Monitoring of pellets and mesoplastic fragments on Dutch beaches in 2022

Summary Report

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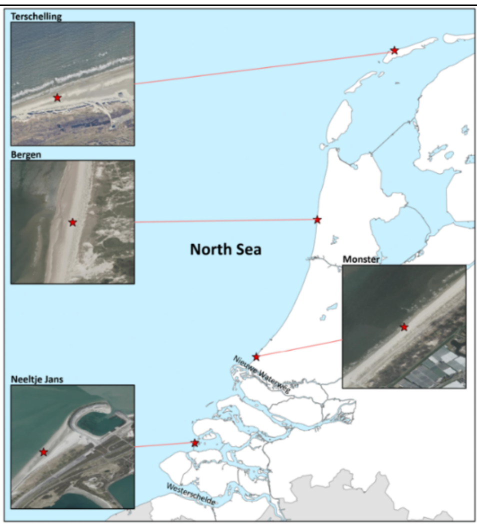
Ministry of Infrastructure and Water Management
The Netherlands
Report number: BM 23.39



Key findings

There has emerged a need in the past years for the monitoring of pellets on beaches (see 1.2). The Netherlands has cooperated in the development of an EU monitoring method for pellets and mesoplastic fragments on beaches (Galgani et al., 2023) and started Dutch monitoring in 2021 (Wenneker et al., 2022).

We first established that there are strong relationships between the number and weight of both pellets and mesoplastic fragments (Van Loon et al., 2023). Therefore, it was chosen to only present number data, in order to present uniform and clearer results. The average weight per pellet is 26.9 mg, and per mesoplastic fragment is 39.6 mg.
In addition, we established that there is a strong relation between the median and mean number results per survey, and that the median value is on average 0.57 of the mean value (Van Loon et al., 2023). This shows that the data are not normally distributed; and that the median is correct to report. This is consistent with the use of the median for beach litter results.

The main results for the Dutch coastline for 2022, based on four locations, are: **pellets: 615 per 100 m beach length and mesoplastic fragments: 235 per 100 m beach length**. These results were monitoring using the EU guidelines with a larger sampling area from July 2022 onwards, and therefore probably still slightly underestimate the concentrations. We expect that this monitoring programme will have sufficient power and precision to reveal possible trends (due to reduction measures) after a period of six years. The monitoring of five morphology classes of mesoplastic fragments provides additional information and shows a dominance of mesoplastic fragments.

1 Introduction

1.1 Definitions of target materials

Pellets, also called nurdles, pre-production pellets (OSPAR, 2018) or industrial plastics (Van Franeker et al., 2021) are small plastic particles. They are used to make nearly all plastic products and are classified as large microplastics (Galgani et al., 2023). Their shape varies and include pellets (3-4 mm), flakes and powders (OSPAR, 2018). Only pellets are monitored because they can be identified clearly (Galgani et al., 2023). A recent Dutch study (Haskoning, 2023) gives background information on the sources of pellets in Dutch surface waters.

Mesoplastics, by definition in the size (length) range of 0.5-2.5 cm, include fragments of plastic items and consists of different types of plastics. In most cases these fragments are unrecognisable pieces of plastic, but e.g. cigarette butts and bottle caps may also partly fall within the mesoplastic size range. However, in the underlying method based on the EU method (Galgani et al., 2023) only mesoplastic fragments are counted and weighted, because these are difficult to monitor reliably and comparably in the beach macrolitter monitoring programs. Mesoplastics items that can be identified well, like cigarette butts or bottle caps, are not included in this monitoring as they are already monitored and assessed via the regular OSPAR and EU Beach Litter Monitoring Programmes (Hanke et al., 2019).

1.2 Information needs

The basic information needs are the MSFD criteria D10C1 (for monitoring of beach macro- and mesolitter) and D10C2 (for monitoring beach micro-litter) (Galgani et al., 2023). In addition, the EU has recently issued a legislation proposal to prevent pellet loss (COM, 2023). OSPAR's Regional Action Plan Marine litter (RAP ML2) has defined a RAP action C.1.1 Prevent microplastic pollution resulting from plastic pellet, powder and flake loss | OSPAR Commission. Finally, IMO has launched a proposal recently to classify plastic pellets as hazardous materials (IMO, 2022).

For these three information needs, reliable monitoring data are needed for pellets on European coastlines using a standardized EU method (Galgani et al., 2023). In view of the ecological harm that mesoplastic fragments may cause (Van Franeker et al., 2021), data on mesoplastic fragments on beaches are also a valuable product of this method.

1.3 Overview of the monitoring method

The results in this Summary Report have been produced using the methods in the report of Van Loon et al. (2023): Methods for Monitoring of Pellets and Mesoplastic fragments on Dutch beaches. In the Netherlands, four monitoring locations, evenly distributed along the Dutch coast, are sampled four times a year. This monitoring strategy mimics the monitoring strategy for beach macrolitter, but two of the four locations (Monster and Neeltje Jans) are more focussed on riverine and estuarine sources, respectively. Data analysis is performed only for number data and not for mass data (see Key Findings). Only median results are presented.

2. Results

2.1 Pellets

The median number results for pellets are presented in detail in Table 1.
Note that these results are based per location on only four surveys, which only gives indicative results. According to the rule-of-thumb used in the litteR software (Walvoort et al., 2022), a minimum of 10 surveys is necessary to provide location results with a useful confidence. This number of surveys will be approached after two years of monitoring (8 surveys per location) and will be reached after three years of monitoring (12 surveys per location).

However, at the national level 16 surveys are available for 2022, which already provides median results with a useful confidence. At this spatial level, three years of monitoring will provide 48 surveys, which will enable a beach macrolitter like TV assessment, for which at least 40 surveys are needed (Van Loon et al., 2020).

Table 1: Median number of pellets per location, and aggregated for all locations in 2022. The location results are indicative (N=4; <10); the Dutch result has a useful confidence (N=16).

Location name	year	parameter	N/100 m (median)	N surveys
Bergen	2022	NPEL	380	4
Monster	2022	NPEL	1000	4
Neeltje Jans	2022	NPEL	270	4
Terschelling	2022	NPEL	850	4
Netherlands	**2022**	**NPEL**	**615**	**16**

Quality control with Infrared Spectrometry (see Methods report) showed that 98% of the pellets (49 in 50) was correctly identified as plastic.
Pellets were found during all surveys (100%). In 2022 an estimated (extrapolated from 5 m data to 100 m beach length) median value of 615 pellets per 100 m has been found on the 4 Dutch reference beaches. The highest median number of pellets were found at Monster (1000; near river mouth downstream of the Rotterdam harbour), the lowest at Neeltje Jans (270; near estuarine mouth).
The average weight of a pellet is 26.6 mg.

As described above the data in Table 1 are the results of one year monitoring with two slightly different methods (monitoring of 2 squares of 1 m^2 (positioned on springtide lines) per transect versus monitoring of the complete transect). The amount of pellets found would have been higher if the EU method (monitoring of 5 transects) would have been used for all surveys.

2.2 Mesoplastic fragments

The median number results for mesoplastic fragments are presented in detail in Table 2.
Note that these results are based per location on only 4 surveys, which only gives indicative results. According to the rule-of-thumb used in the litteR software (Walvoort et al., 2022), a minimum of 10 surveys is necessary to provide location results with a useful confidence. This number of surveys will be available after three years of monitoring.
However, at the national level 16 surveys are available for 2022, which already provides results with a useful confidence. At this spatial level, three years of monitoring will provide 48 surveys, which will enable a beach macro-litter like TV assessment, for which at least 40 surveys are needed (Van Loon et al., 2020).

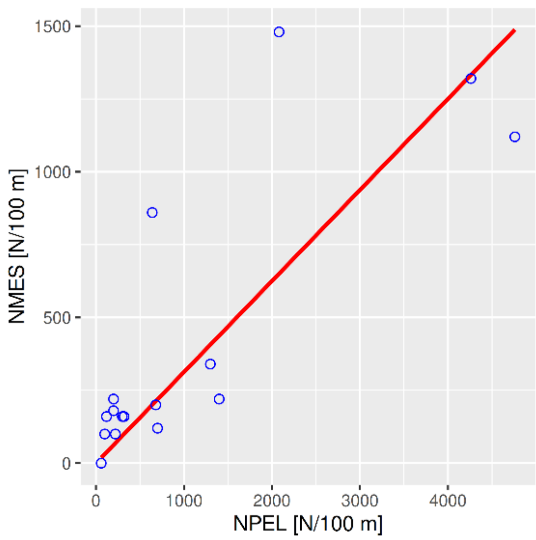
Mesoplastic fragments were found in 94% of the beach surveys. These fragments were not found in 1 out of the 16 surveys (Bergen).
For mesoplastics an estimated median value of 235 mesoplastic fragments per 100 m beach has been found. Again the amount of mesoplastics found would have been higher if the EU method, in which five transects are monitored opposed to two tidelines only, was used for all surveys.
Like with pellets, Neeltje Jans has the lowest median value for mesoplastics.
The mean weight of a mesoplastic fragment is 39.6 mg.

Table 2: Median number of mesoplastic fragments per location, and aggregated for all locations. The location results are indicative (N = 4; <10); the Dutch result has a useful confidence (N=16).

Location name	year	parameter	N/100m (median)	N surveys
Bergen	2022	NMES	510	4
Monster	2022	NMES	280	4
Neeltje Jans	2022	NMES	170	4
Terschelling	2022	NMES	190	4
Netherlands	**2022**	**NMES**	**235**	**16**

The correlation between NPEL and NMES is shown in Figure 1. The good correlation coefficient shows that it is likely that NPEL (pellet pollution) and NMES (mesoplastic fragment pollution) correlate well. We are not sure if this presents a causal relation, because the sources of pellets and mesoplastic fragments are different. However, the pathways of both litter type groups may be related.

*Figure 1: Relation between NPEL and NMES for all Dutch surveys (N=16) in 2022. The model formula is: NMES = 0.313*NPEL (R^2 0.78).*



2.3 Mesoplastic morphology groups

The median number results for mesoplastic fragments are presented in detail in Table 3. Note that these results are based per location on four surveys, which only gives indicative results. Figure 3 clearly shows that fragments are the most occurring mesoplastic fragments. We hypothesize that this may partly be caused by the relatively high median weight per mesoplastic fragments (51 mg), compared to the median weight of mesoplastic foams (27 mg), filaments (13 mg), styrofoams (11 mg) and films (22 mg), respectively. This relatively high weight of hard plastic fragments may make them less susceptible to wind. On the other hand, the relatively low weight of films, combined with their flat surface, make these mesoplastic fragment types probably the most susceptible to wind.

Table 3: Median number of mesoplastic fragments per morphology group per location. At the national level, the median of the location medians is presented (blocking method).

Spatial level	Period	Morphology group	N/100 m (median)	N surveys
Bergen	2022-2022	NMES_Filaments	80	4
Monster	2022-2022	NMES_Filaments	10	4
Neeltje Jans	2022-2022	NMES_Filaments	0	4
Terschelling	2022-2022	NMES_Filaments	20	4
Netherlands	**2022-2022**	**NMES_Filaments**	**15**	**16**
Bergen	2022-2022	NMES_Films	20	4
Monster	2022-2022	NMES_Films	20	4
Neeltje Jans	2022-2022	NMES_Films	0	4
Terschelling	2022-2022	NMES_Films	0	4
Netherlands	**2022-2022**	**NMES_Films**	**10**	**16**
Bergen	2022-2022	NMES_Foams	50	4
Monster	2022-2022	NMES_Foams	40	4
Neeltje Jans	2022-2022	NMES_Foams	0	4
Terschelling	2022-2022	NMES_Foams	30	4
Netherlands	**2022-2022**	**NMES_Foams**	**35**	**16**
Bergen	2022-2022	NMES_Fragments	320	4
Monster	2022-2022	NMES_Fragments	210	4
Neeltje Jans	2022-2022	NMES_Fragments	120	4
Terschelling	2022-2022	NMES_Fragments	130	4
Netherlands	**2022-2022**	**NMES_Fragments**	**170**	**16**
Bergen	2022-2022	NMES_Styrofoams	10	4
Monster	2022-2022	NMES_Styrofoams	40	4
Neeltje Jans	2022-2022	NMES_Styrofoams	10	4
Terschelling	2022-2022	NMES_Styrofoams	20	4
Netherlands	**2022-2022**	**NMES_Styrofoams**	**15**	**16**

The relative morphology distributions on the four locations seem to be roughly comparable but the number of surveys per location (N =4) is too low to be conclusive.

3. Trend analysis

At present, we do not yet have five or six years of EU-standardized monitoring data (Galgani et al., 2023), which are necessary to perform a valid trend analysis. These results will be available by the end of 2028.

4. Conclusions

See Key Findings.

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Annex 1: Monitoring Data Table 2022

location	date	unit_N	unit_W	NPEL	NMES	WPEL	WMES	NMES_Fil	NMES_Film	NMES_Foa	NMES_Frag	NMES_Sty	WMES	WMES_Fil	WMES_Film	WMES_Foa	WMES_Frag	WMES_Sty
BGN	2022-04-20	N/100 m	g/100 m	120	160	3.034	6.954	40	0	100	20	0	6.954	0.164	0	1.156	5.634	0
BGN	2022-06-17	N/100 m	g/100 m	2080	1480	53.2	46.88	200	40	200	620	420	46.88	3.144	0.634	3.64	35.518	3.944
BGN	2022-10-13	N/100 m	g/100 m	640	860	17.7	39.154	120	40	0	680	20	39.154	1.036	0.36	0	37.496	0.262
BGN	2022-12-11	N/100 m	g/100 m	60	0	1.625	0	0	0	0	0	0	0	0	0	0	0	0
MSR	2022-04-05	N/100 m	g/100 m	700	120	21.306	4.226	20	20	0	40	40	4.226	0.078	1.038	0	2.956	0.154
MSR	2022-07-02	N/100 m	g/100 m	200	220	4.614	10.086	0	20	20	140	40	10.086	0	0.244	0.966	8.794	0.082
MSR	2022-09-28	N/100 m	g/100 m	4260	1320	116.452	59.966	40	20	100	1020	140	59.966	0.104	1.86	1.654	54.062	2.286
MSR	2022-11-27	N/100 m	g/100 m	1300	340	37.398	8.326	0	0	60	280	0	8.326	0	0	1.578	6.748	0
NTJ	2022-04-19	N/100 m	g/100 m	200	180	5.744	2.758	0	0	0	80	80	2.758	0	0	0	2.466	0.292
NTJ	2022-06-16	N/100 m	g/100 m	220	100	6.246	2.764	0	0	0	100	0	2.764	0	0	0	2.764	0
NTJ	2022-10-12	N/100 m	g/100 m	320	160	8.55	3.098	20	0	0	140	0	3.098	0.012	0	0	3.086	0
NTJ	2022-11-26	N/100 m	g/100 m	680	200	21.912	16.488	0	0	0	180	20	16.488	0	0	0	16.462	0.026
TSL	2022-04-03	N/100 m	g/100 m	100	100	2.772	1.022	20	0	40	40	0	1.022	0.284	0	0.122	0.616	0
TSL	2022-07-03	N/100 m	g/100 m	300	160	5.594	2.304	20	20	20	60	40	2.304	0.234	0.106	0.126	1.646	0.192
TSL	2022-09-29	N/100 m	g/100 m	4760	1120	127.868	44.498	20	0	160	860	100	44.498	0.062	0	8.382	32.226	3.828
TSL	2022-12-12	N/100 m	g/100 m	1400	220	32.136	30.32	0	0	20	200	0	30.32	0	0	1.638	28.682	0