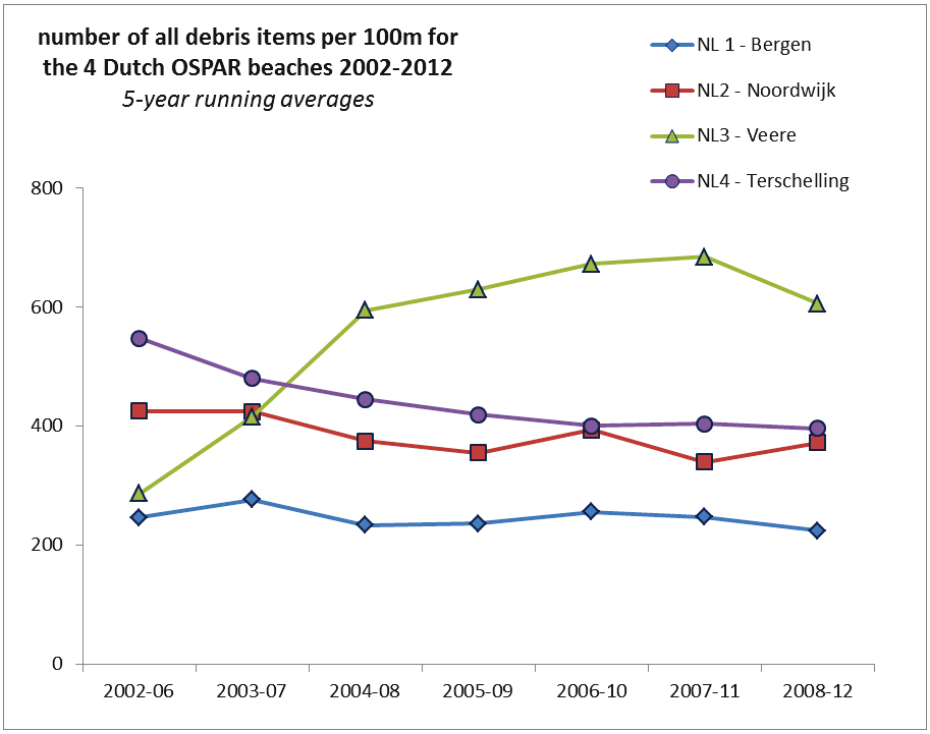



*Figure 7. Data visualisation by data points for A. annual or B. 5-year running arithmetic averages with standard errors; 5-year running averages are calculated from all surveys in the 5 year period (not as the average of annual averages).*

The 5-year moving averages have also been calculated for the four individual beaches, and the results are shown in Figure 8.

*Figure 8. Running 5-year arithmetic averages at the 4 Dutch reference beaches since 2002 showing patterns in all debris abundance (100m surveys). Bars for standard errors not shown for clarity of the graph .Linear regression trend data given in Table 4. None of the trends is significant; but Veere shows a nearly significant increasing trend; and Terschelling suggests a decreasing trend.*



### 3.5 Non-classifiable items and monitoring notes

Several non-classifiable items were found on the reference beaches during the monitoring sessions in 2012 as displayed in table 7. These non-classifiable items are registered in a separate worksheet in the database (Excel file). If a specific items is found regularly in larger numbers, it can be proposed to OSPAR to add to the item list.

*Table 7. Pellets and non-classifiable items found on the Dutch reference beaches in 2012; and monitoring notes.*

| Beach | Year | Season | Non-classifiable items found |
|---|---|---|---|
| Bergen | 2012 | 1 | clinkers, harbor porpoise |
| Bergen | 2012 | 2 | Pellets Yes, 48:flower pot, ignition fuse, purification disk |
| Bergen | 2012 | 3 | Beach cleaned very recently, fresh tracks. Also litter bins on beach |
| Bergen | 2012 | 4 | No remarks |
| Noordwijk | 2012 | 1 | pellets on beach, (48) tie wrap, ear plug, flower pot, ignition fuse, purification disk |
| Noordwijk | 2012 | 2 | pellets yes. (48) ignition fuse, purification disk, handle, power cable |
| Noordwijk | 2012 | 3 | Litter bins on beach, public cleaned the beach, lots of sea based litter in bins, see also photos. 48: door mat, incinerator ash 5x. |
| Noordwijk | 2012 | 4 | 59: tent bag, 33: full gill net |
| Veere | 2012 | 1 | Pellets yes, (48): razor shell ring (mesheft), red plastic ring, flower pot, plaster, square protection plastic piece (packaging), (59): filter, (89): iron nut |
| Veere | 2012 | 2 | Pellets yes, all yellow. 48: tiewrap, ignition fuse,razor shell ring (mesheft), purification disk, flower pot |
| Veere | 2012 | 3 | Pellets yes. 48: ignition fuse, electric resistance/stop. 75: broom |
| Veere | 2012 | 4 | Pellets yes. 48: purification disk, razor shell ring (mesheft), ignition fuse, ear plug |
| Terschelling | 2012 | 1 | Pellets yes, very much!. (48): plastic measuring roller, fireworks, printer, flower pot, teat, broom, hose. Wind power 7, water reached high on the beach. Guillemot (zeekoet) 2x |
| Terschelling | 2012 | 2 | Because of heavy winds, sand dunes all over the beach, covering the surface. 48: toilet soap holder. 59: winter childrens glove |
| Terschelling | 2012 | 3 | Pellets yes. 48: glasses, plug, bags drinking water, feet hygene cover |
| Terschelling | 2012 | 4 | Pellets yes |

## 4. Conclusions and Recommendations

**Conclusions**

The available Dutch OSPAR beach litter monitoring data appear to be effective for the detection of a range of significant trends in the beach litter abundances; using the statistical methods recently developed for beach litter by Van Franeker (2013). More specifically, significant trends in total abundance in the 1000m-data; and in 6 of the 10 top-10 items from the 100m data, were found (see table below). The Top-10 contains 81% of the total item abundance. Differences (non-significant) between the development of total abundance could be observed between the different beaches. These promising results give several options for the effective assessment of Dutch beach litter; and for waste management measures.

*Top 10 most frequently counted items in the Dutch 100m beach surveys during the period 2002-2012 and trends over this time frame (4 reference beaches, each usually surveyed 4 times per year: in total now available 154 surveys; 60839 items counted, average 395 per 100m survey). Trends over time are tested for significance by linear regression of log transformed data of individual counts against the year of survey. A significance level of p<0.05 is used, all values higher considered as non-significant (ns), p<0.05 marked *, p<0.01 marked **, and the highest significance level of p<0.001 marked as ***. Increases indicated by ↑ and decreases by ↓ up to probabilities of p=0.25. The symbol ↕ indicates uncertainty of direction of trend for probabilities greater than p=0.25.*

| RANK | Item or item cluster | % of total | n / 100m | trend |
|---|---|---|---|---|
| **1** | All Nets & ropes etc | 38% | 147.3 | ↑*ns* |
| **2** | All Plastic/Polystyrene pieces | 19% | 72.6 | ↕*ns* |
| **3** | All plastic bags | 6% | 23.6 | ↕*ns* |
| **4** | Plastic Caps/lids | 5% | 20.2 | ↑** |
| **5** | Plastic Crisp/sweet packets and lolly sticks | 4% | 15.1 | ↓ns |
| **6** | Rubber Balloons, incl valves ribbons, strings etc | 3% | 12.7 | ↑*** |
| **7** | Plastic Drinks Bottles, containers, drums | 2% | 8.4 | ↓** |
| **8** | Wood Other < 50 cm | 2% | 7.9 | ↓*** |
| **9** | Plastic Food Bottles, container incl fast food | 2% | 7.1 | ↓** |
| **10** | Plastic Industrial packaging, sheeting | 2% | 7.0 | ↑** |
| | **ALL Debris** | **100%** | **395** | ↕***ns*** |

**Recommendations**

1. In future assessments, it is proposed to describe numbers of debris items on the beaches on the basis of 5-year arithmetic average values with associated standard errors
2. It is proposed to assess significance of trends over time by linear regression of log transformed data from individual counts against year of survey. For 'recent trends' it is recommended to use data from last 10 years of surveys. The same approach of 5-year averages and tests for trends is used in the Fulmar plastic particle EcoQO monitoring by OSPAR.
3. To define targets for EcoQO in OSPAR or Good Environmental Status in the MSFD, policy makers may use either (changes in) 5-year average values or significance levels of trends over time. The desired baselines and targets are a choice for policy makers.
4. It is recommended to set the Dutch EcoQO or GES target on the basis of abundance of ALL beach debris on the combined data for the four Dutch reference beaches. Underlying analyses of specific beaches, particular items, or clusters of items of materials, sources etc. can be used to assist in decisions on priorities of policy actions and measurements of the effect of those actions
5. From the recent study of Van Franeker (2013), it appears that it is not necessary, and even unwise, to discontinue the monitoring of the Bergen beach.
6. The beach at the south point of Texel (*) may be used occasional additional study.
7. It is recommended that RWS Zee and Delta organize the installation of clear signposts on the reference beaches, with texts explaining the research and the request not to remove or deposit litter. Furthermore, no litter bins should be available near these reference beaches.
8. It is recommended to perform a source (land, sea, unknown/uncertain) analysis study; and a material analysis study (plastic and other materials), in 2014. The results of this additional study must be added to the available IMARES Report (Van Franeker, 2013), and finalized into a complete IMARES Beach litter analysis report.
9. It is recommended to start with the occasional monitoring by SDN of the weight of total plastics in 2014 as follows: collect the plastic debris of all net/rope/cord materials in a plastic bag, all other plastics in a second one, and remaining debris in a third, and weigh these on a spring scale.
10. Plastic pellets, also called mermaid tears, are not counted within the BLM protocol. Only the presence of the pellets is recorded. In 2014 a pilot is planned to obtain semi-quantitative pellet data with an efficient method, which has to be defined then. Sieving of pellets will probably be a useful method.

## 6. References

OSPAR 2010. Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area. Edition 1.0. OSPAR Commission, 2010, London, 16pp plus appendices forms and photo guides. http://www.ospar.org/v_publications/download.asp?v1=p00526.

OSPAR Marine Litter Monitoring Survey Form; 100 m (version 2010.10).

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**Appendix 1: Complete Dutch beach monitoring data set for total abundance and top-10 items.**

See separate document.