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Marine Litter Watch 2021
European Beach Litter Assessment

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1 Introduction

Litter is piling up in all aquatic systems, particularly on sea beaches, being their last stop on the journey through the linear economy. With at least 11 million tonnes of plastic ending up in the oceans every year (UNEP, 2021), plastics make up 80 % of all marine debris along beaches, surface waters and deep-sea sediments. The Marine Litter Watch (MLW) initiative is the European Environment Agency`s (EEA) project to engage citizens, communities and NGOs to collect data on litter along the beaches of European seas whilst using EU guidelines. What can we learn from the data reported by citizens and communities over the last decade?

This report builds on the recently published EEA report entitled "Marine Litter and European Beaches: learning from citizen science", also utilizing 2021 data on when the COVID-19 epidemic could have affected marine litter composition and levels. It is worth noting that the EEA is currently preparing a report entitled "From source to sea: Untold story of the marine litter", which was built on the findings of the ETC report "Marine Litter in Europe: An integrated assessment from source to sea**".** Both reports attempt the holistic evaluation of marine litter and its pathways, including those from beaches, and they use the data analysed in this report.

A large investment and policy effort at the European level has been made in recent years to tackle the problem of marine litter pollution, in particular from plastics. Analysis of the MLW database in this report provides an invaluable source of information on the status of litter and plastic pollution on EU beaches. This is crucial for determining the environmental status better, as requested by the Marine Strategy Framework Directive (MSFD), and assessing the effectiveness of EU policies and directives such as the Zero Pollution Action Plan (ZPAP) and Single Use Plastics Directive (SUPD).

2 Key messages

- Citizens and communities populate the 'EEA's MLW database with data on many '"monitoring' events according to the EU Technical Group on Marine Litter (TGML) standards, supplemented by 'clean-'up' events; making it an important database for beach litter worldwide.
- Plastics represent 85 % of total marine litter items found on European beaches between 2015–2021.
- Single Use Plastic (SUP) items make up the bulk of the top ten list of total litter found on European beaches. MLW data confirms that the effective implementation of the EU legislation on SUP/Fisheries is vital for decreasing levels of plastic litter in the marine environment.
- The Mediterranean Sea and the Black Sea's beaches are more littered and have the highest SUP item abundance, compared to the North-east Atlantic Ocean and Baltic Sea.
- Fishing-related litter is higher in the Mediterranean Sea than in the North-east Atlantic Ocean, Baltic Sea, and Black Sea.
- A decrease in litter numbers in recent years, possibly linked to the COVID-19 epidemic restrictions (including reduced access to beaches) might have occurred. Still, it was not evident in the MLW dataset.
- More time and more data are needed to build confidence in the current patterns of spatial and temporal distributions. Short time series suggest caution in the interpretation of the data.
- MLW 'monitoring' event data was used for the assessment, as the data was found more reliable in the previous MLW assessment evaluations.
- To provide more representative data on marine litter found on EU beaches, regular monitoring at the same beach sites by MLW communities is recommended.

3 Marine Litter Watch: citizen science for cleaner seas

Information and data on marine litter are essential for tackling it. The EEA developed a MLW web/mobile app to strengthen 'Europe's knowledge base and thus provide support to European policymaking. The initiative uses citizen science — scientific research conducted, at least partly, by members of the public — and smartphone technology to encourage and support citizen communities to provide structured data on marine litter and to clean up 'Europe's beaches at the same time.

2 448 011 litter items

have been collected under the Marine Litter Watch initiative since 2013.[1]

The MLW dataset has constantly been growing by community inputs based on clean-up events (surveys) as well as more systematic monitoring events since 2013. Until 2021, 4481 events at 2368 beaches were organised by 77 different communities (citizen groups). The events have been taking place in 73 countries all over the world.

Table 1 presents the events for the four European seas. Since these sites have the best data coverage collected from numerous events, they also fall under the scope for further data assessment, described in the next section.

Table 1 Overview of all events at beaches of the European regional seas reported to Marine Litter Watch (MLW) in the period 2013–2021

Regional sea	Events (nº)	Clean-up (%)	Monitoring (%)	Total litter (nº)
North-east Atlantic Ocean	1198	85	15	680 124
Mediterranean Sea	1194	63	37	1 019 229
Black Sea	355	55	45	304 594
Baltic Sea	173	70	30	34 080
Total	**2920**	**72**	**28**	**2 038 027***

***Note:** Numbers in this table reflect only the data of sea beach events (i.e. excluding river and lake shore events), period 2013–2021.

3.1 Which data are used for the assessment?

There are two types of events covered in the MLW dataset: "monitoring" and "clean-up". Within the scope of the MLW initiative, the term "monitoring" event is used to describe the data (which includes also the data officially reported by some EU Member States) collected at preferably seasonal intervals from the same beach by the experienced MLW communities, applying the Methodology for Monitoring Marine Litter on Beaches (EU MSFD TGML, 2013). Since 2015, the MLW communities have been moving towards organising monitoring events to provide more reliable information in support of relevant European policies. However, "clean-up" events (which may not take the MLW methodology fully into account and are typified by a relatively simple protocol and a reduction in the levels of standardisation) still compose 72 % of all events in the assessment dataset. In this report, for simplification and consistency, only the MLW “monitoring” events data were considered.

[1] Includes all data reported and accepted to the MarineLitterWatch database, i.e. the period since 2013, all event types, all waterbody and beach types (including rivers and lakes).

For this report, a subset of MLW monitoring events was selected according to the following conditions: (i) events that took place in the period of 2015-2021; (ii) events at one of the four European seas; (iii) events at sea beaches (since the MLW dataset also covers some river and lake shores); (iv) beach sites between 90 and 850m in length; and (v) data records that pass the quality control criteria (e.g. checking for duplication, location, litter count, or other data inconsistencies).

Such selection criteria yielded data from 175 beach sites in 17 countries, covering four regional seas of Europe – with more than two-thirds of all sites located in Italy (77 sites), Denmark (22), and Romania (20); followed by the Ukraine (11) and other countries with less than 10 sites. From these beaches, 657 events are recorded, with the majority in 2015–2019, and a substantial decrease in 2020 probably due to the COVID-19 epidemic measures. The reference dataset analysed includes 511 838 litter items. The number of events varies between marine regions. To compare the beach litter abundance across the events, the counts of litter items are normalised to transects of 100 m.

Why do we use median values besides the mean for averaging the data?

TGML, as the main policy advising body on marine litter, has agreed to use the median as the calculation method to average beach litter data among surveys. The median is the middle value when a dataset is sorted from smallest to greatest. Unlike the mean, very high or very low values do not affect the median value in the dataset. Consequently, when some of the values are extreme (e.g. an anomalously high litter count), their effect on the median is smaller and hence a better averaging is achieved.

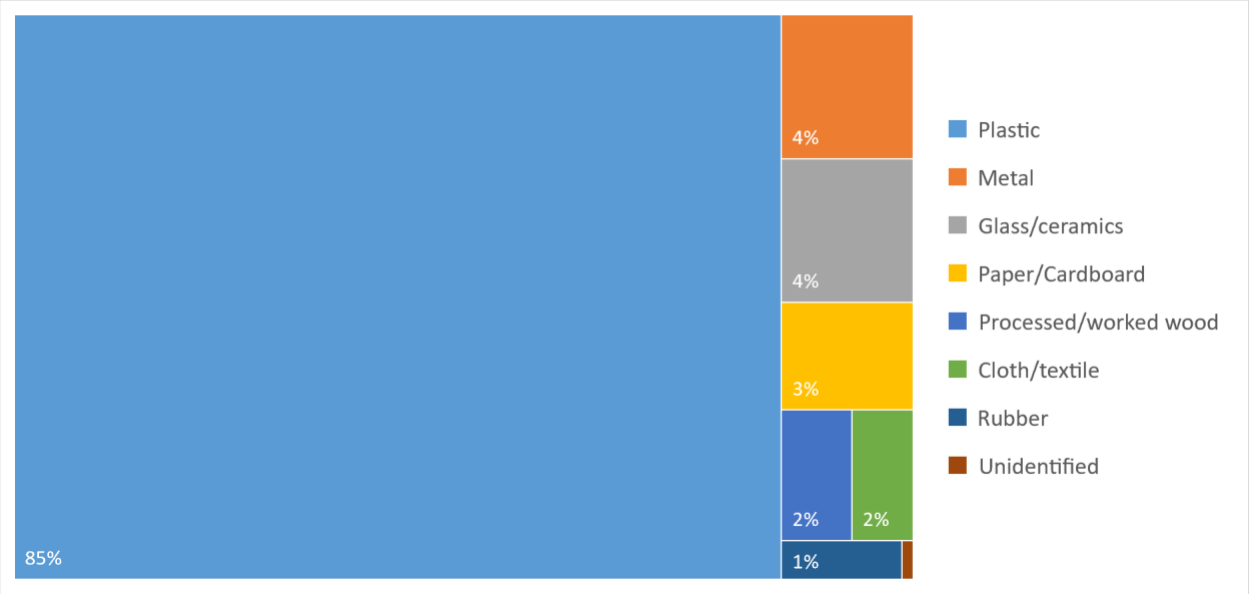
What are the litter items?

Currently, the MLW uses the 2013 litter categories list (known as G codes) of the EU MSFD TGML (TGML, 2013). A new scheme of the categorisation of beach litter items (known as J codes) was implemented by the TGML in 2021 to include new litter items continuously appearing in the environment (Fleet et al., 2021). MLW is expected to adopt this new scheme to harmonise with other relevant EU databases. For this, a methodology of list harmonisation and approaches for G-to-J codes conversion needs to be developed. In the present assessment, reported litter items were divided into SUP, fishing gear, fragments, other plastics and non-plastics according to J codes.

4 What is deposited on beaches as litter?

A total of 163 different litter items were recorded in the assessment dataset. Dividing the items per material type (plastic, glass/ceramics, metal, paper/cardboard, cloth/textile, processed wood, rubber and unidentified) clearly reveals that plastic is the most commonly found material on European beaches, representing 85 % of to the total marine litter items between 2015–2021 (Figure 1).

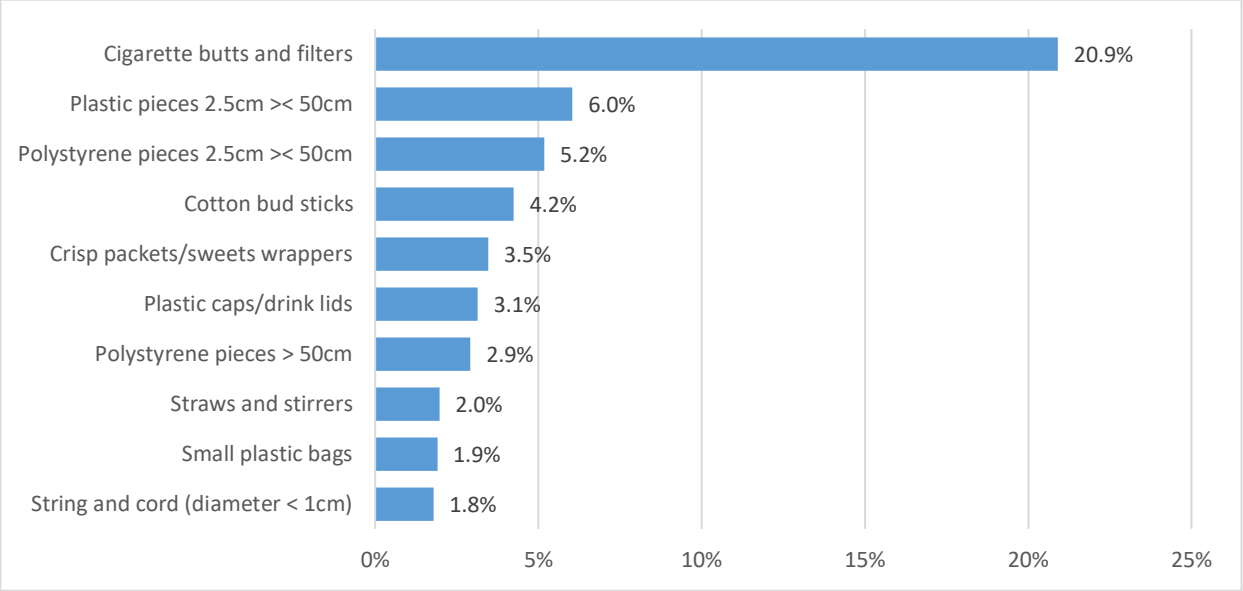
Figure 1: Contribution (%) of litter categories (based on total litter items per beach values) to total litter found on European beaches between 2015–2021 according to monitoring data



Looking at the top ten litter items in the MLW dataset (Figure 2), which represent more than half (52 %) of the total items, they are all made of plastic. The SUPs in the top ten items (cigarette butts and filters, plastic caps/drink lids , cotton bud sticks, crisp packets/sweet wrappers, small plastic bags (e.g. freezer bags incl. pieces), and straws and stirrers) comprised 36 % of the top ten items and 52 % of the total litter items reported found on EU beaches during 2015-2021. The only fisheries-related item found in the top 10 item list is string and cords (1.8 %).

Cigarette butts and filters are the most commonly reported item. Plastic fragments (plastic and polystyrene 2.5cm to 50cm) are the second and third most common item, accounting for 11 % of the top 10 items. Particular attention should be given to these plastic fragments (of an unspecified origin), as they have the potential to further fragment over time into numerous micro- and nanoplastics through physical and chemical processes.

Figure 2: Top 10 items (%) found on European beaches according to monitoring data

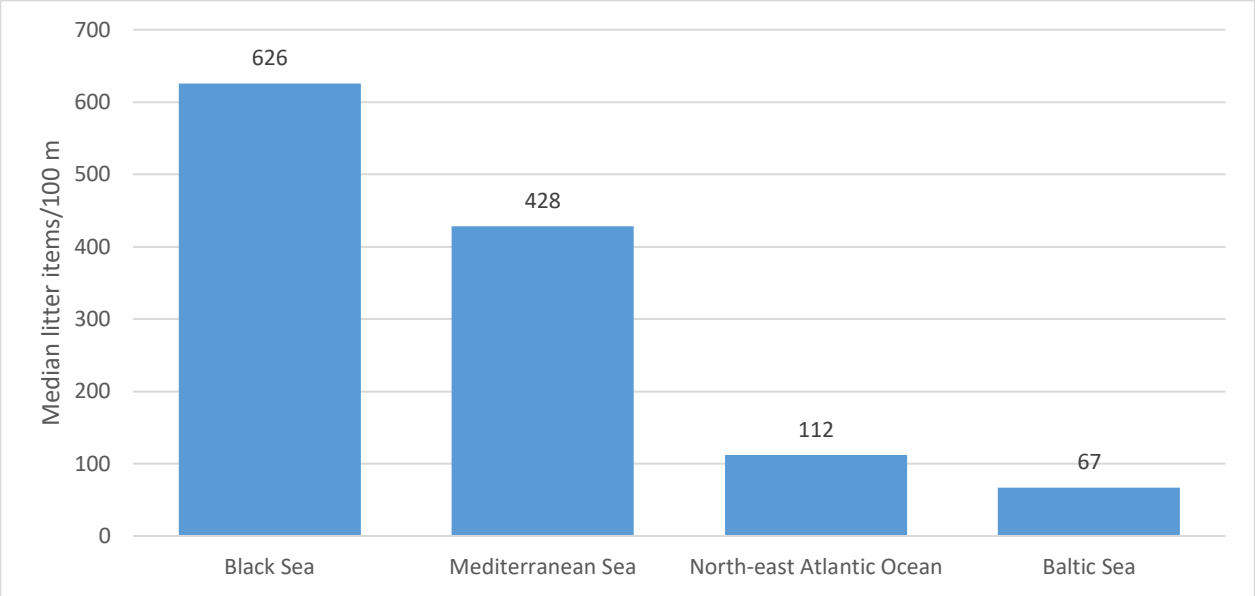


Note: The accumulated abundance of listed items is 52 %, thus less than the 80 % value recommended by OSPAR when listing top 10 items. The remaining items to reach 80 % were omitted for brevity.

5 Temporal and regional differences in the composition of beach litter

Beach litter abundance clearly differs across the four regional seas in Europe (Figure 3 and Map 1). The MLW data shows that the Black Sea is the most littered (median of 626 items/100 m), followed by the Mediterranean Sea (median of 428 items/100 m). The less littered beaches are found in the Baltic Sea (median of 67 items/100 m) and the North-east Atlantic Ocean also has a relatively low litter abundance (median of 122 items/100 m). The higher values in the Mediterranean Sea and the Black Sea could be related to the lower levels of environmental awareness, as well as to regional characteristics (semi-enclosed sea basins).

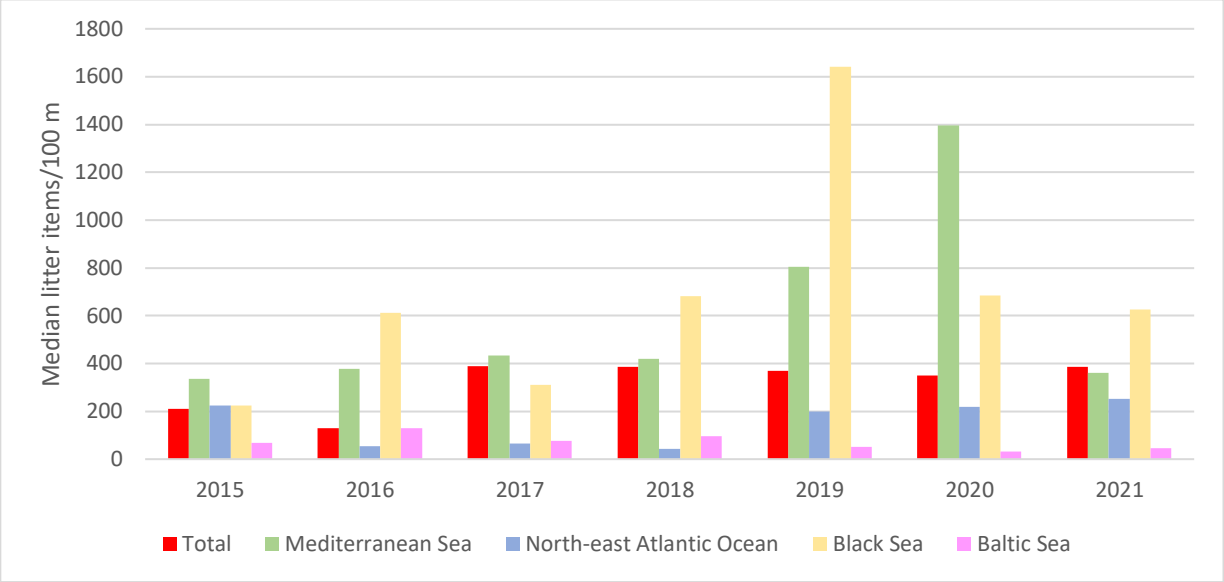
Figure 3: Median litter levels (items/100 m) found on the beaches of EU regional seas during 2015–2021 based on Marine Litter Watch monitoring data



A total of seven years of monitoring data (2015–2021) from the MLW dataset is not sufficient to undertake statistical analysis on long-term trends. The difference in surveying effort between the years also makes interpretation of year-to-year differences challenging. However, analysing the temporal changes in median beach litter abundance for the whole of the EU beaches (Figure 4) suggests a general increase in beach litter abundance from 2015 (a median of 210 items/100 m) to 2021 (a median of 388 items/100 m). When considering the annual evolution of beach litter abundance for each EU region (Figure 4) there is also a tendency for increasing values over the analysed period in the more polluted regions (the Black Sea and the Mediterranean Sea). For the less polluted regions, trends are more complex and data for the Baltic Sea in particular suggests a decreasing trend over the analysed period.

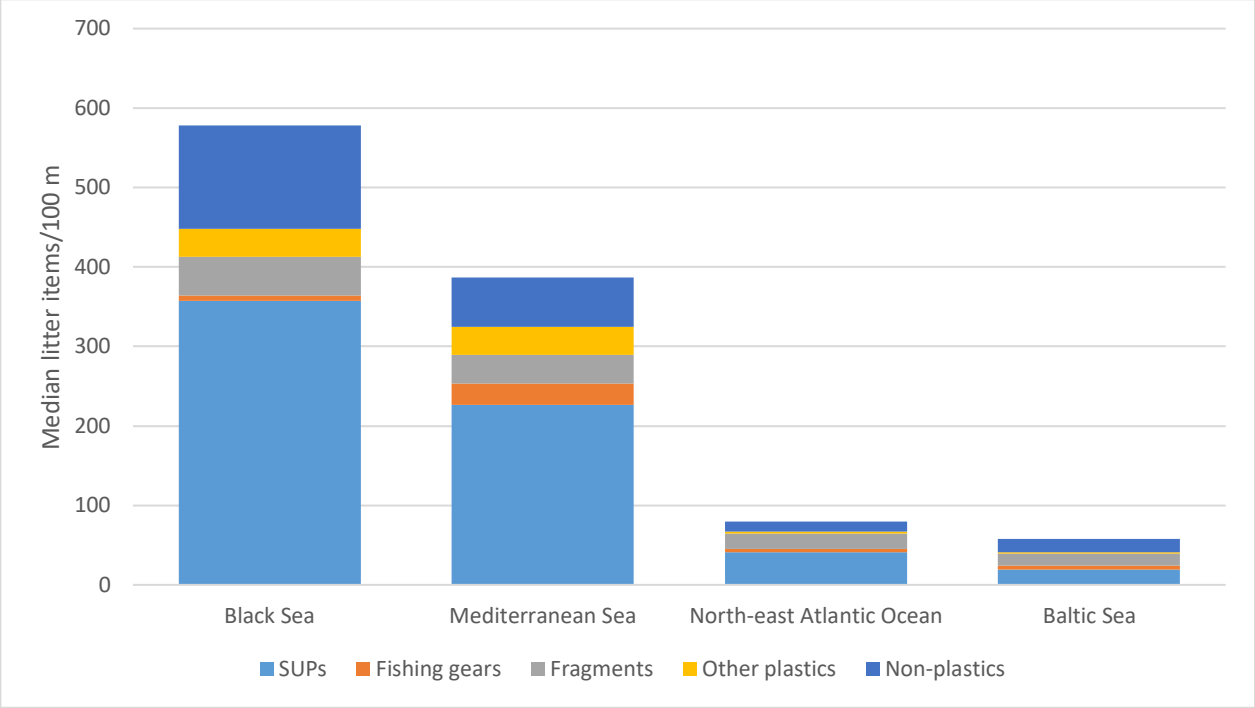
A change in litter abundance linked to the COVID-19 epidemic restrictions (e.g. reduced access to beaches) is likely to have occurred in 2020–2021. A notable decrease in 2021 was observed in the Mediterranean Sea, and there were also lower values in previous years for the Baltic Sea and Black Sea. Nevertheless, it is difficult to attribute these decreases in litter abundance to COVID restrictions with confidence.

Figure 4: Median litter items/100 m found on European beaches in the period 2015–2021 based on Marine Litter Watch monitoring data



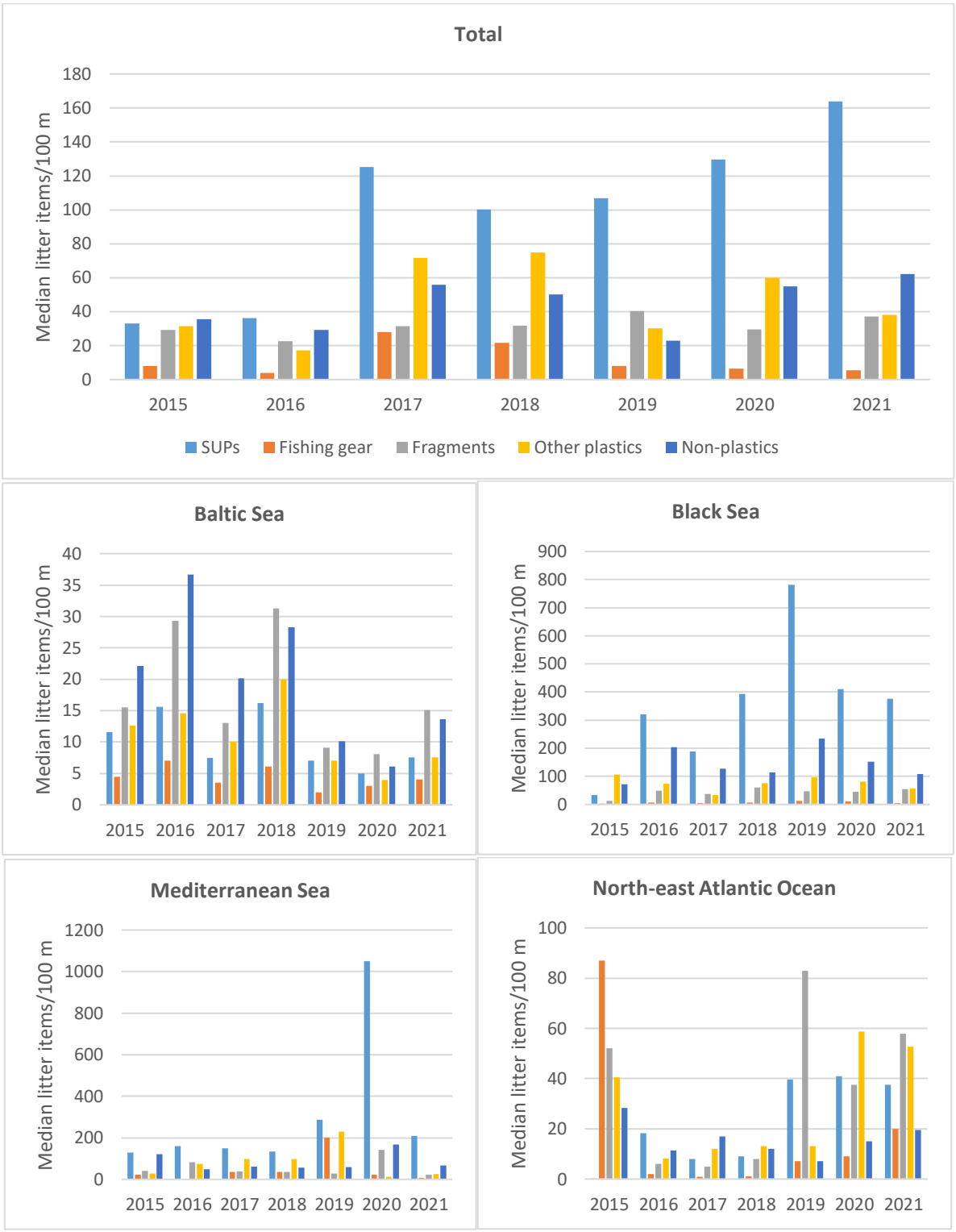
The MLW dataset reveals regional differences in litter composition (Figure 5). Amongst the five litter classes (SUP, fishing gear, fragments, other plastic and non-plastics), SUP stand out as the most abundant type of litter in the Black Sea (overall a median of 342 items/100 m), Mediterranean Sea (an overall median of 142 items/100 m) and in the North-east Atlantic Ocean (an overall median of 22 items/100 m); in the Baltic Sea, non-plastic litter was more abundant (overall a median of 20 items/100 m). In the Baltic Sea, it is interesting to note that fragments are more common (an overall median of 15 items/100 m) than SUP (overall a median of 10 items/100 m). The median number of fragments was the highest in the Black Sea (overall a median of 49 items/100 m), followed by the Mediterranean Sea (overall a median of 36 items/100 m) and the Nort-east Atlantic Ocean (overall a median of 19 items/100 m). The median number of fishing gear is the highest in the Mediterranean Sea (overall a median of 32 items/100 m), followed by the Black Sea (overall a median of 7 items/100 m), Baltic Sea (overall a median of 5 items/100 m) and the North-east Atlantic Ocean (overall a median of 4 items/100 m). MLW monitoring data in the Black Sea is mainly from the western part, whereas the intense fisheries occur along the south-eastern Black Sea, which might also influence the results. Another explanation would be that the Mediterranean Sea is subject to more litter originating from the fishery, when compared to the North-east Atlantic Ocean, Baltic Sea and Black Sea.

Figure 5: Median number of Single Use Plastics (SUP), fishing gear, fragments (2.5 to 50 cm and > 50 cm plastic and polystyrene pieces combined), other plastics and non-plastic litter items found on the European regional seas' beaches



The annual evaluation of litter composition is shown in Figure 6. Overall, for all regional seas combined, MLW monitoring data suggest an increase in SUPs abundance from 2015 (a median of 210 items/100 m) to 2021 (a median of 388 items/100 m), in parallel with the previously described trend in total litter abundance. This general increasing trend in SUP is also observed for the Black Sea, the Mediterranean Sea and the North-east Atlantic Ocean. In the Baltic Sea, which is the less polluted region, trends are more complex showing lower values of SUP towards the end of the analysed period.

Figure 6: Median number of Single Use Plastics (SUP), fishing gear, fragments (plastic and polystyrene pieces 2.5 to 50 cm and > 50 cm combined), other plastics and non-plastic litter items found on European regional seas' beaches



The list of top 10 items for the four European seas (Table 2) reveals the prevalence of cigarette butts and filters as the most common item in the Black Sea and Mediterranean Sea, with lesser contributions in the North-east Atlantic Ocean and Baltic Sea. Plastic pieces 2.5 cm to 50 cm are the most common items found on beaches of the North-east Atlantic Ocean, while the construction material (brick, cement, pipes) are the most common items found on beaches of the Baltic Sea. Fisheries-related items in the top 10 litter list (string and cords, and nets & pieces of net < 50 cm) were only found in the North-east Atlantic Ocean and Baltic Sea.

Table 2: Top 10 items found at EU regional seas and their contribution (%) to total litter

North-east Atlantic	%	Mediterranean Sea	%	Black Sea	%	Baltic Sea	%
Plastic pieces 2.5 cm > < 50 cm	21	Cigarette butts and filters	12	Cigarette butts and filters	42	Construction material (brick, cement, pipes)	12
String and cord (diameter less than 1 cm)	9	Polystyrene pieces 2.5 cm > < 50 cm	7	Crisp packets/sweet wrappers	6	Polystyrene pieces 2.5 cm > < 50cm	10
Cotton bud sticks	8	Polystyrene pieces > 50 cm	6	Plastic caps/ drink lids	4	Plastic pieces 2.5 cm > < 50cm	8
Polystyrene pieces 2.5 cm > < 50 cm	6	Cotton bud sticks	5	Plastic pieces 2.5 cm > < 50 cm	4	String and cord (diameter less than 1 cm)	4
Cigarette butts and filters	6	Plastic pieces 2.5 cm > < 50cm	3	Small plastic bags	3	Foam sponge	4
Crisp packets/sweet wrappers	4	Plastic caps/ drink lids	3	Straws and stirrers	3	Bottles incl. pieces	4
Foam sponge	3	Bottle caps, lids & pull tabs	2	Glass or ceramic fragments > 2.5 cm	3	Other textiles (incl. rags)	4
Plastic caps/ drink lids	3	Shopping bags incl. pieces	2	Other paper items	2	Crisppackets/ sweet wrappers	4
Nets and pieces of net < 50 cm	2	Straws and stirrers	1	Polystyrene pieces 2.5 cm > < 50 cm	2	Other wood < 50 cm	3
Plastic/ polystyrene pieces 2.5 cm > < 50 cm	2	Shotgun cartridges	1	Other textiles (incl. rags)	2	Cigarette butts and filters	3
TOTAL	**64**		**42**		**71**		**57**

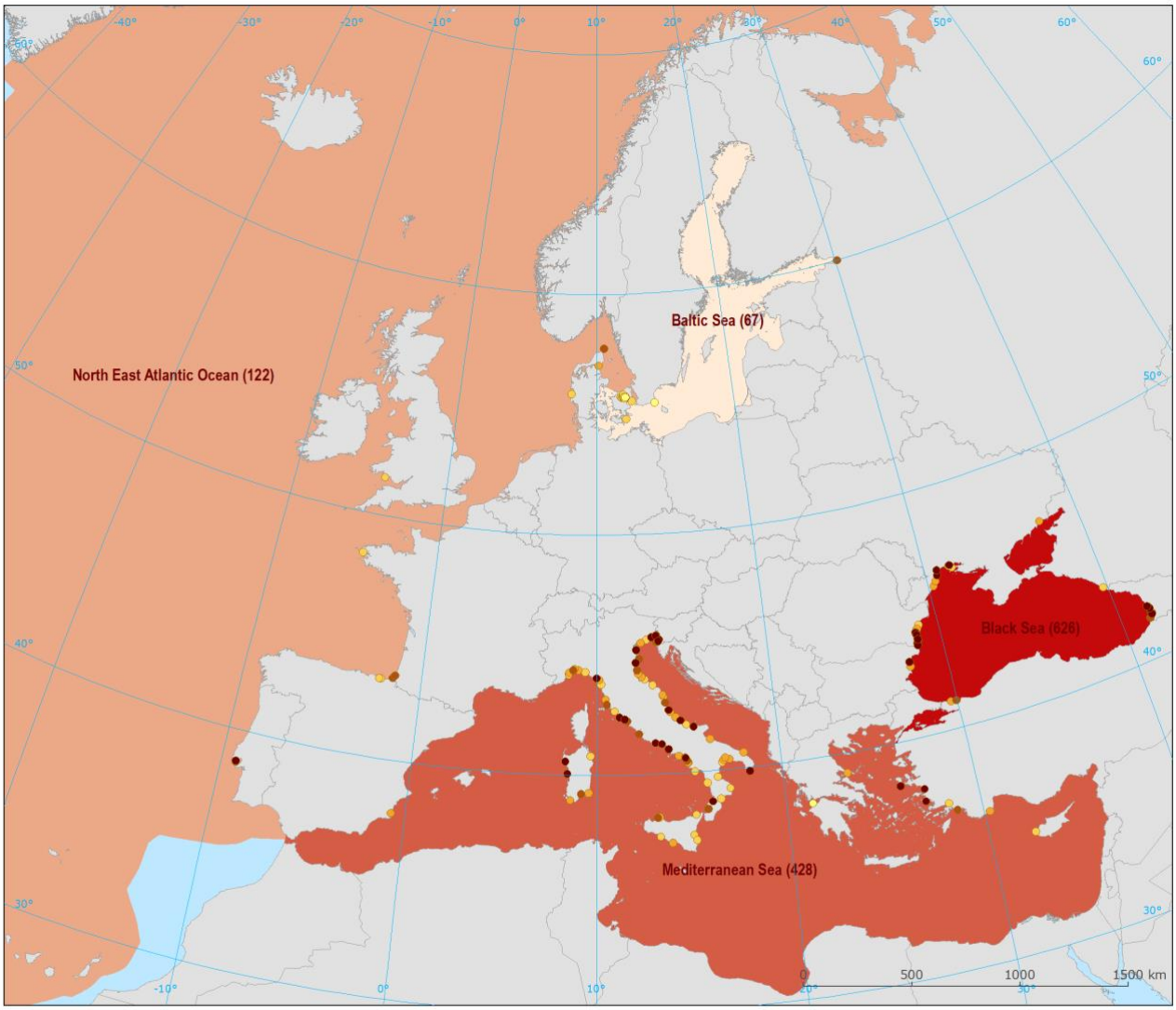
6 The prospects of beach litter and how litter concentration relates to EU marine litter policies

Following the recognition of marine litter as one of the major threats to the oceans, there is an urgent call for policy development and long-term monitoring litter programs. The EEA MLW initiative has successfully engaged citizens in collecting a massive amount of data on the litter along the beaches of European seas. The MLW dataset provides a unique view of the status of litter on beaches and has revealed important regional differences among the European seas. Monitoring results are used to identify the types and sources of litter and support and justify policy decisions, such as those that aim to protect and restore the marine environment by introducing bans or restrictions on certain items to minimise their environmental impacts. The MSFD, the ZPAP, and the SUPD are the most important of the various directives and policies at the EU level that tackle the problem of marine litter.

The MSFD provides the EU legal framework for the protection of the European seas (EU, 2008). Marine litter is included as one of the descriptors (D10) for achieving and maintaining Good Environmental Status (GES) of European marine waters and protecting marine resources. The achievement of GES will occur only when properties and quantities of marine litter do not cause harm to the coastal and marine environment.

The threshold value for beach litter "Good Environmental Status" was defined as 20 macro litter items/100 m of beach strip by the EU MSFD TGML, universally for all European beaches (Van Loon et al. 2020). Applying this threshold value to the MLW monitoring database for the period 2015-2021 reveals that the overall median values of beach litter abundance exceed the threshold in all four European seas (Figure 4). However, MLW data assessment is indicative and can only be used supplementary to the MSFD monitoring data of the EU Member States.

Map 1: Median number of beach litter items per 100 m by marine region and beach



One of the six main interim targets of the ZPAP for 2030 is reducing litter at sea by 50 % (EU, 2020). The MLW data shows slightly decreasing trends on a European scale except for 2021. It must not be forgotten that MLW data is complementary to the MSFD-reported official Member States` data. Member States` data is used for the evaluation of achieving the MSFD GES, and the ZPAP main target on reducing litter, whereas the MLW data is indicative.

More years worth of data in the MLW dataset and standardisation of the monitoring efforts will support the presently observed differences among European seas and clarify on temporal trends, providing useful information to aid the EU policies on the marine litter problem.

SUPD aims to prevent and reduce the impact of certain plastic products on the environment, in particular the aquatic environment (EU, 2019). Member States must have in place measures to ensure that certain single-use plastics (cotton bud sticks, cutlery, plates, straws, stirrers, balloons sticks, as well as cups, food

and beverage containers made of expanded polystyrene and all products made of oxo-degradable plastic) can no longer be placed on the EU market. The MLW monitoring data indicates that SUP items such as cigarette butts and filters, plastic caps/ drink lids, cotton bud sticks, crisp packets/sweet wrappers, small plastic bags, straws and stirrers comprised 52 % of total litter items found on EU beaches. MLW monitoring data confirms that the implementation of EU legislation on SUPs/fisheries is important for decreasing the levels of plastic litter in the marine environment. Concerning the implementation of the SUPD, it is too early to comment on SUP item trends. The Directive`s implementation and restrictions/bans started very recently, and therefore we will only be able to observe the results in the coming years.

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