Survey of methods and data analyses in the Netherlands OSPAR Beach Litter Monitoring program

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photo 1 Jeroen Dagevos and Merijn Hougee of North Sea Foundation (SDN) during the OSPAR Beach Litter survey at the beach of Langevelderslag Noordwijk (NL2), 14 jun 2013. With industrial glove, debris type nr OSPAR100_113

photo 2 small debris is counted and collected during the 100m survey

SUMMARY and MAIN CONCLUSIONS

1. Major effort in this short project had to be dedicated to prepare source data for analysis. Changes introduced in the OSPAR categories in 2010 caused major problems in the Dutch data tables, frustrating reliable analyses and interpretation. These tables have now been corrected to hold the right categories and columns. New data collected by the North Sea Foundation (SDN) should be entered carefully on this basis.
2. It is not known in what shape Dutch data are currently stored in the international OSPAR database, but assuming that the original data-tables for this report were either the source files for, or the output of that database system, it may be useful to consider resubmitting corrected Dutch data, derived from the data tables provided with this report. Datasets from other countries may face similar problems.
3. If anything, the lesson from this project is that the current OSPAR format for standard surveys on long term reference beaches should in principle NOT be changed. Any future changes should be very carefully thought through on all their impacts on the quality of the monitoring data. In general, it seems better to persist in consistent monitoring methodology, even if in theory improvements could be made. Improved or more detailed additional data on top of basic monitoring results may be better achieved by dedicated incidental additional research.
4. In combination with other findings, this leads to the advice against dropping the NL1 Bergen beach from the Dutch monitoring (replacing it by a beach on Texel), and against the introduction of 'national' special categories in data collection within the standard OSPAR surveys. There may be highly useful elements in dedicated, incidental research efforts on other locations, or using other categorisation, but these need not necessarily be (are better NOT) linked to the standard OSPAR surveys.
5. The thought of not using information from the category 'plastic/polystyrene pieces smaller than 2.5 cm' because of detection problems and related data reliability is incorrect at least within the Dutch dataset. Dropping this category would cause bias in data before and after 2010. Collection of field data for these small items AND their use in analyses should be continued in the careful and consistent manner as implemented by the experienced and trained staff of SDN.

Within the data analyses and interpretations of results for this project, not all problems related to the 2010 changes could be fully worked out, and this needs to be a topic of future work. Nevertheless, the dataset holds powerful information, leading to the following initial conclusions:

6. Graphic representation of temporal or location differences, is best given by using arithmetic averaged data with standard errors over five year periods (running averages). A recent 5 year period (e.g. 2008-2012) could well serve as the fixed reference against which to measure achievements in the framework of the MSFD Good Environmental Status.
7. Averaged for 79 100m OSPAR Surveys on the 4 Dutch beaches in the 2008-2012 period, an arithmetic average of 400±39 debris items per 100m was counted (range 23-2308). This easy, clear-cut and single figure could be used as the reference to which to identify a proportional improvement or absolute target figure for the year 2020. Details for specific categories of litter, or for different beaches should (only) be used in the background to identify the major problem issues and priorities for policies, and measuring the effects of those.
8. Assessment of trends, to evaluate whether direction of change is towards targets, is best conducted using linear regression evaluating logarithmic transformed results of individual counts (in principle 16 per year) against the year of the survey. This is similar to the approach used in the Fulmar monitoring for OSPAR and MSFD. The 2002-2012 trend analysis for all debris in the 100m surveys, using data of 154 counts, shows stability and no change ($p=0.38$).
9. However, analysis of the larger debris items, as surveyed in the 1km OSPAR survey, show a highly significant decrease in larger litter items ($p<0.001$). Although various factors may be involved, it is speculated that the difference in smaller versus larger items is largely linked to an increased effort by authorities, NGOs and public in cleaning beaches, in which the larger items are most easily removed. Details of these findings need to be analysed further, but do emphasize need to continue the 1km surveys carefully and consistently alongside the 100m surveys.
10. Analysis shows that quantities of debris and trends are not identical on all beaches. Grosso modo, results suggest that the southern location Veere is not doing well, the northern one at Terschelling seems to be improving, and the central Bergen and Noordwijk locations are relatively stable. However further analysis needs to confirm such details

11. In a Top list of most abundant items recorded on beaches, the total dominance of synthetic debris ('plastics') is clear. Partly due to the changes in 2010, earlier item clusters or labels indicating type of materials or sources may confuse interpretation. Data analyses found to suffer from this bias, e.g. using the standard OSPAR source labels, are not presented in this report. A first proposal to new clustering and material/source labelling is given, but needs careful discussion before being implemented in standard data analyses.
12. To further explore the power of the approach for analyses as proposed in this report, results for the ten most abundant categories were provisionally analysed. The most abundant category of rope and litter shows a non-significant upward trend. However, in some of the smaller categories some remarkable strong trends were found. For example, balloons were recently a hot topic in media around the festivities related to the crowning of king Willem Alexander. Averaged over the 2002-2012 period (154 counts) 12.6 balloons per 100m were recorded. Linear regression analysis shows that within this 11 year period, a highly significant increase in balloon debris has occurred ($p<0.001$), a result that would have been valuable in the recent media discussion and policy decisions. Also of interest is the finding of contrasting trends between decreasing densities of plastic bottles and increasing densities of bottle caps, a phenomenon possibly also related to clean up activities or to the sinking of PET plastics at sea, but not the PE or PP caps.
13. As in monitoring of Fulmar plastic ingestion, tests for trends over time by linear regressions are probably best split into a recent trend (10 years) or the full dataset. Such distinction was not yet made in the analyses in this first report, and all trend analyses were based on the currently available dataset of 11 years (2002-2012)
14. Much remains to be done, but the preliminary results from this initial data survey clearly show good potential of the OSPAR Monitoring approach for scientifically sound and solid data analyses and conclusions as a basis for policy decisions and information to public and media.

In conclusion, for beach litter monitoring in the Netherlands, it is advised to continue the standard OSPAR beach surveys (100m and 1 km) using standard methods and standard categories as established in 2010 on the 4 beaches monitored professionally by staff of SDN since 2002. It is advised to base policy targets on the single figure for all combined debris, using 5 year arithmetic averages with standard error to describe absolute levels of abundance and to analyse trends on the basis of log transformed individual count data against year. Details for sub-categories of debris are essential for specific policy decisions to reduce sources and to monitor of the effect.

photo 3 part of a candy wrapper (ice lolly) OSPAR item nr OSPAR100_019

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photo 4 Willem van Loon (RWS) with an artificial plastic plant (item type OSPAR100_048, 'other plastic-polystyrene items') recovered from the beach during the OSPAR survey at NL2, 14-jun-2013.

1. Introduction

This report is the result of a short evaluation of field practises, data analyses and reporting in the Dutch OSPAR Beach Litter Monitoring program. Since 2002, for most years, Rijkswaterstaat (RWS) Ministry of Infrastructure and the Environment (I&M) have assigned the North Sea Foundation (SDN) the task to survey 4 beaches in the Netherlands, 4 times a year, using the standard methods as agreed in OSPAR (OSPAR 2007, 2010). Results were reported in unpublished annual reports with data prepared for submission to OSPAR by the Ministry.

Tasks requested were to provide an informal report with evaluations and advice on:

MTR1. Participate in 'audit' field methods in a beach survey by SDN

MTR3. Evaluate and advise on item clustering in data analyses, including the option to disregard small particles in the data analyses.

MTR4. Based on best clustering, calculate the currently optimal top-10 item(cluster) list

MTR8. Advise on the option to drop monitoring from the beach at Bergen (NL01, OSPAR Beach ID 21) as the impression is that highly frequent cleaning in recent years reduces its monitoring value, and replace this by a beach on Texel.

MTR10. Advise on methods for data-analysis, suitable for application in MSFD (KRM) evaluations, if possible in line with evaluation methods in the Fulmar monitoring program using regressions to quantify trends, and 5 year running arithmetic averages or geometric means to quantify levels of pollution.

Indicators to analyse:

* total abundance (possibly omitting small pieces because of lowered count reliability)
* total abundance plastics, (in 2014 add possibly plastics mass)
* top-10 abundances based on new clustering
* optional as far as possible in this short project: analysis of sources (by standard OSPAR or revised classification)

MTR12. Comment on the up to now standard mode of Beach Litter Monitoring in reports by SDN and advise on revised format for the 2012 report.

2. Audit of beach fieldwork

On June 14, 2013, field survey methods were observed and discussed during the standard OSPAR beach litter survey for summer 2013 by the North Sea Foundation (Jeroen Dagevos and Merijn Hougee) of the beach at Noordwijk, Langevelderslag (beach NL2; OSPAR Beach ID 22) .

Recommendations based on the fieldaudit AND data analyses in this report:

- **Start and End Points of survey beach sections**

Record high quality GPS locations for Start-points (=fixed beach-pole with marker) AND endpoits of both the 100m stretch and the full km stretch of all four standard beaches. Do so by repeated measurement with modern GPS equipment; calculate endpoints for the 100m and 1000m distances on the basis of GPS coordinates, and compare these in the field to those assessed by e.g. measuring tapes, or beach-poles with identifying marks. Once confident about accuracy, list GPS coordinates for start and end-points in the database, and use where necessary during fieldwork. Best use WGS Lat Lon coordinates with decimals rather than minutes.

- **Debris Removal**

Try to remove **all** debris, including larger items. E.g. also remove larger wood debris, if necessary by simply replacing them up the dune-foot above the strip normally surveyed. Mark remaining items clearly by carving, string of coloured rope or….. other lasting marker methods to avoid inclusion of the same item at the next survey.

- **Small plastic/polystyrence particles < 2.5 cm (OSPAR 100m item nr 117)**

Continue the current mode of field-records of plastic-polystyrene particles < 2.5 cm, as requested by OSPAR (Item nr 117 in OSPAR 100m survey), even if being aware that data become less accurate the smaller items get. Data-analyses will include item nr 117 as omitting them would cause bias in trend analyses using data from before and after 2010 (***see Chpt. 3.3***)

- **Item measurement of size limits**

Carry small rulers or measuring tapes/stick in order to easily and consistently decide on the various size limits in the OSPAR list (1 cm; 2.5 cm, 10 cm, 50 cm). Smaller sizes 1, 2.5 and 10 cm can also be easily marked on the writing board. Estimates by eye are not very accurate (the photograph in OSPAR Guideline (Edition 1.0) page 12, bottom left, is misleading in respect, as the piece shown is

clearly larger than 2.5 cm, and should be replaced, preferably showing an item with a ruler, to emphasize the need to measure size limits.

- **Weighing debris & Mass of items and categories**

Recording debris trends in terms of numbers is a complicated issue, as combined data in numbers can only give the same value to a 1 gram piece of plastic candywrapper and a 4 kg plastic fishbox. Assuming ultimate disintegration of both to microplastic then leads several orders of magnitude different impacts on the environment. This issue even plays in single OSPAR categories, as an entangled rope/cord/net item can represent mass of synthetics between a few grams and 100s of kilograms. The basic method of OSPAR surveys, based on numbers of items, should not be changed, but pilot studies may give an impression of what OSPAR BLM surveys mean in terms of mass. This can be done in special studies, not necessarily linked to the surveys, but incidental inclusion in the surveys could be considered. An option is for example, at the 100m stretches to occasionally 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.
The same line of reasoning is true for assessments of origins of wastes by bar-codes or other identifiers on waste items. This is a usefull source of information, but can be linked to surveys intermittently or just to incidental larger scale other beach surveys or educational clean-ups. There is no need to make this an obligatory part of the standard OSPAR surveys.

- **1km Surveys and Item codes**

The one km survey in OSPAR has many flaws, but nevertheless has powerful information (this report). So for the moment it is certainly recommended to continue the standard 1km surveys, also in cases where the beach seems to be cleaned of larger debris recently. The lesson learned from the methodological changes in 2010 is that one should be extremely cautious to change even details in the methods. For the time being, efforts should be in the analytical phase to link information from 100m and 1km surveys, and maybe related incidental fieldstudies to achieve this. But as for the field surveys, 4 times a year on the 4 Dutch beaches, nothing should be changed with full attention for both the 100m and 1km survey, no matter if conditions (cleaning, windblown…) give the impression that an individual count is of limited use.

- **New item codes, splits in item codes**

The lesson learned from the changes made in the OSPAR data collection in 2010 is (this report!) that it is extremely tricky to make changes in the system, even if methods have known flaws, and improvements seem possible. Changes, if not made extremely cautiously and then maintained for long periods (decades), are more a jeopardy to analysis and interpretation of monitoring data than a benefit. For example, the idea to split the category of drink bottles into a litre/larger and halflitre/smaller category is highly attractive, certainly so in the light of discussions of deposits on bottles in the Netherlands. However, it should be considered that plastic drink bottles occur "only" in about 8 bottles per survey, only part of which would be classifiable in one of the above two extra categories. The statistical power of such split records within the category is likely to be low, and the risk that items are attributed to wrong subcategories fairly high, and risk for errors in data passed on to the international database will increase. The same is true for introducing categories of "new" items to the list. It is therefore NOT recommended to introduce new subcategories in the Dutch data collection system for the standard OSPAR surveys. Stick to the 2010 formats and forms. Issues like the bottle case or new items are best studied in incidental larger scale projects where much higher numbers of items may be collected. If from those the absolute need should arise to change OSPAR methods, this should be implemented in the whole OSPAR group, after careful thought!

- **Concerns about / initiatives against cleaning activities on survey beaches.**

Findings in this report do not show major impact of perceived beach clean activities on results of the 100m surveys, probably they do occur on the 1km survey. Althoug in general, uncontrolled cleaning activities on OSPAR survey beaches should be avoided (by e.g. communicating with local municipalities in timing and location of activities of cleaning and placing rubbish bins and RWS in e.g. placing study beach signs) there is no reason to give this excessive effort, or the skip counts after a specific activity. The Dutch OSPAR monitoring results seem powerful also with regular cleanup activities on the study area and surrounding stretches (which may be of similar impact, and cannot be avoided anyway!)

- **Experienced staff or volunteer effort?**

From oberving the beach survey and seeing the detail and consistency needed in searches and recording items in a standard way on the forms, it is clear how valuable it is that experience staff of North Sea foundation is carefully conducting these surveys in the Netherlands. It is extremely unlikely that volunteers could collect data in a similar consistent way allowing the detailed analyses of abundances and trends as conducted in this report.

3. Data Pre-treatment (data review, clustering, top list)

3.1 Data review and clean-up

This project used the ORIGINAL DATAFILE named ***'24.5.13.BLM.Mastersheet.xlsx'***, as included in email of Jeroen Dagevos 24 May 2013. This sheet contained a table with all data for 100m and 1000m surveys conducted in the Netherlands since 2002, using the item-names and numbers and sequence as in the
In addition structural information on data organisation was used from data-tables in the 2012 NL submission to the OSPAR database as provided by Willem van Loon 5-Jun-2013 ***('OSPAR Data Entry NL_Rest part periode4 2012.zip***') and the OSPAR Survey Item forms as also used in the ***Guide line for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area Edition 1.0.*** *(Data tables in the Access Database are: BeachCode, 100mItemCodes, 1000mItemCodes, 100mSurveys, 1000mSurveys, 100mData, 1000mData)*

It was a highly complicated and time consuming puzzle to find out, evaluate and properly understand, the content of the dataset and fully grasp the implications of the changes made in the OSPAR monitoring categories in 2010, when 10 new category numbers were introduced (nrs 112-121) and 11 old ones were changed in description or deleted.
In the SDN masterfile the 100m dataset included 5 columns no longer existing in the post-2010 data sheets. In a few cases, items had been listed (mostly zeros entered) in these columns after 2010, even if the item code had ceased to exist. Zero values were deleted, numbers transferred to the appropriate category. However, of considerable greater concern, the OSPAR database formats showed that there should be 10 of such columns (OSPAR item nrs 200 to 210). Confusion was understandable because the OSPAR changes in 2010, next to the above mentioned deleted numbers, included sometimes continuation of an existing number but with a different contents after 2010 (e.g. Nr 31 and 32, prior to 2010 represented the counts of Ropes/cord/nets<50m or >50cm, but in 2010 this changed to Rope/Cord >1cm or <1cm diameter; as the identification number had not changed, the North Sea dataset listed counts both before and after 2010, whereas the old data should have been transferred to the new numbers 200 and 201. An attempt to describe the confusing situation in a concise manner is given in *Table 1.*
The earlier mastersheet table ***(sheet '100mOriginal'*** in excel-file to be delivered with this report) now has been completely revised with all relevant changes made, that is transferring the pre-2010 data for items are no longer used after 2010 to the correct columns with item codes 200 to 210 (columns at far right of table on ***sheet '100mJAF'***). Also further corrections were made, e.g. blanks were replaced by zero's where the counted number actually was zero, or vice versa zeros were replaced by blanks where no counts were conducted or texts had been entered (the differentiation blanc or zero is extremely important in data tables and various calculations!).

In the 1km datastructure, similar changes were made by OSPAR in 2010. Three new numbers (22-24) were added to the earlier list of 21 items in the 1km survey. Three old object types were renamed or deleted and were given a new identifier (nrs 90,91,92). The changed or deleted item numbers and/or descriptions and the new numbers were confusingly present in the Dutch mastersheet, with partially old data present under old number in the same column where after 2010 data were entered for the new description. *Table 2* tries to summarize the changes and their consequences. The original mastersheet for the 1 km data was corrected for the changes, as well as for correct usage of zero values and blanks Original data are in ***sheet '1kmOriginal'*** in excel-file to be delivered with this report; corrected data in ***sheet '1kmJAF'***)

Although the datasets are now corrected and formatted for proper further data entry, interpretation of analyses that consider data from before and after 2010 must remain careful, because impacts of the changes made will be present if incorrect cluster combinations are made, or when old associated links to sources or materials are used in comparisons.

Table 1 Review of changes made by OSPAR in its 100m survey in 2010, for items deleted or replaced in the protocol after 2010, and the implications for continued usage of old numbers in data analyses *(yellow marked items appeared in the SDN mastersheet as separate columns under their old now deleted number; others were still included under their old, but continued item number, but thus actually fitting different descriptions before and after 2010. Pre-2010 data were removed from columns affected by such changes and listed under the correct database numbers 200 to 210).*

Database numbers in the 100m survey for items no longer recorded after 2010 (the OSPAR100_ added by van Franeker, to avoid any confusion with separate number systems in eg. the 1000m dataset)	**item description (before 2010)**	**Before 2010 registered under number**	**Notes on continued use of number or its cessation and implications**
OSPAR100_200	Rope/cord/nets < 50 cm	old31	31 continues to exist but description changed to rope>1cm diameter
OSPAR100_201	Rope/cord/nets > 50 cm	old32	32 continues to exist but description changed to cord/string <1cm diameter
OSPAR100_202	Plastic/polystyrene pieces < 50 cm	old46	46 continues, but restricted to pieces >2.5 and <50cm; the smaller pieces are stored separately under new number 117
OSPAR100_203	**Gloves (rubber)**	**old51**	Old number deleted, and items now recorded new number 113 (sorted under de plastic group)
OSPAR100_204	Cartons/Tetrapacks	old62	62 continues, but restricted to non-milk tetrapacks, whereas milk tetrapacks now separately scored under new item nr 118
OSPAR100_205	Oil drums (new not rusty)	old84	84 continues but for all metal oil drums (new and old)
OSPAR100_206	**Oil drums (old/rusty)**	**old85**	85 deleted, but after 2010 all metal oil drums (new and old) registered under the new 84
OSPAR100_207	Human (faeces)	old106	Item completely deleted, that is no longer recorded on forms / in database after 2010
OSPAR100_208	Animal (faeces)	old107	Item completely deleted, that is no longer recorded on forms / in database after 2010 (sort of "replaced" by totally different category nr 121 for 'bagged dog faeces'
OSPAR100_209	Presence of plastic pellets yes/no	x	Is newly introduced, but not a true item code, as only yes/no recorded and not a number of items, cannot be used in quantitative analyses
OSPAR100_210	**Rope/strings (textile)**	**old58**	Item nr deleted, these after 2010 recorded under nr 58, other textiles

Table 2 Review of changes made by OSPAR in its 1km survey in 2010, for items deleted or replaced in the protocol after 2010, and the implications for continued usage of old numbers in data analyses *(yellow marked items appeared in the SDN mastersheet as separate columns under their old now deleted number; others were still included under their old, but continued item number, but thus actually fitting different descriptions before and after 2010. Pre-2010 data were removed from columns affected by such changes and listed under the correct database numbers 200 to 210).*

Database numbers in the 1km survey for items no longer recorded after 2010 (the OSPAR1km_ added by van Franeker, to avoid any confusion with separate number systems in eg. the 100m dataset)	**item description (before 2010)**	**Before 2010 registered under number**	**Notes on continued use of number or its cessation and implications**
OSPAR1km_090	Rope/cord (in 1km survey by definition over > 50 cm in length)	Old 4	Category 4 continues to exist after 2010, but description changed to (NB = extra restriction!) rope>1cm diameter. Thinner ropes longer than 50cm are now listed under new category 23.
OSPAR100_091	Gloves	Old 16	Old 16 in the rubber group no longer in use. This number is completely replaced by new number 22 for the more industrial type of gloves, which is now grouped among plastics, even if the more plastic type of household gloves now seems to be excluded?
OSPAR100_202	Rope (NB of cloth textile type)	Old 19	Old 19 in the textile/cloth group no longer in use. Such items after 2010 probably scored under nr 21 for 'other' large textile-cloth items

In conclusion:

- **It is strongly recommended to use the fully revised table for any future work including the addition of new data (*sheet '100mJAF' and sheet '1kmJAF*'** from the excel file to be delivered with this report)**!**
- Category numbers 200 to 2010 MUST be included in appropriate clustering for data-analyses that include the period before 2010, see various paragraphs on item clustering.
- WARNING Unless in some future stage, one would decide to no longer use the OSPAR Beach Litter data from the monitoring period 2002-2009, any analysis using clustering or using specific items affected by the form/database changes applied in 2010, need to take careful account of, and include the data from, 'obsolete' item categories OSPAR100_200 to OSPAR100_210. because these replace or partly replace now differently named/numbered new categories. Also links to materials and sources can be affected.
- WARNING I do not know how the pre-2010 data were submitted to the overall OSPAR database, but if derived from (or vice versa) from the data as in the mastersheet that I received, the output for various items or clustered categories from that database are likely to contain errors.
- The problems encountered in the current dataset, and the associated risks for errors in data analyses should at the very least be seen as a serious cautioning when considering future modifications of the OSPAR categories/codes and/or database structure. Consistency is of the utmost importance. If not, the interpretation of time related trends, the major background of this monitoring, may be highly restricted. If data changes are really needed, it is absolutely essential to very carefully prepare full comparability and consistency in identifiers used for old and new categories. For example, the continued use of existing category numbers, but changing their content (as in various items in *Table 1)* should be a no-go! Similarly, changing the number for obsolete categories (the newly assigned 200 – 210 numbers) is an unnecessary and highly confusing complication!

3.2 Other comments to OSPAR data records

The OSPAR database uses the same header for item numbers (OSPARID) in both its 100m and in its 1km data-table structure, but the numbers under these headers are not linked! As a consequence, e.g. OSPARID nr 001 in the 100m set refers to 4-6pack yokes, whereas the identical OSPARID nr 001 in the 1000km data refers to (plastic) buoys. Although theoretically still possible, this makes combined types of database queries extremely tricky and prone to errors.

From descriptions for OSPARID's in the 1km data-structure, it seems that the currently used 22 categories all have a sort of match with categories in the 100m structure. For example the 1km OSPARID 001 for (plastic) buoys matches the 100m OSPAR ID 037. It does seem logical that 1km items have their equivalent in the 100m items list, but this makes it even more unclear and confusing that in the 1km data structure different numbers are used, and only for what seems a fairly random selection of items (for all other than the 'other large plastic, wood, metal etc categories). Categories for large glass (eg. TL tubes), ceramics, sanitary and other pollutants are completely missing in the current OSPAR 1km item list, and can only be entered non quantitatively as a note. Thus, the 1km survey methods is very far from ideal, but dropping it or changing methods and item codes have serious consequences that cannot be sufficiently evaluated in this preliminary study to provide a balanced advise.

To avoid confusion in Dutch data-analyses, in the data tables as prepared for this report and associated excel-sheet, item identifiers have been expanded to ensure unique reference. Thus, for the 100m data, the column header for item numbers has been expanded to 'OSPAR100_ID' and in the 1km data to OSPAR1km_ID with item numbers expanded to e.g. OSPAR100_001, OSPAR1km_001 etc. to make unique reference to items and their descriptions.

In addition, the texts for item descriptions in the OSPAR data structure do not include the material description resulting in the same item description recurring several times, eg in the 100m survey protocol *'Crab/Lobster pots'* being used for plastic ones (item 26), wooden ones (item 71) and metal ones (item 87). In the field forms, materials are grouped, and this is not a real problem, but in data analyses isolated categories may be used, in which the lack of material identifiers is at least not easy to the user. Thus, again to avoid confusion in Dutch data-analyses, in the data tables as prepared for this report, the material description has been included in each item description (e.g. to *'Plastic Crab/Lobster pots'* to describe item nr *OSPAR100m_026).* See *Table 3* for numbers and descriptions in the Dutch data analysis of the 100m surveys of this report, including labels for material or source clustering.
Full details of these, with the original OSPAR tables and SDN mastersheet, as well as possible linkage of item codes in the 100m survey to those in the 1km data recording system are additionally shown in the spreadsheet delivered with this report, in ***sheet 'JAF-itemtable'***.

Unless specifically indicated otherwise, data analyses and discussions refer to the 100m survey results.

Some item codes from the OSPAR 100m item list have been completely omitted from analyses (exclusion indicated in table *Table 3*):

- Pollutants under nrs OSPAR100_108 to OSPAR100_111 for paraffin like or other pollutants e.g. oily, palmoil etc wastes on the beach have been omitted. These are not always easily and consistently identified, and generally not considered as 'litter' or 'debris' but as chemical pollution. In policy terms they are certainly addressed through other channels, for example in international shipping regulations under MARPOL, debris or litter is addressed in MARPOL Annex V, whereas unpacked oily or chemical wastes are dealt with in Annexes I and II.
- Faeces items are excluded from because changes made in 2010 prevent any comparability over time. Nr OSPAR100_121 was a new category only introduced in 2010, and at the same time OSPAR100_207 (=former 106 for human faeces) and OSPAR100_208 (former 107 for animal faeces) were completely deleted. A 'faeces' cluster before and after 2009 would thus be totally different, and data cannot be used in any higher clustering.
- Presence/absence of industrial granules OSPAR100_209 is not included in the analysis. This is more a note field (just recording yes or no present) than quantitative data.

The grouping 'All debris' in the 100m analyses contains ALL items from the table, except those as specified as excluded here.

Table 3 Item numbers, descriptions and options for material or source clusters in the 100m surveys. Analyses in this report referring to 'all debris' contain all items in this list, except for those marked 0 in column 'exclude analyses'. Item classifications by OSPAR are preceded by OSP_ or OSJ (where few blanks in OSPAR list were filled in this report), or SDN_. Proposed new material or source clusters to be discussed in next phases are preceded by label 'JAF_…'.

OSPAR100_ID	JAF_ItemName	exclude analyses	OSP_Mat	JAF_MAT	OSJ_Source	sourceadd JAF	SDN_Source	JAF_Source _1	JAF_Source_2
OSPAR100_001	*Plastic* 4/6-pack yokes		**Pla**	Synth	Tourism		T	Mix	Mix
OSPAR100_002	Plastic Bags (shopping)		**Pla**	Synth	Tourism		T	Land	Recr
OSPAR100_003	Plastic bags, small e.g., freezer bags		**Pla**	Synth	Tourism		T	Mix	Mix
OSPAR100_004	Plastic Drinks Bottles, containers, drums		**Pla**	Synth	Tourism		T	Mix	Mix
OSPAR100_005	Plastic Cleaner Bottles, containers, drums		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_006	Plastic Food Bottles, container incl. fast food		**Pla**	Synth	Tourism		T	Mix	Mix
OSPAR100_007	Plastic Cosmetics bottles and containers		**Pla**	Synth	Tourism		T	Land	Recr
OSPAR100_008	Plastic container: Engine oil <50 cm		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_009	Plastic container: Engine oil > 50 cm		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_010	Plastic Jerry cans (square containers with handle)		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_011	Plastic Injection gun containers		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_012	Plastic other bottle/container/drum		**Pla**	Synth	Other		O	Sea	Ship
OSPAR100_013	Plastic Crates (not fishbox see OSPAR100-ID 034)		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_014	Plastic Car parts		**Pla**	Synth	Other		O	Sea	Ship
OSPAR100_015	Plastic Caps/lids		**Pla**	Synth	Other		**T**	Mix	Mix
OSPAR100_016	Plastic Cigarette lighters		**Pla**	Synth	Other		**T**	Mix	Mix
OSPAR100_017	Plastic Pens		**Pla**	Synth	Other		**T**	Land	Recr
OSPAR100_018	Plastic Combs/hair brushes		**Pla**	Synth	Tourism		T	Land	Recr
OSPAR100_019	Plastic Crisp/sweet packets and lolly sticks		**Pla**	Synth	Tourism		T	Land	Recr
OSPAR100_020	Plastic Toys & party poppers		**Pla**	Synth	Tourism		T	Land	Recr
OSPAR100_021	Plastic Cups		**Pla**	Synth	Tourism		T	Mix	Mix
OSPAR100_022	Plastic Cutlery/trays/straws		**Pla**	Synth	Tourism		T	Mix	Mix
OSPAR100_023	Plastic Fertiliser/animal feed bags		**Pla**	Synth	Shipping		S	Land	Agri
OSPAR100_024	Plastic Mesh vegetable bags		**Pla**	Synth	Other		**S**	Sea	Ship
OSPAR100_025	Plastic Gloves (household, washing up rubber gloves)		**Pla**	Synth	Fishing		V	Mix	Mix
OSPAR100_026	Plastic Crab/lobster pots		**Pla**	Synth	Fishing		V	Sea	Fish
OSPAR100_027	Plastic Octopus pots		**Pla**	Synth	Fishing		V	Sea	Fish
OSPAR100_028	Plastic Oyster nets and Mussel bags incl stoppers		**Pla**	Synth	Fishing		V	Sea	Fish
OSPAR100_029	Plastic Oyster trays (round from oyster cultures)		**Pla**	Synth	Fishing		V	Sea	Fish

OSPAR100_ID	JAF_ItemName	exclude analyses	OSP_Mat	JAF_MAT	OSJ_Source	sourceadd JAF	SDN_Source	JAF_Source _1	JAF_Source_2
OSPAR100_030	Plastic sheeting from mussel culture (**Tahitians**)		**Pla**	Synth	Fishing		V	Sea	Fish
OSPAR100_031	Plastic Rope (diameter more than 1cm)		**Pla**	Synth	Shipping	*	**V**	Sea	Ship
OSPAR100_032	Plastic String and cord (diameter less than 1cm)		**Pla**	Synth	Shipping	*	**V**	Sea	Ship
OSPAR100_033	Plastic Tangled nets/cord		**Pla**	Synth	Fishing		V	Sea	Ship
OSPAR100_034	Plastic Fish boxes		**Pla**	Synth	Fishing		V	Sea	Fish
OSPAR100_035	Plastic Fishing line (angling)		**Pla**	Synth	Fishing		**T**	Land	Recr
OSPAR100_036	Plastic Light sticks (tubes with fluid)		**Pla**	Synth	Fishing		V	Sea	Fish
OSPAR100_037	Plastic Floats/Buoys		**Pla**	Synth	Other		O	Sea	Fish
OSPAR100_038	Plastic Buckets		**Pla**	Synth	Other		O	Sea	Ship
OSPAR100_039	Plastic Strapping bands		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_040	Plastic Industrial packaging, sheeting		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_041	Plastic Fibre glass		**Pla**	Synth	Other		O	Sea	Ship
OSPAR100_042	Plastic Hard hats		**Pla**	Synth	Shipping		S	Sea	Ship
OSPAR100_043	Plastic Shotgun cartridges		**Pla**	Synth	Shipping		**O**	Land	Recr
OSPAR100_044	Plastic Shoes/sandals		**Pla**	Synth	Tourism		T	Sea	Ship
OSPAR100_045	Plastic Foam sponge		**Pla**	Synth	Other		**S**	Mix	Mix
OSPAR100_046	Plastic/polystyrene pieces 2.5 cm > < 50cm		**Pla**	Synth	Other	*	**O**	Mix	Mix
OSPAR100_047	Plastic/polystyrene pieces > 50 cm		**Pla**	Synth	Other		O	Mix	Mix
OSPAR100_048	Plastic Other plastic/polystyrene items		**Pla**	Synth	Other		O	Mix	Mix
OSPAR100_049	Rubber Balloons, incl valves ribbons, strings etc		**Rub**	Synth	Tourism		T	Land	Recr
OSPAR100_050	Rubber Boots		**Rub**	Synth	**Tourism**		**S**	Sea	Ship
OSPAR100_052	Rubber Tyres and belts		**Rub**	Synth	Shipping		S	Mix	Mix
OSPAR100_053	Rubber other pieces		**Rub**	Synth	Other		O	Mix	Mix
OSPAR100_054	Cloth-Textile - Clothing		**Clo**	Synth	**Tourism**		**O**	Mix	Mix
OSPAR100_055	Cloth-Textile - Furnishing		**Clo**	Synth	Other		O	Mix	Mix
OSPAR100_056	Cloth-Textile - Sacking		**Clo**	Synth	Other		O	Mix	Mix
OSPAR100_057	Cloth-Textile - Shoes (leather)		**Clo**	Synth	Tourism		T	Sea	Ship
OSPAR100_059	Cloth-Textile - Other textiles		**Clo**	Synth	Other		O	Sea	Ship
OSPAR100_060	Paper Bags		**Pap**	Paper	**Other**		**T**	Land	Recr
OSPAR100_061	Paper Cardboard		**Pap**	Paper	Other		O	Mix	Mix
OSPAR100_062	Paper Cartons/Tetrapack (others)		**Pap**	Paper	Tourism	*	**T**	Mix	Mix
OSPAR100_063	Paper Cigarette packets		**Pap**	Paper	Tourism		T	Land	Recr
OSPAR100_064	**Paper Cigarette butts**		**Pap**	Synth	Tourism		T	**Land**	**Recr**

OSPAR100_ID	JAF_ItemName	exclude analyses	OSP_Mat	JAF_MAT	OSJ_Source	sourceadd JAF	SDN_Source	JAF_Source _1	JAF_Source_2
OSPAR100_065	Paper Cups		**Pap**	Paper	Tourism		T	Mix	Mix
OSPAR100_066	Paper Newspapers & magazines		**Pap**	Paper	Tourism		T	Land	Recr
OSPAR100_067	Paper Other items		**Pap**	Paper	**Other**		**T**	Land	Recr
OSPAR100_068	Wood - Corks		**Woo**	Wood	Tourism		T	Mix	Mix
OSPAR100_069	Wood Pallets		**Woo**	Wood	Shipping		S	Sea	Ship
OSPAR100_070	Wooden Crates		**Woo**	Wood	Shipping		S	Sea	Ship
OSPAR100_071	Wooden Crab/lobster pots		**Woo**	Wood	Fishing		V	Sea	Fish
OSPAR100_072	Wooden Ice lolly sticks/chip forks		**Woo**	Wood	Tourism		T	Land	Recr
OSPAR100_073	Wooden Paint brushes		**Woo**	Wood	Shipping		S	Sea	Ship
OSPAR100_074	Wood Other < 50 cm		**Woo**	Wood	Other		O	Mix	Mix
OSPAR100_075	Wood Other > 50 cm		**Woo**	Wood	Other		O	Mix	Mix
OSPAR100_076	Metal Aerosol/Spray cans		**Met**	Metal	Shipping		S	Sea	Ship
OSPAR100_077	Metal Bottle caps		**Met**	Metal	Tourism		T	Land	Recr
OSPAR100_078	Metal Drink cans		**Met**	Metal	Tourism		T	Mix	Mix
OSPAR100_079	Metal Electric appliances		**Met**	Metal	**Tourism**		**O**	Mix	Mix
OSPAR100_080	Metal Fishing weights		**Met**	Metal	**Fishing**		**T**	Land	Recr
OSPAR100_081	Metal Foil wrappers		**Met**	Metal	Tourism		T	Mix	Mix
OSPAR100_082	Metal Food cans		**Met**	Metal	Tourism		T	Land	Recr
OSPAR100_083	Metal Industrial scrap		**Met**	Metal	Other		O	Land	Mix
OSPAR100_084	Metal Oil drums		**Met**	Metal	Shipping		**S**	Sea	Ship
OSPAR100_086	Metal Paint tins		**Met**	Metal	Shipping	*	S	Sea	Ship
OSPAR100_087	Metal Lobster/crab pots and tops		**Met**	Metal	Fishing		V	Sea	Fish
OSPAR100_088	Metal Wire, wire mesh, barbed wire		**Met**	Metal	Other		O	Land	Mix
OSPAR100_089	Metal Other pieces < 50 cm		**Met**	Metal	Other		O	Mix	Mix
OSPAR100_090	Metal Other pieces > 50 cm		**Met**	Metal	Other		O	Mix	Mix
OSPAR100_091	Glass Bottles		**Gla**	Glass	**Other**		T	Mix	Mix
OSPAR100_092	Glass Light bulbs/tubes		**Gla**	Glass	Shipping		S	Sea	Ship
OSPAR100_093	Glass Other items		**Gla**	Glass	Other		O	Mix	Mix
OSPAR100_094	Stone Construction material e.g. tiles		**Cer**	Stone	Other		O	Land	Mix
OSPAR100_095	Stone Octopus pots		**Cer**	Stone	Fishing		V	Sea	Fish
OSPAR100_096	Stone Other ceramic/pottery items		**Cer**	Stone	Other		O	Mix	Mix
OSPAR100_097	Sanitary - Condoms		**San**	Synth	Sanitation		R	Mix	Mix
OSPAR100_098	Sanitary - Cotton bud sticks		**San**	Synth	Sanitation		R	Mix	Mix

OSPAR100_ID	JAF_ItemName	exclude analyses	OSP_Mat	JAF_MAT	OSJ_Source	sourceadd JAF	SDN_Source	JAF_Source _1	JAF_Source_2
OSPAR100_099	Sanitary - towels/panty liners/backing strips		**San**	Synth	Sanitation		R	Land	Mix
OSPAR100_100	Sanitary - Tampons and tampon applicators		**San**	Synth	Sanitation		R	Land	Mix
OSPAR100_101	Sanitary - Toilet fresheners		**San**	Synth	Sanitation		R	Sea	Ship
OSPAR100_102	Sanitary - Other items		**San**	Synth	Sanitation		R	Mix	Ship
OSPAR100_103	Medical - Containers/tubes		**Med**	Synth	Sanitation		R	Sea	Ship
OSPAR100_104	Medical -Syringes		**Med**	Synth	Sanitation		R	Sea	Ship
OSPAR100_105	Medical - Other items (swabs, bandaging etc.)		**Med**	Synth	Sanitation		R	Sea	Ship
OSPAR100_108	Paraffin or wax pieces Size range 0–1 cm number/m	**0**	**Opo**	Paraf	**Other**		**S**	Sea	Ship
OSPAR100_109	Paraffin or wax pieces Size range 1–10 cm number/m	**0**	**Opo**	Paraf	**Other**		**S**	Sea	Ship
OSPAR100_110	Paraffin or wax pieces Size range > 10 cm number/m	**0**	**Opo**	Paraf	**Other**		**S**	Sea	Ship
OSPAR100_111	Other pollutant	**0**	**Opo**	Other	**Other**		**S**	Sea	Ship
OSPAR100_112	**Plastic bag ends**		**Pla**	**Synth**	Tourism	*	**T**	**Sea**	**Ship**
OSPAR100_113	**Plastic** Glove industrial/professional rubber gloves		**Rub**	**Synth**	**Fishing**		**S**	**Sea**	**Fish**
OSPAR100_114	**Plastic Lobster and cod tags**		**Pla**	**Synth**	Fishing	*	**V**	**Sea**	**Fish**
OSPAR100_115	**Plastic Nets and pieces of net < 50 cm**		**Pla**	**Synth**	Shipping	*	**V**	**Sea**	**Fish**
OSPAR100_116	**Plastic Nets and pieces of net > 50 cm**		**Pla**	**Synth**	Shipping	*	**V**	**Sea**	**Fish**
OSPAR100_117	**Plastic/polystyrene pieces 0 - 2.5 cm**		**Pla**	**Synth**	Other	*	**O**	**Mix**	**Mix**
OSPAR100_118	**Paper Cartons/Tetrapack Milk**		**Pap**	**Paper**	Tourism	*	**T**	**Mix**	**Mix**
OSPAR100_119	**Wooden Fish boxes**		**Woo**	Wood	Fishing	*	**V**	Sea	Fish
OSPAR100_120	**Metal Disposable BBQ's**		**Met**	Metal	Tourism	*	**T**	Land	Recr
OSPAR100_121	**Faeces Bagged dog poo**	**0**	**Fae**	**Faeces**	Sanitation		**T**	**Land**	**Recr**
OSPAR100_200	**Old category - Rope/cord/nets < 50 cm**		**Pla**	Synth	Fishing		*S*	**Sea**	**Ship**
OSPAR100_201	**Old category -Rope/cord/nets > 50 cm**		**Pla**	Synth	Fishing		*S*	**Sea**	**Ship**
OSPAR100_202	**Old category -**Plastic/polystyrene pieces < 50 cm		**Pla**	Synth	Other		*S*	**Mix**	**Mix**
OSPAR100_203	**Old category -Gloves**		**Rub**	Synth	**Fishing**		*S*	**Sea**	**Ship**
OSPAR100_204	**Old category -Cartons/Tetrapacks**		**Pap**	Paper	Tourism		*O*	**Mix**	**Mix**
OSPAR100_205	**Old category -Oil drums (new not rusty)**		**Met**	Metal	Shipping		*O*	**Sea**	**Ship**
OSPAR100_206	**Old category -Oil drums (old/rusty)**		**Met**	Metal	**Shipping**		***S***	**Sea**	**Ship**
OSPAR100_207	**Old category -Human**	**0**	**Fae**	**Faeces**	Sanitation		***S***	**Land**	**Recr**
OSPAR100_208	**Old category -Animal**	**0**	**Fae**	**Faeces**	Sanitation		***T***	**Land**	**Recr**
OSPAR100_209	**Presence of plastic pellets yes/no**	**0**						**Mix**	**Mix**
OSPAR100_210	**Old category -Textile Rope/strings**		**Clo**	Synth	**Other**		*S*	**Sea**	**Ship**

OSPAR clusters for materials (plastic, rubber, paper, wood, textile, metal, glass, ceramic, sanitary, medical and paraffin/other-pollutant and and sources (shipping, fishing, tourism, sanitation and other) have been indicated in the above table. These are not ideal, because already the materials list is partly more source related than material (sanitary, medical), and sources often questionable. In addition in initial analyses, it was learned that the category changes made in 2010 also impact data evaluations based on clusters. OSPAR clusters were not always same as often used by North Sea Foundation for the Dutch reports. *Table 3* also gives a preliminary proposal for alternative clustering of items, but these need to be very carefully thought of for their impacts on various types of data analysis, especially when these include data from before and after year 2010.
The usage of the material label 'plastic' in the OSPAR system is confusing as for example polystyrene IS a plastic, most materials that we describe as rubber are in fact largely synthetic (=plastic); clothing textile is largely of polyamids and nylons, so plastics. And as indicated, the labelling of materials as sanitary or medical makes no sense. For these reasons, currently just for internal Dutch analyses, the alternative column (JAFMAT) uses the broader indicator 'synthetic' for plastic. But this is only a 'sorting label' in a data-table, and texts on data clusters based on that sorting label can make its meaning as 'plastic' clear with notes on the difference with the OSPAR usage of that word.

3.3 Evaluation of usage of OSPAR Item nr 117 (plastic/polystyrene pieces < 25mm)

It was asked to consider the option to omit *'plastic/polystyrene pieces smaller than 2.5cm'* (OSPAR Item nr 117) out of data analyses and maybe field surveys. This category was specified in 2010, and in combination with a category of pieces between 2.5 and 50cm (revised OSPAR item 046) it replaced the old OSPAR Item 046 which was used prior to 2010 for all pieces <50cm. When category 117 was introduced, the pre-2010 data for 046 were reattributed to the 'obsolete' category OSPAR Item Nr 202.
This suggestion to maybe leave out data for the new number 117 was triggered by the fact that this seemed to be a new category, forcing observers to give higher attention to small particles on the beach leading to bias in comparisons pre- and post 2010 for the combination of all pieces <50cm (Item 202 before 2010; compared to sum of items 177+new046 for later years).
An additional complication with usage of the new 177 category is the fact that it emphasizes that it is unclear what the lower size limit should be and the complications in detectability of different colours and shapes and material types in the smaller size ranges.
At evaluation of the Dutch dataset, it became clear that the reattribution of categories for pieces of plastic/polystyrene, had not seriously changed the overall numbers recorded by Dutch observers (*Figure 1*;*Table 4*). Although the similarity in averages pre- and post 2010 provides no real evidence, the additional lack of a clear change between 2009 and 2010 in the graph plotting individual data shows the consistency in observations, now split over 2 categories starting 2010.

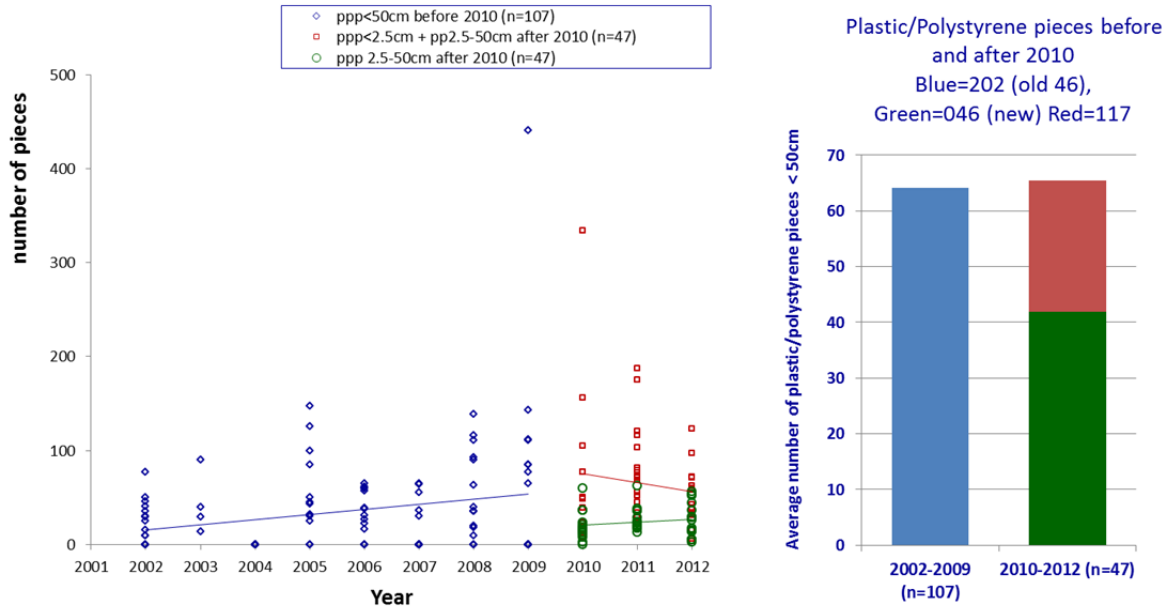

Figure 1 **Abundance of plastic & polystyrene pieces < 50 cm per 100 m beach, before and after split between pieces <25mm and pieces 25><500mm in 2010. Red datapoints in the left graph are for the sum of items < 2.5cm plus the ones between 2.5 and 50cm. NB Regression lines only shown to indicate approximate levels.**

Table 4 Category averages for plastic/polystyrene pieces under 50cm, before and after 2010

ppp = plastic & polystyrene pieces	Avg ± se	OSPAR100_ItemNr
ppp<50cm before 2010 (n=107)	**64.2 ± 6.2**	**202 (= old 046)**
ppp < 2.5cm after 2010 (n=47)	41.9 ± 7.8	117
ppp 2.5-50cm after 2010 (n=47)	23.5 ± 15.5	046 (new)
ppp<2.5cm + pp2.5-50cm after 2010 (n=47)	**65.5 ± 8.6**	**117 + 046 (new)**

In conclusion, it would be unwise to drop category OSPAR100_117 from the Dutch data analysis. Also, the proven consistency of data before and after 2010 in this respect, indicates that there is no need to change field methods for continued records for the plastic/polystyrene pieces. The findings do emphasize the importance of field work being conducted by the same experienced observers.
Cautionary notes:

- As long as data analyses include data from before 2010, data MUST be clustered as the sum of items in categories 202+046+117 and cannot be conducted for any of these separately. Only when analyses are restricted to the period 2010 and later, items 046 and 117 may be analysed in separation
- This finding for the Dutch data does not necessarily apply for the larger international OSPAR dataset. In the Netherlands, the same experienced observers did the fieldwork and did not change their mode of searching smaller items. However, it cannot be assumed that less experienced or changing teams of observers elsewhere have used a consistent search mode after the introduction of the new 117 category in 2010. Comparability of the old 046 category (now named 202 in the database) with the new 046 plus 117 categories should be evaluated for the different countries in order to be able to analyse trends over time.

4. Practical item clustering and top-10 of items

For advise on a 'Top-ten-list' of debris types, it was requested to first consider clustering of categories with unclear subdivisions, especially so when affected by the changes made in the OSPAR numbers and descriptions in 2010. Clusters considered essential in this respect have been specified in ***Table 5*** and this concerns seven clusters of all rope & netlike materials, all unidentified plastic/polystyrence pieces (including the small ones), all plastic bags, all tetrapacks, all rubber/synthetic work gloves, all metal oil drums and all 'other' cloth/textile items.

Using these clusters as items in a rank list for all debris found over the 2002-2012 period (154 100m-surveys; total number of debris items counted 60839) gives results as in ***Table 6.***

Compared to the Top-ten list provisionally prepared by North Sea Foundation based on only data from year 2012 in the Excel mastersheet provided, the all data list is the same for 7 out of 10 items. Rank numbers 7, 8 and 9 of the all data ranking were not in the single year list but those ranked as ranked numbers 11, 12 and 13. Thus there seems to be good consistency over the years in the most abundant

The overwhelming importance of synthetic materials is shown in ***Figure 2*** 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-20 list holds 91% of all items. 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.

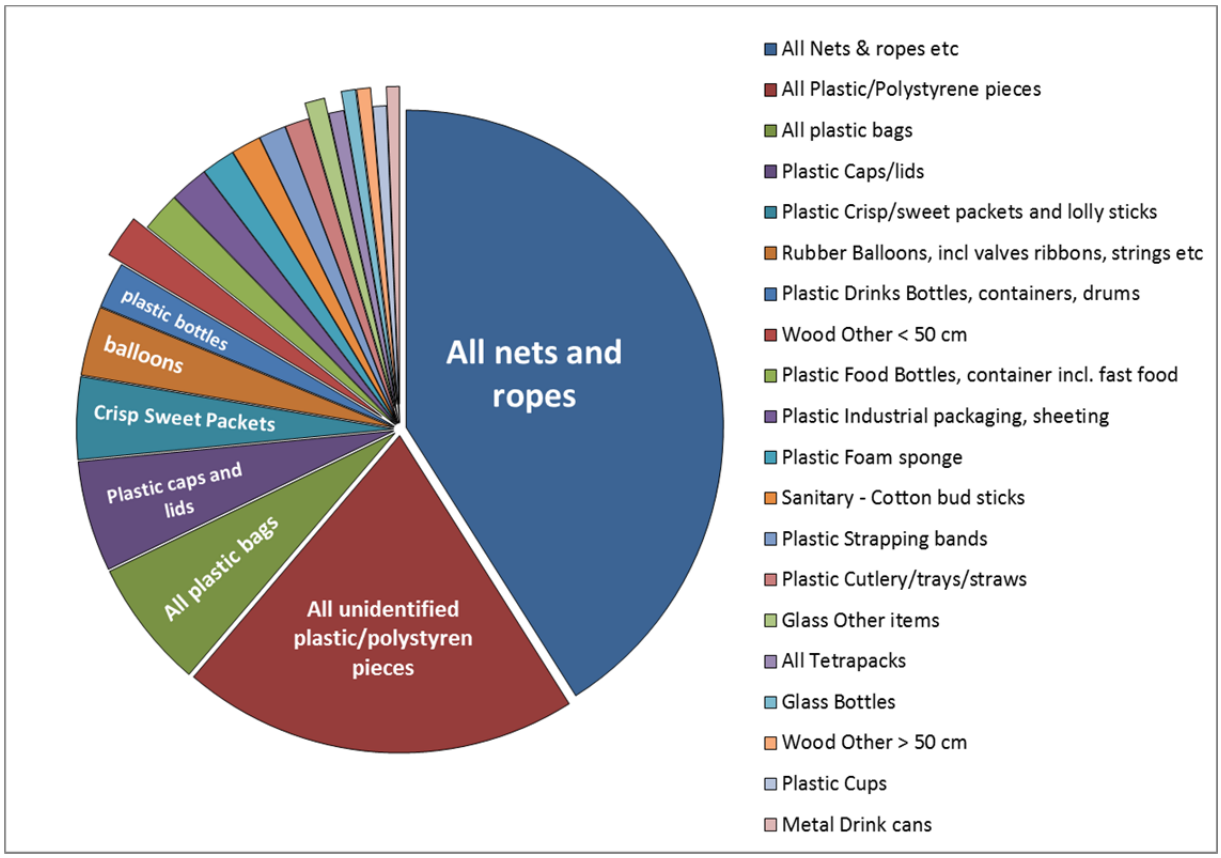

Figure 2 **Proportional abundance by number of Top-20 debris types** (from *Table 6;* the Top-20 list holds 91% of the number of all 60839 litter items found in during all 154 Dutch 100m-surveys over the monitoring period 2002-2012; pie pieces of non-synthetic materials slightly shifted outward)

Table 5 **Initial clustering before ranking of top 10 most abundant types of debris on Dutch Beaches** (data from full 2002-2012 period of 100m surveys in the Netherlands, total number of surveys 154, total number of counted items 60389, see also **Table 6**).

Description	OSPAR100_ID	*n*
Plastic Rope (diameter more than 1cm)	OSPAR100_031	631
Plastic String and cord (diameter less than 1cm)	OSPAR100_032	4750
Plastic Tangled nets/cord	OSPAR100_033	2214
Plastic Nets and pieces of net < 50 cm	OSPAR100_115	1585
Plastic Nets and pieces of net > 50 cm	OSPAR100_116	236
Old category - Rope/cord/nets < 50 cm	OSPAR100_200	11577
Old category -Rope/cord/nets > 50 cm	OSPAR100_201	1684
All Nets & ropes etc	**=31+32+33+115+116+200+201**	**22677**
Plastic/polystyrene pieces 0 - 2.5 cm *	OSPAR100_117	1971
Plastic/polystyrene pieces 2.5 cm > < 50cm	OSPAR100_046	1106
Plastic/polystyrene pieces > 50 cm	OSPAR100_047	329
Plastic Other plastic/polystyrene items	OSPAR100_048	906
Old category -Plastic/polystyrene pieces < 50 cm	OSPAR100_202	6868
All Plastic/Polystyrene pieces (inc 'other')	**=46+47+48+202**	**11180**
Plastic Bags (shopping)	OSPAR100_002	1696
Plastic bags, small e.g., freezer bags	OSPAR100_003	1936
All plastic bags	**=002+003**	**3632**
Paper Cartons/Tetrapack (others)	OSPAR100_062	79
Paper Cartons/Tetrapack Milk	OSPAR100_118	48
Old category -Cartons/Tetrapacks	OSPAR100_204	299
Tetrapacks	**=062+118+204**	**426**
Old category -Gloves	OSPAR100_203	98
Plastic Gloves (household, washing up rubber gloves)	OSPAR100_025	66
Plastic Gloves (industrial/professional rubber gloves)	OSPAR100_113	29
All synthetic work gloves (rubber, plastic)	**= 025+113+203**	**193**
Metal Oil drums	OSPAR100_084	6
Old category -Oil drums (new not rusty)	OSPAR100_205	0
Old category Oil drums (old/rusty)	OSPAR100_206	4
All Metal Oil drums	**=084+205+206**	**10**
Old category - textile Rope/strings	OSPAR100_210	46
Cloth-Textile - Other textiles	OSPAR100_059	224
All other cloth-textile	**=059+210**	**271**

Table 6 **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, see also**Table 5**).

Table 5

RANK	Item or item cluster	OSPAR-100-ID	count	% of total	n / 100 m	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	
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	

RANK	Item or item cluster	OSPAR-100-ID	count	% of total	n / 100 m	Cumula -tive %
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	
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	

RANK	Item or item cluster	OSPAR-100-ID	count	% of total	n / 100 m	Cumula -tive %
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			

5. Total Abundance Analysis

Data for the total abundance of marine debris items, as derived from the counts in the standard 100m OSPAR surveys over the 4 Dutch beaches and the period 2002-2012, will be used to illustrate the approach in data analysis. In earlier reports, data were usually presented as numbers of items encountered, or at best as arithmetic average data as in ***Figure 3.***

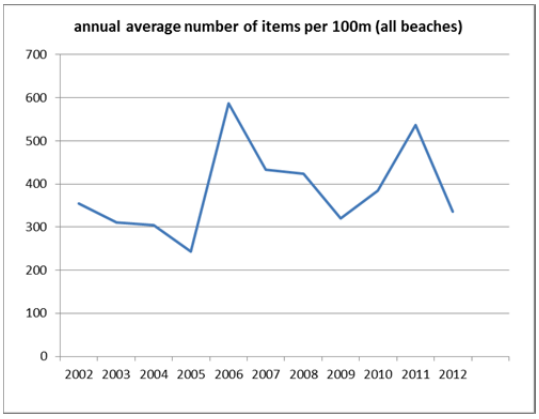

Figure 3 **Data impression by line connecting for example annual averages in earlier reports**

There are various ways to more clearly illustrate variations in data, several options being shown in ***Figure 4*** and ***Figure 5***. ***Arithmetic averages*** per 100m (simply calculated as the sum of item counts divided by the number of counted 100m stretches) can be associated with indicators of sample size (x-axis) from which the averages were derived plus variation shown by bars representing plus and minus the ***standard error (se)*** ***(Figure 4 A)***. The maximum number of data values to calculate annual average count data in the Dutch dataset is 16 (4 OSPAR beaches, each counted 4 times a year). Occasionally, counts will show exceptionally high numbers (outliers) that can strongly affect arithmetic annual averages making graphic representations erratic and obscuring visualization of trends. There are two ways to reduce the impact of outliers. A first one is to simply increase the number of data over which an average is calculated. Following the approach in the Fulmar EcoQO monitoring, arithmetic averages over 5-year periods may be used (bottom left in ***Figure 4 B***). For the OSPAR data, this clearly removes the erratic pattern in annual data, and shows that over the past 11 years, remarkably little consistent change has occurred when combining the data from the various locations along the Dutch coast.

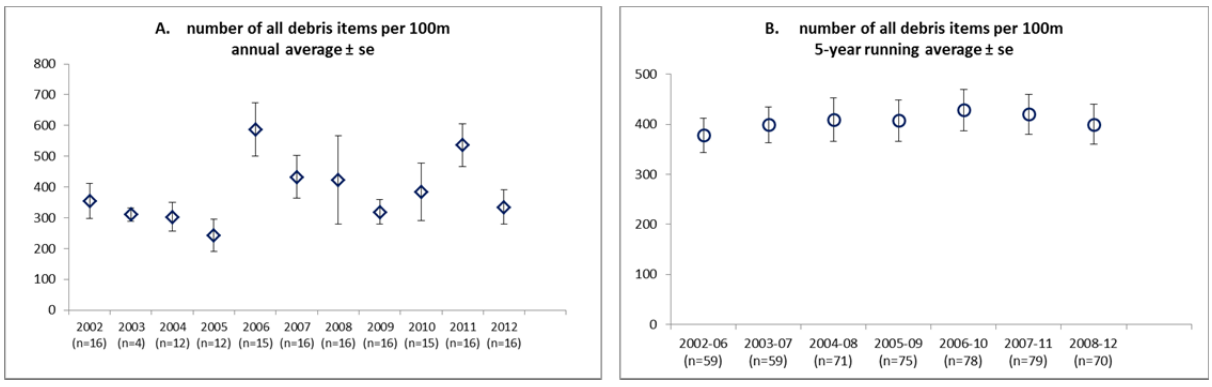

Figure 4 **Data visualisation by datapoints for A. annual or B. 5-year running arithmetic averages with standard errors;** 5-year running averages are calculated from all surveys in the 5 year period (not as the average of annual averages).

Another commonly used approach to reduce the influence of outliers is logarithmic transformation of count data. This reduces the impact of outliers. The average of the log transformed data can be back calculated to a 'normal' average, and is then referred to as the '***Geometric Mean'***. Because

a log value cannot be calculated for the value 'zero', before transformation, the value of 1 is added to each counted number. When back calculating from the average of the transformed values, the value 1 is subtracted to obtain the Geometric Mean. Somewhat surprisingly, the smoothing effect of log transformation on the visualisation of data (***Figure 5)*** is very limited. Apparently the interannual variation is not so much affected by individual outliers, but simply truly strong differences exist between years. There is no obvious advantage of illustrating data by geometric means as both annual and 5-year geometric mean data do not result in better graphics than the arithmetic average data.

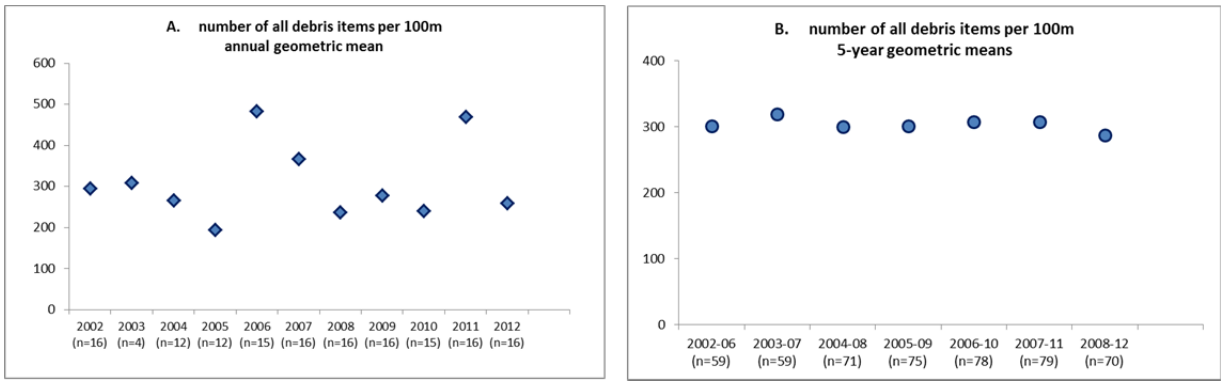

Figure 5 **Data visualisation by datapoints for A. annual or B. 5-year running geometric means;** 5-year running means are calculated from all surveys in the 5 year period (not as the average of annual means).

The stability in arithmetic averages over 5-year periods indicates that for example **the 5 year average for the 2008-2012 period is suitable to be used as a reference value to measure progress towards Good Environmental Status (GES) in the Marine Strategy Framework Directive (MSFD). In the 2008-2012 period, the average number of debris items per 100m survey stretch in the Netherlands (79 counts) was 400± 39 items. Targets for 2020 might then be defined in terms of 'less than' this reference period or as a fixed value, e.g. derived from specified percentage reduction of the 2008-12 value.** Whether a target is likely to be achieved, may be evaluated using trend analysis of the data (see below). Analyses of subsets of the data, e.g. for separate beaches or particular sources or types of debris may assist in identification of problem areas and identifying and measuring most efficient policies. As such is not always a straightforward analysis, **it is strongly recommended to use the 'All debris items' dataset as the single reference for the purpose of the MSFD, and use details only in the background to understand patterns and optimize additional measures**.

Table 7 provides all details of data used in ***Figure 4*** and ***Figure 5*** and may be used as reference format. The chosen standard for tabulated data in this report gives sample size (number of counts), incidence (=the number of counts in which the specified debris occurred), the arithmetic average ± its standard error, minimum and maximum number encountered in any single count, and the geometric mean value.

For the time being in this table format, also the data for 'all beaches except Bergen' are included because a specific request for this report was to advise on the option to stop monitoring the beach at Bergen and replace it by a new reference beach on the south of Texel. The reason for this request was in recent years the Bergen Beach seems very frequently cleaned, which likely affects monitoring results. As can be seen in ***Figure 6*** and ***Table 7*** debris densities at the Bergen beach are relatively low. This issue will be evaluated further in ***chapter 7.***

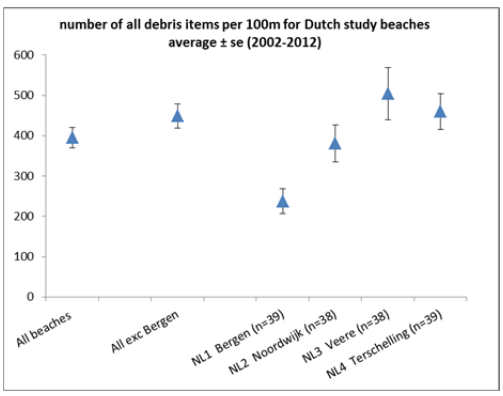

Figure 6 Arithmetic average numbers of debris items on the 4 Dutch OSPAR 100m survey beaches 2002-2012

Table 7 **Standard data table format providing overview for abundance by number of all debris items in the Dutch 100m OSPAR surveys** (all 4 beaches years 2002-2012).

	number of debris items per 100m				
2002-2012	*n*	**Incidence**	**average ± se**	**min -max**	**geometric mean**
All beaches	*154*	100%	395 ± 25	(23 - 2308)	300
All except Bergen	*115*	100%	448 ± 30	(23 - 2308)	353
NL1 Bergen	*39*	100%	238 ± 30	(32 - 854)	186
NL2 Noordwijk	*38*	100%	381 ± 45	(97 - 1187)	310
NL3 Veere	*38*	100%	504 ± 65	(89 - 2308)	393
NL4 Terschelling	*39*	100%	460 ± 44	(23 - 1179)	362
annual data 4 beaches combined	*n*	**Incidence**	**average ± se**	**min -max**	**geometric mean**
2002	*16*	100%	355 ± 58	(110 - 889)	296
2003	*4*	100%	311 ± 22	(280 - 375)	309
2004	*12*	100%	304 ± 46	(103 - 625)	266
2005	*12*	100%	243 ± 52	(89 - 596)	194
2006	*15*	100%	587 ± 86	(141 - 1173)	483
2007	*16*	100%	433 ± 70	(179 - 1053)	367
2008	*16*	100%	423 ± 144	(32 - 2308)	238
2009	*16*	100%	320 ± 40	(90 - 585)	279
2010	*15*	100%	385 ± 93	(23 - 1187)	240
2011	*16*	100%	536 ± 69	(151 - 1179)	470
2012	*16*	100%	336 ± 55	(49 - 785)	260
running 5-year data 4 beaches combined	*n*	**Incidence**	**average ± se**	**min -max**	**geometric mean**
2002-06	*59*	100%	378 ± 34	(89 - 1173)	302
2003-07	*59*	100%	399 ± 36	(89 - 1173)	320
2004-08	*71*	100%	410 ± 43	(32 - 2308)	300
2005-09	*75*	100%	407 ± 41	(32 - 2308)	301
2006-10	*78*	100%	428 ± 42	(23 - 2308)	308
2007-11	*79*	100%	420 ± 40	(23 - 2308)	308
2008-12	*79*	100%	400 ± 39	(23 - 2308)	288

6. Rates of change: statistical tests to evaluate trends

From figures Figure 4 and Figure 5 it was concluded that logarithmic transformation of data did not result in major differences for graphic data presentation, with apparently similar variability in annual data and 5-year data by arithmetic or geometric calculations. Requirements for log transformation for statistical tests was therefore re-analyzed in more detail. Genstat provides a dataview format to evaluate normal distribution of data and related suitability of the data for statistics that assume normally distributed data such as linear regressions. The comparison of data suitability on non-transformed and log transformed data for linear regression tests of trends is shown in Figure 7, A and C which shows skewed distribution of the original data, and good normality of log transformed data. Figure 7 B and D show dataplots with regression lines and 95% confidence limits of the estimates. The evaluation shows that logarithmic transformation should be applied when investigating the trends in marine litter abundance in the Dutch OSPAR 100m dataset. Test results for all beaches combined as in the graph, and for individual beaches are given in ***Table 8***

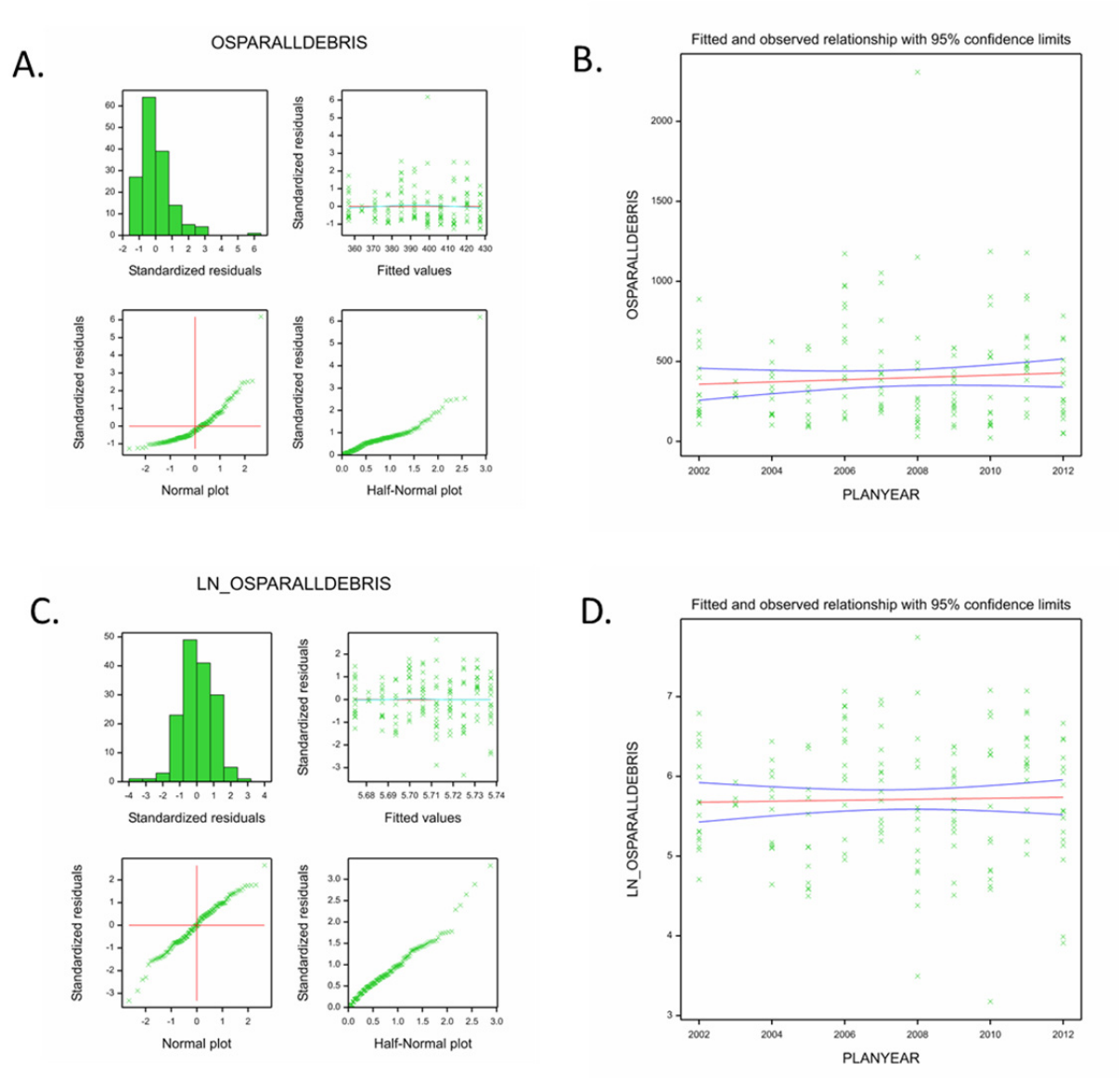

Figure 7 **Evaluation of suitability of basic original count numbers (A, B, for data 'OSPARALLDEBRIS') and log-transformed data (C,D for data 'LN-OSPARALLDEBRIS) of the 100m OSPAR survey data for trend analyses by linear regression** (all data, all beaches 2002-2012, 154 surveys). A and C show data evaluation indicating normality and therefor superiority of log transformed data for tests. B and D show dataplots with lineair regression lines and 95% confidence limits. Details of test results, non-significant in both B and D, are tabulated in ***Table 8***.

Table 8 **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, al 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. Dataplots for both analyses on all 4 beaches were shown in ***Figure 7.***

Linear regression results for ALL DEBRIS counts in the Dutch 100m OSPAR survey beaches

example of trend analysis on ***non-tranformed individual count data*** *against year of count*

	items	***n counts***	***Constant***	***est***	***se***	***t***	***t pr.***	
NL all 4 beaches	*All debris*	*154*	*-13773*	*7.06*	*8.06*	*0.88*	*0.383*	↕ns

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 ***8*** and ***Figure 7*** clearly show that for the combination of the 4 OSPAR reference beaches in the Netherlands (100m sections) there has virtually been no change in the abundance of marine litter by numbers 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 tending 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 ***Table 9***. Proportionally this seems in line with the small 100m debris surveys, in which Veere was the only beach with a near significant increase ***Table 8.*** Further checks need to be conducted to exclude potential bias from category changes made in 2010, but the annual data in ***Table 10*** nor the boxplot in Figure 8 do not suggest a jumplike change from up to 2009 and 2010 and after. 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 by priority. 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.

Table 9 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								
	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	↓**

Table 10 Standard data table format providing overview for abundance by number of all large debris items in the Dutch 1km OSPAR surveys (all 4 beaches years 2002-2012).

number of large debris items per km					
2002-2012	*n*	**Incidence**	**average ± se**	**min -max**	**geometric mean**
All beaches	*149*	99%	81 ± 6	(0 - 459)	60
All except Bergen	*112*	99%	89 ± 7	(0 - 459)	64
NL1 Bergen	*37*	97%	57 ± 5	(0 - 125)	47
NL2 Noordwijk	*38*	97%	64 ± 7	(0 - 267)	50
NL3 Veere	*35*	100%	77 ± 11	(7 - 409)	60
NL4 Terschelling	*39*	100%	124 ± 16	(6 - 459)	87
annual data, 4 beaches combined	*n*	**Incidence**	**average ± se**	**min -max**	**geometric mean**
2002	*16*	100%	94 ± 9	(47 - 198)	89
2003	*4*	100%	96 ± 32	(48 - 191)	83
2004	*12*	100%	93 ± 23	(16 - 267)	67
2005	*11*	100%	119 ± 32	(20 - 385)	88
2006	*14*	100%	109 ± 15	(33 - 214)	95
2007	*16*	100%	63 ± 8	(15 - 136)	55
2008	*16*	100%	79 ± 23	(12 - 409)	55
2009	*15*	100%	62 ± 11	(7 - 148)	49
2010	*13*	93%	80 ± 33	(0 - 459)	39
2011	*16*	100%	65 ± 8	(20 - 132)	58
2012	*16*	94%	57 ± 18	(0 - 317)	34
running 5-year data 4 beaches combined	*n*	**Incidence**	**average ± se**	**min -max**	**geometric mean**
2002-06	*57*	100%	103 ± 9	(16 - 385)	85
2003-07	*57*	100%	94 ± 9	(15 - 385)	74
2004-08	*69*	100%	90 ± 9	(12 - 409)	69
2005-09	*72*	100%	84 ± 8	(7 - 409)	64
2006-10	*74*	99%	78 ± 9	(0 - 459)	56
2007-11	*76*	99%	70 ± 8	(0 - 459)	51
2008-12	*76*	97%	68 ± 9	(0 - 459)	46

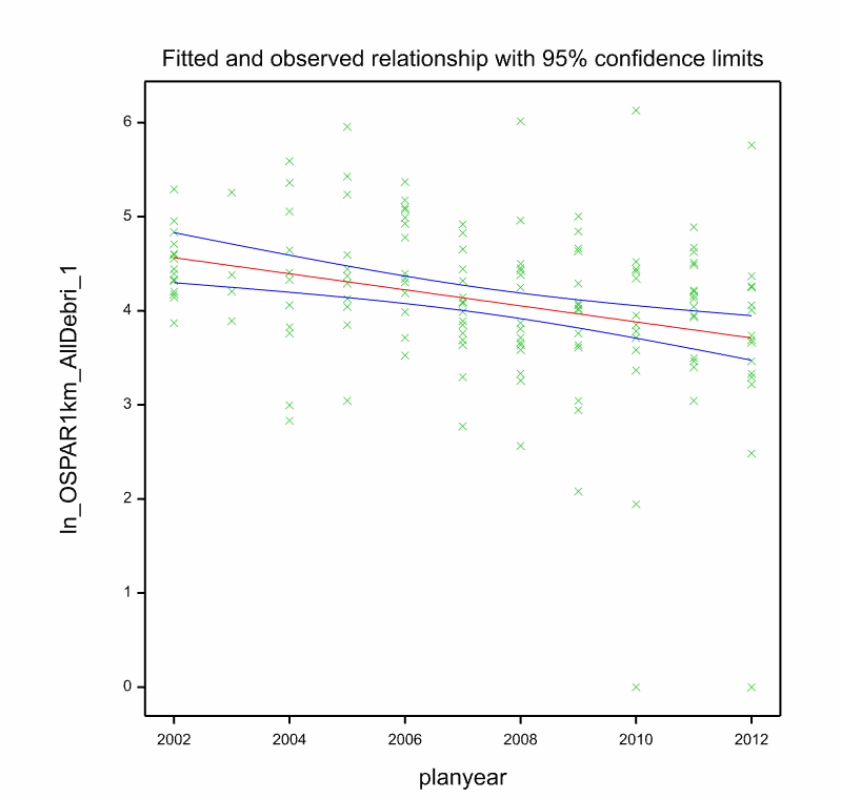

Figure 8 Dataplot and regression line for all large debris counted in the 1km OSPAR surveys, all beaches 2002-2012 (149 km surveys). The downward trend is highly significant (p<0.001). See **Table 9** and **Table 10** for details.

It would be good to be able to make a direct comparative evaluation of the trend in the large 1km items to the 'large' debris items in the 100m surveys. However, this is not well possible, because of the limited number of categories in the 1km system, which cannot always be directly linked to the 100m categories. Furthermore, both suffer from changes made in 2010. In the 100m surveys, all cord-rope-net materials can only be dealt with as a single cluster which cannot be split in large or small. However, based on a selection of items in the 100m surveys for which it is possible to identify them as large, it is safe to say that also the 100m dataset supports the evidence for a significantly reduced presence of large debris on the Dutch beaches since 2002 (***Table 11***).

Table 11 Trend 2002-2012 in a selected set of large debris items in the 100m surveys.

Linear regression results for selected LARGE DEBRIS items in the Dutch 100m OSPAR surveys								
	items	***n counts***	**Constant**	**est**	**se**	**t**	**t pr.**	
NL all 4 beaches	Large debris *	*154*	176.5	-0.0871	0.0241	-3.62	<.001	↓***

** buoys (OSPAR100_037), fish boxes (034), jerrycans(010), large plastic containers (009),metal oil drum (84+205+206), wooden pallet (069); pieces over 50cm of plastic (047) metal (090) or wood (075)*

7. Discontinue the OSPAR Beach Litter Monitoring at Bergen?

One of the questions for this preliminary review, was whether the OSPAR surveys at the beach of Bergen should be discontinued, because it was felt that cleaning activities in recent years were biasing results. The surveys made in this report show no evidence for such bias. In large debris items of the 1km there is indeed a decrease, but this seems not to be specific for the Bergen beach. In results of the 100m surveys, the Bergen beach is very constant. It is indeed relatively clean, but this has been the case since the start of the monitoring in 2002.
A beach on Texel, on the southern tip, along the eastern side of the Hors has been proposed as an alternative. It is undoubtedly less frequently cleaned, and has a very low touristic level, making it very suitable for estimating abundance of litter arriving from sea. For this reason it would be a useful location for additional regular or incidental detailed study.
However, changing an OSPAR reference beach has an enormous impact on data evaluations, as not only the individual beach, but also the integrated data for the whole of the Netherlands are affected for many years. The only way to do this 'nicely' would be to plan for e.g. 10 years to come to investigate both beaches, before dropping one of them.
Considering the absence of evidence that beach cleaning at Bergen has a more serious effect on survey data from that location than on those from other locations, or Dutch beaches in general, it seems unwise to discontinue the observations. **Thus it is advised to continue the surveys on the current 4 Dutch reference beaches, including Bergen, for the 100m surveys as well as the 1km stretch. There have been a very few occasions when the 1km counts were not conducted because of recent cleaning. This is not a wise approach for data analysis, please complete also the 1km census conscientiously, even if beach cleaners seem to have removed almost all larger debris. Comparability of the 100m and 1km datasets depends on consistency in counting them both at EACH occasion.** It is recommended to use the Texel beach for occasional detailed studies in relation to source identification, mass of debris, rates of influx from sea etc.

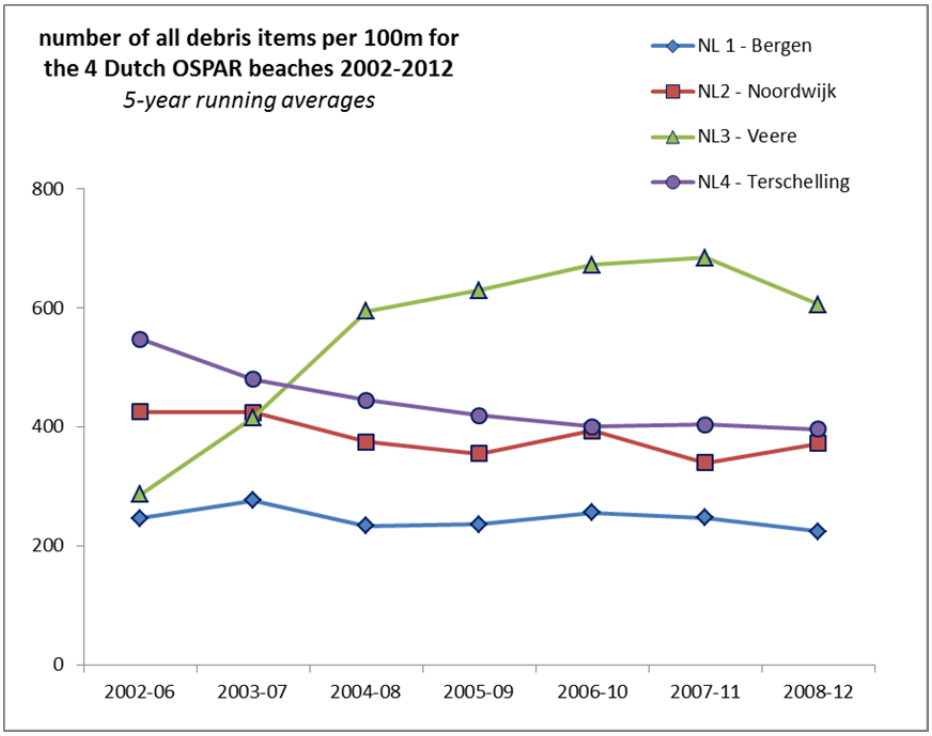

Figure 9 Running 5-year arithmetic averages at the 4 Dutch reference beaches since 2002 showing patterns in all debris abundance (100m surveys). For numerical details see ***Table 12****; linear regression trend data given in* ***Table 8****. None of the trends is significant. The Bergen data are low, but consistently so since 2002, and show no evidence of serious bias from recently intensified beach cleaning activity.*

Table 12 Details of 5-year running data for the separate Dutch OSPAR survey beaches (100m surveys). See also ***Figure 9***

	number of debris items per 100m				
running 5-year data	*n*	**Incidence**	**average ± se**	**min -max**	**geometric mean**
Bergen 2002-06	*15*	100%	246 ± 50	(97 - 835)	202
Bergen 2003-07	*15*	100%	277 ± 49	(97 - 835)	231
Bergen 2004-08	*18*	100%	234 ± 45	(32 - 835)	178
Bergen 2005-09	*19*	100%	237 ± 43	(32 - 835)	184
Bergen 2006-10	*20*	100%	256 ± 51	(32 - 854)	188
Bergen 2007-11	*20*	100%	248 ± 45	(32 - 854)	188
Bergen 2008-12	*20*	100%	224 ± 46	(32 - 854)	164
Noordwijk 2002-06	*15*	100%	425 ± 78	(165 - 1173)	351
Noordwijk 2003-07	*15*	100%	425 ± 78	(165 - 1173)	353
Noordwijk 2004-08	*18*	100%	375 ± 69	(120 - 1173)	301
Noordwijk 2005-09	*19*	100%	355 ± 66	(120 - 1173)	287
Noordwijk 2006-10	*19*	100%	394 ± 80	(97 - 1187)	294
Noordwijk 2007-11	*19*	100%	340 ± 63	(97 - 1187)	273
Noordwijk 2008-12	*19*	100%	373 ± 67	(97 - 1187)	294
Veere 2002-06	*14*	100%	287 ± 48	(89 - 643)	239
Veere 2003-07	*14*	100%	416 ± 85	(89 - 1053)	308
Veere 2004-08	*17*	100%	595 ± 135	(89 - 2308)	403
Veere 2005-09	*18*	100%	630 ± 123	(89 - 2308)	462
Veere 2006-10	*19*	100%	672 ± 108	(110 - 2308)	561
Veere 2007-11	*20*	100%	684 ± 103	(110 - 2308)	578
Veere 2008-12	*20*	100%	606 ± 104	(110 - 2308)	495
Terschelling 2002-06	*15*	100%	548 ± 65	(165 - 976)	483
Terschelling 2003-07	*15*	100%	481 ± 65	(165 - 976)	417
Terschelling 2004-08	*18*	100%	445 ± 59	(158 - 976)	380
Terschelling 2005-09	*19*	100%	419 ± 58	(90 - 976)	346
Terschelling 2006-10	*20*	100%	400 ± 63	(23 - 976)	299
Terschelling 2007-11	*20*	100%	404 ± 65	(23 - 1179)	302
Terschelling 2008-12	*20*	100%	397 ± 65	(23 - 1179)	286

8. Top-10 item analyses

Reorganisation of the dataset to a format that takes proper account of the changes in item categories and their descriptions has taken a great deal of time of the limited project. However, as experienced in several analyses, this data work was absolutely essential to understand potential bias and misinterpretation. For the Top-10 items from ***Table 6*** this has resulted in lack of time for a full analysis. Clustering of groups, such as dealing with all cords and ropes and nets as a single unit in the Top-10 list, was done to avoid bias from category changes introduced by OSPAR in 2010, but one needs to remain cautious as experienced in source analysis in Chpt 9. Taking this into account, an initial analysis of trends in the Top-10 items is shown in Table 13.

Table 13 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***

The lack of change from 2002 to 2012 in overall debris abundance (all types combined) for Dutch beaches (***Table 8*** and ***Figure 8***), is also seen in the combined top ten list of ***Table 13***. The by far most abundant category for all nets and ropes suggest a (just not significant) upward trend of sea sourced wastes from shipping and fisheries. Remarkable clear trends are seen in some of the less abundant items.

For example, an initial data survey was made of the 6th of the Top10 items: balloons. Recently, around the coronation of the Dutch King Willem Alexander, balloon releases were a topic of much debate and media attention. From ***Table 6*** it can be seen, that on average over the 2002-2012 period, 12.6 balloon remains were found on each stretch of 100m. Analysis of trends for abundance of balloons (***Table 13*** and ***Figure 10***) over the 2002-2012 period show a highly significant increase ($p<0.001$). It would have been useful to have these data at hand during the discussions on this topic earlier this year!

It is also remarkable to see that where plastic drink bottles (7th of Top10) appear to be significantly decreasing (same for food bottles), that the presence of bottle caps (4th of Top10) is significantly increasing (***Figure 11***). In line with earlier suggestions for secondary clean-up of larger items, this could suggest that the number of bottles discarded has actually increased, but that the bottles themselves are often later removed in clean-ups whereas the smaller caps are not. An alternative or additional explanation may be that when discarded PET bottles at sea break up into fragments, the PET material of the bottle sinks, but not the cap, usually made of polyethylene or polypropylene, which remains afloat and can reach the shores.

As indicated in ***Chapter 5***, it is advised to base policy targets for marine beached litter in for example OSPAR or the MSFD on the single figure for all combined debris, and its trends or absolute abundance. However, from the analyses of subcategories shown here, it is also clear that underlying details can be detected and may assist in more specific policy decisions and measurement of the efficacy of such decisions.

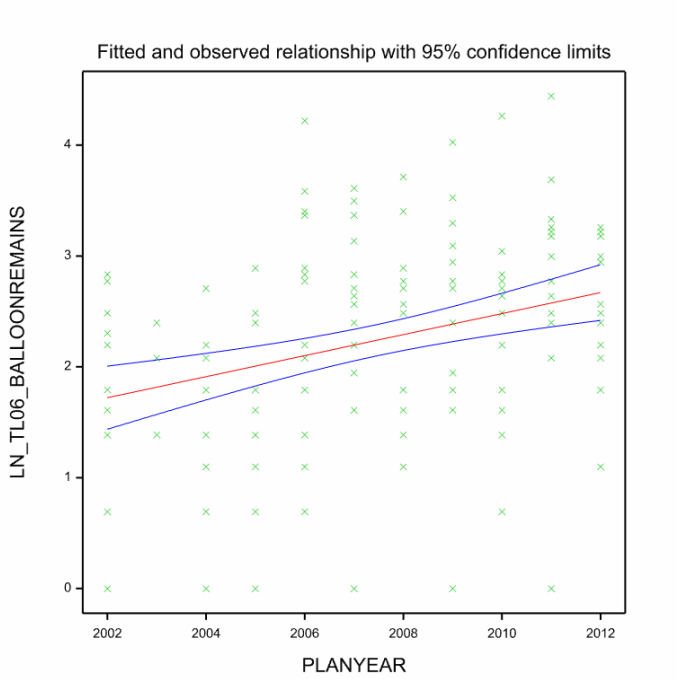

Figure 10 Trend in balloon abundance on Dutch beaches (100m surveys 2002-2012; 154 counts), showing a highly significant increase.

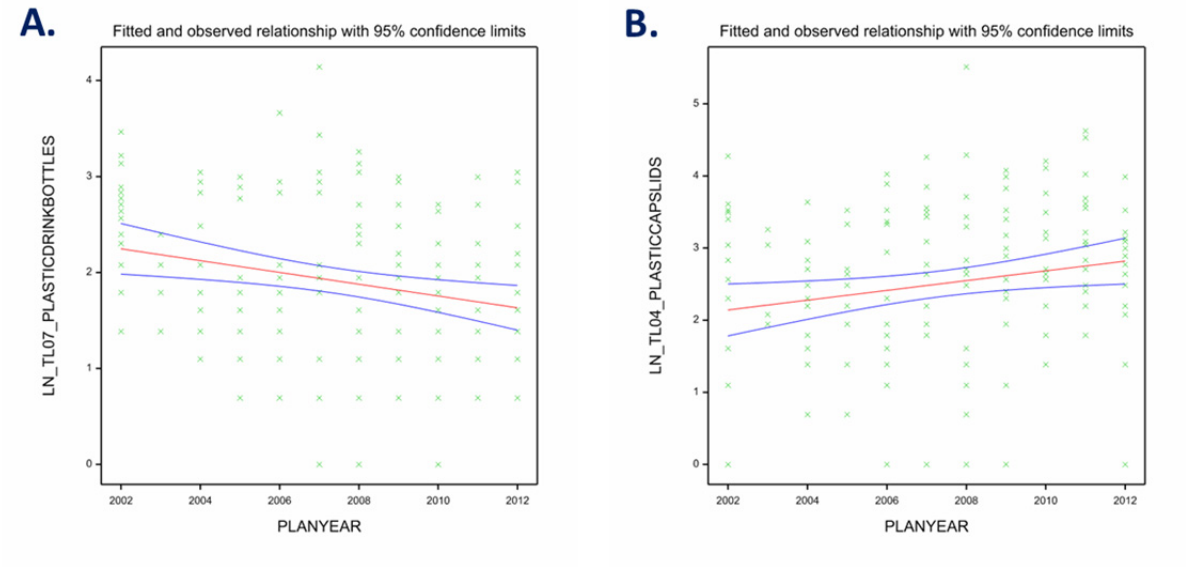

Figure 11 Opposite trends in abundance of plastic bottles (A. decreasing) and bottle caps (B. increasing) on Dutch beaches (100m surveys 2002-2012; 154 counts)

9. Sources

A serious start was made with analysis of the data for sources of materials, using the existing OSPAR labelling for sources of items. Surprising changes were suggested for a strongly increased role of shipping and reduced role of fisheries. However, data will not be shown, as a closer look learned that this effect was completely caused by the changed categorisation and descriptions for cords, ropes and net remains in 2010 and linked labels for sources. Great effort was made to improve the quality of the dataset by correctly specifying the changed categories over time. However, this could not prevent misinterpretations due to the standard OSPAR source labels with those categories. The 'wasted' effort on these complications once more is a strong signal that extreme caution should be taken before making changes to the (categories in) the survey system. Consistency, even in imperfect record methods, may be preferred above inconsistency causing bias and interpretation of results, or obstructing analysis overall! In a later phase, new analyses for source may be conducted, but such is only possible after thorough thinking and agreement about source and material labels given to both former and current item categories.
In some individual items, as for balloons above, source identification and related trends are easy to assess, but for the larger groups of debris with changed categorisation this is more complicated.

10. References

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photo 5 In the 100m survey, the full beach width is surveyed by repeated transects bands of limited width. The item in front of the picture (tetrapack, item type OSPAR100_062) will be included in the next survey band down.