

Marine litter and European beaches: learning from citizen science



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The report is based on the work of the European Topic Centre for Inland, Coastal and Marine Waters (ETC/ICM) in relation to the EEA Marine Litter Watch (MLW) project, and the data collected and reported by MLW communities and individuals. We thank all the MLW communities and individuals who provided beach litter data and contributed to the initiative for more than six years.

We acknowledge the review done by Dr Angel Borja (AZTI, Spain), EEA support and guidance by Stéphane Isoard, and also Peter Christian Kjeld for compiling/sending the raw data. We also thank Andrea Winterstetter and Joana Veiga for their packaging related comments and suggestions made in this report.

1 Introduction

As a result of the linear economy, litter is piling up on beaches. Litter could be transported via atmosphere, rivers, run-off and sewerage. It can enter the marine environment mainly from land but also sea-based (e.g. such as fishing, aquaculture, shipping and coastal tourism) activities. Once in the marine environment, it can move with currents globally whilst some are deposited on the seafloor or the coast.

Globally, as early as 2010, about 8 million tonnes of plastic was estimated to end up in oceans in a year (Jambeck et al. 2015; Ritchie & Roser 2018). González-Fernández et al. (2021) calculated the annual leakage of floating macroplastic from European rivers to the ocean as between 1,656–4,997 t (or 307–925 million items). Plastics made up 82 % of all riverine litter transported to the European seas (González-Fernández et al. 2021).

Not only is plastic the most common beach litter item, but also its environmental impacts are largest in coastal and marine ecosystems because, (a) they make the bulk of the debris; (b) are susceptible to fragmentation that is in turn very harmful when ingested easily by many organisms; (c) made up of hundreds of different synthetic polymers and additives, which are in many cases well documented for their harmful effects on organisms; and (d) having long life cycles. Other litter groups, such as metals, glass, cloth/textile, etc., are also harmful to marine organisms causing entangling, blockages in digestive systems following consumption and smothering of their habitats.

Marine litter causes enormous economic cost, ecological damage and social impact, adversely affecting tourism, fisheries, shipping and many other economic sectors. Costs of litter to EU fishery and tourism/recreation were once calculated as a minimum of 61.7 and 630 million Euros respectively for the EU ([ARCADIS 2013](#)). Predominately consisting of improperly disposed of plastic waste and mismanaged plastic materials, marine litter is one of the biggest threats to marine biodiversity. Microplastics (< 0.5 mm) following ingestion by marine animals, such as fish and mussels, may eventually end up in the human food chain. Therefore, marine litter is also an important issue for human health.

In this context, the Marine Litter Watch (MLW) initiative is the European Environment Agency's (EEA) attempt on engaging citizens to collect data on litter along the beaches of European seas (Rubio-Iglesias et al. 2020). Assessment of these citizens' data may help to strengthen Europe's knowledge base on beach litter and thus provide support to relevant/interrelated European policies in tackling plastic pollution and marine litter, whilst accelerating the transition to a circular plastics economy, most notably the Marine Strategy Framework Directive (MSFD), the Single Use Plastics Directive (SUPs), the Zero Pollution Action Plan (ZPAP), Green Deal and Circular Economy Action Plan (CEAP).

It is worthy to note that at present the EEA is also preparing a report entitled "Marine Litter in Europe: An Integrated assessment from source to sea" considering a holistic evaluation of litter, including those discharged via run-off and rivers from inland sources. This technical report aims at assessing marine litter from a life-cycle perspective, starting from production until which some of it reaches the marine environment as waste following inadequate disposal or mismanagement. This report provides further beach litter information for EEA holistic marine litter assessment.

This report builds on the recently published ETC report entitled "[Marine Litter Watch \(MLW\) European Beach Litter Assessment 2013–2019](#)" where some conclusions were drawn (Kideys & Aydın 2020a). It was shown that the beaches of all EU seas, rivers or lakes are all polluted with litter, but there are spatial and temporal differences among the four regional seas of Europe until the end of 2019. The present report utilizes also 2020 data when the COVID problem also affected marine litter composition and had an affect on the amount of litter production and abundance. Both monitoring and clean-up events were used in this report as opposed to analyses from mainly monitoring type events in the previous report. In addition to separate analyses for the SUPs and fisheries-related items, an assessment of specifically plastic packaging items was also undertaken for the first time in this report.

KEY MESSAGES:

- Although both clean-up and MLW-type monitoring data are included in this report, the conclusions here are not very different than those found in the "[Marine Litter Watch \(MLW\) European Beach Litter Assessment 2013-2019](#)" report published last year.
- It could be reiterated that citizens populate the EEA's MLW database with an immense amount of data (over 2 million items), making it an important database for beach litter worldwide.
- Plastics dominate the litter collected from European beaches, reaching more than a 80 % share of beach litter found in all seas except the Baltic Sea (67.3 %).
- SUPs, together with fishery-related items, make up the bulk of the top ten list of beach litter.
- Whilst the share of SUP is highest in the Black Sea (65.3 %) and the Mediterranean (53.3 %), fishery and shipping related litter is highest in the North Atlantic Ocean (15.2 %) among EU seas.
- Shares of packaging related litter ranged between 17.7 % and 27.9 % in EU seas.
- The Mediterranean Sea and the Black Sea coasts appear more polluted compared to the North Atlantic Ocean and Baltic Sea. Shares of SUPs and Packaging+small non-packaging items were also highest in the Black Sea and the Mediterranean Sea.
- When the Black Sea is excluded, the evolution of the litter abundance trend was high until 2017 after which it was consistently heading towards a downwards trend, with the lowest values occurring in 2020, possibly due to the COVID lockdowns. Hence, the median values estimated from the MLW database for the Baltic Sea and the northeast Atlantic Ocean in 2020 (about 32 items/100 m) were close to the threshold set for the EU beaches (20 items/100 m of beach).

2 Marine Litter Watch: citizen science for cleaner beaches

Information and data are essential for tackling marine litter. The EEA developed the 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 in providing structured data on marine litter and at the same time to clean up Europe's beaches.

2 101 280 ITEMS

belonging to plastic, rubber, textile, paper, wood, metal, glass and ceramic
collected under the MLW globally (2013–2020, excluding duplicates/test cases/zero values)

The MLW [dataset](#) has been constantly growing via community inputs based on clean-up events (surveys) as well as via more systematic monitoring (as explained below) events since 2013. Until the end of 2020, 3311 events have been organised by at least 59 different communities (citizen groups). The events have been taking place in 36 countries from all over the world. Here, we present results for the four European seas; the North Atlantic Ocean, Mediterranean Sea, Baltic Sea and the Black Sea.

Box 1 How did we process the data for this report?

For this report, a subset of the MLW dataset was selected according to the following conditions: events that took place between 2013 and 2020; events at one of the four European seas; events at sea beaches (since the MLW dataset also covers some river and lake shores); beach sites between 90 and 850 meters in length; data records that pass the quality control criteria; e.g. checking for duplication, location, litter count (zero or blank excluded, as well as paraffin/wax), or other data inconsistencies.

Such selection criteria yielded data on > 800 beaches in 27 countries covering the four regional seas of Europe – with one-third of all sites being located in three countries: France, Italy, and Spain. From these beaches, 1440 events were recorded, with the majority in 2015–2019. The reference dataset analysed includes 1 178 143 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 metres.

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 include also official data from some EU countries) collected at preferably seasonal intervals from the same beach by the experienced MLW communities, fully using the [Methodology for Monitoring Marine Litter on Beaches](#) (based on Galgani et al. 2013). Since 2016, 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 MLW methodology fully into account and are typified by a relatively simple protocol and a reduction in the levels of standardisation) still compose 53 % of all events in this report dataset.

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

The EU [Technical Group on Marine Litter](#) (TGML), the main policy advising body on marine litter, [agreed to use the median](#) as the averaging method to mean beach litter data among surveys (Hanke et al. 2019). 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, their effect on the median is smaller and hence better than mean values.

What are the litter items?

At present, the MLW uses the 2013 litter list (known as G codes) of the TGML. It is worthy to note that a new scheme of categorization of beach litter items has been suggested by the TGML in 2021 to include new litter items continuously appearing in the environment. The MLW is expected to adopt this new scheme to harmonize with other relevant EU databases. In this report, in addition to the usual evaluation of SUPs and Fishery Related Items (FISH), a separate assessment for “packaging” items was used for the first time, following a categorization by Dr Andrea Winterstetter and Dr Joana M. Veiga (personal communication).

3 What is deposited at beaches as litter?

Belonging to eight groups (plastics, glass/ceramics, metal, paper/cardboard, cloth/textile, processed wood, rubber and unidentified), 163 different litter items were recorded in the MLW dataset. During 2020, COVID related items, such as single-use masks and gloves, were also recorded for the first time in the MLW database. The MLW database populated by citizens is apparently showing the immediate effects of the COVID-19 epidemics.

In the MLW database, cigarette butts/filters are the most abundant plastic litter item, with 24 % (Figure 1). The share of these items could be even higher considering their underestimation due to sampling problems.

Figure 1: Top ten items found at European beaches (2013–2020, total number is 1 178 143 litter items)

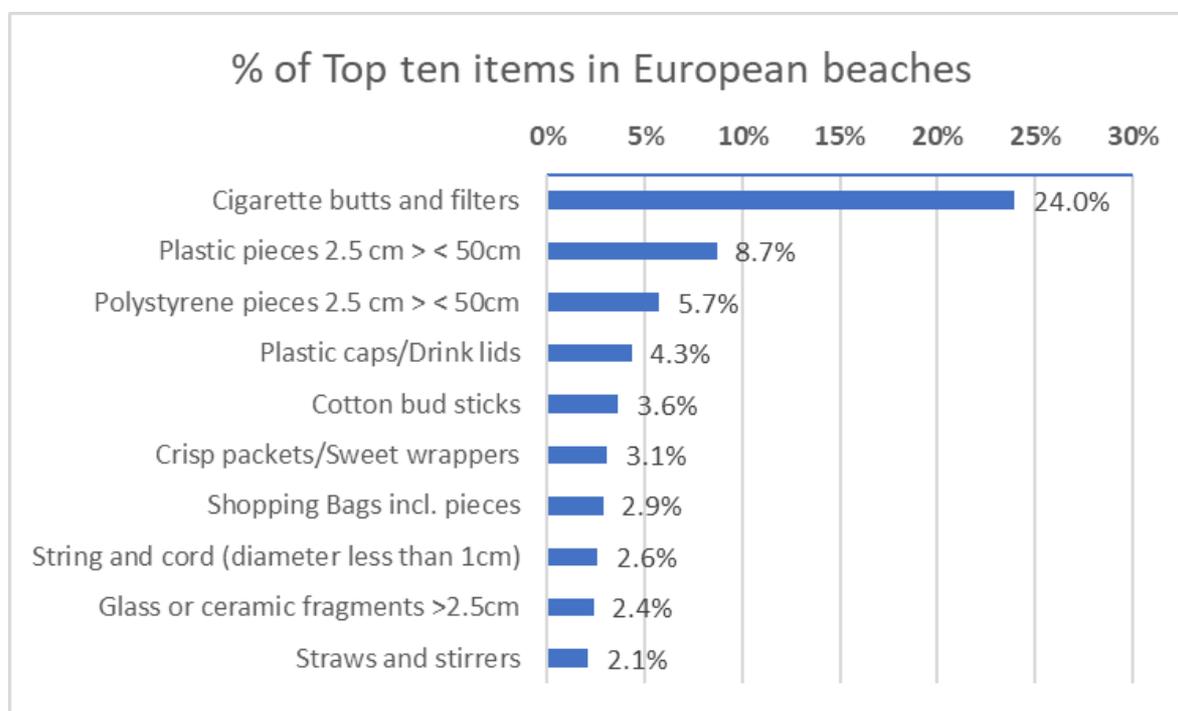


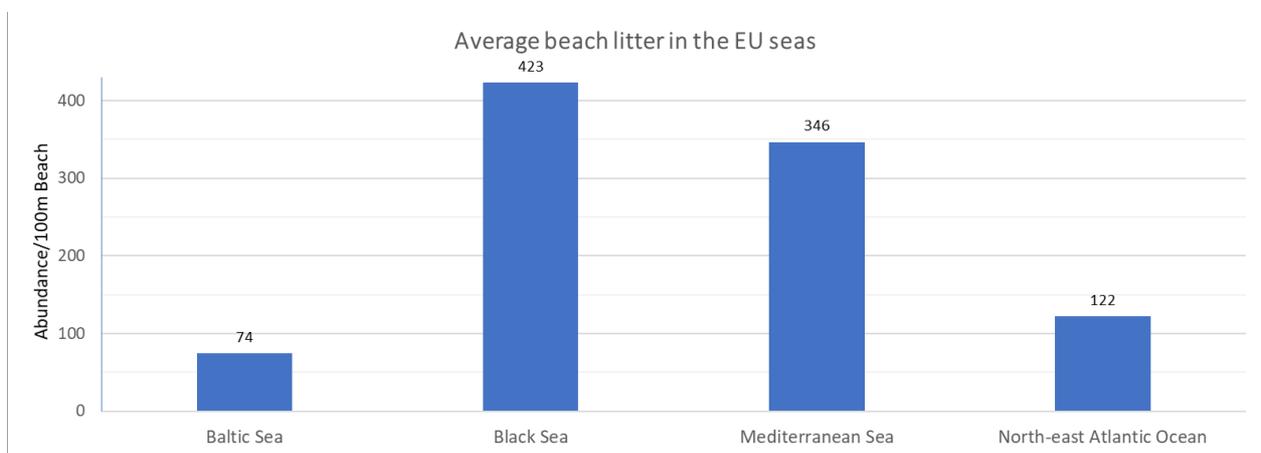
Figure 1 shows that SUP items (i.e. plastic/polystyrene pieces, caps/drink lids, cotton bud sticks, shopping bags, straws/stirrers) comprise the largest component of the total litter. SUPs make up about one-third of plastic production globally (ref: <https://sourceofplasticwaste.org/>; accessed in November 2021).

4 There are regional differences in the levels and composition of beach litter

Regional differences in the levels and share of different litter groups/items can be depicted through the four regional seas of Europe. For the combined clean-up and monitoring data having only 90–850 m of beach length, the Black Sea (median 423 items) and Mediterranean Sea (median 346 items) coasts appear more polluted when compared to the north Atlantic Ocean (median 122 items) and Baltic Sea (median 74 items), being the median values standardized per 100 m of beach (Figure 2 and Map 1). One main reason for the higher values in the Mediterranean Sea and the Black Sea could be related to a lower level of environmental awareness in general, compared to the latter two regions. It is worthy to note that all these median values are much higher than the threshold set for EU beaches (i.e. 20 items/100 m of beach, Van Loon et al. 2020).

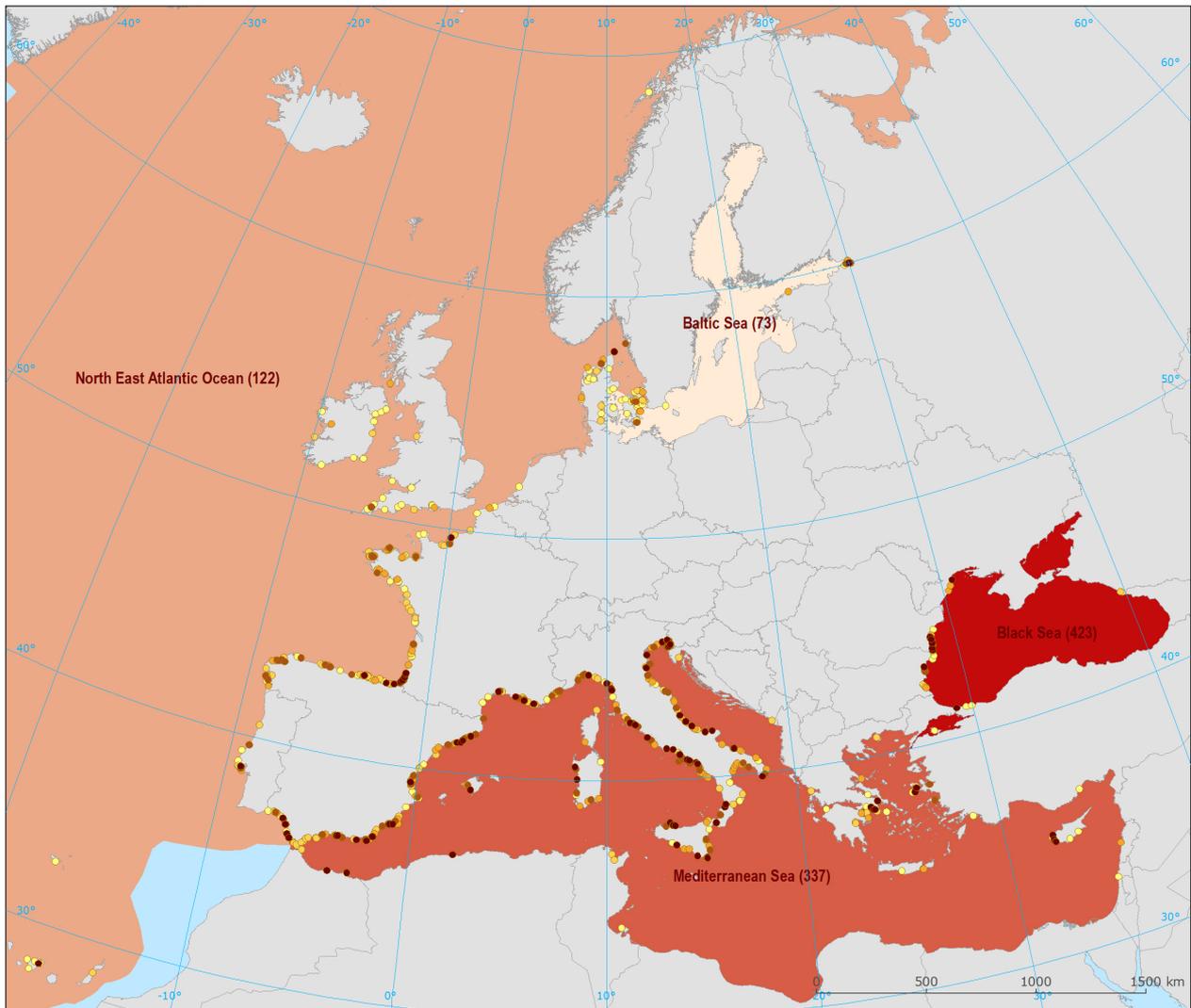
The median values were generally high in some non-EU countries such as Algeria (4029 items) or Morocco (1152 items), but low for some others such as Israel (67 items) or Tunisia (154 items), and close to the region median for some others such as Russia (289 items) and Ukraine (269 items), (it is worthy to note that survey numbers were very low in these countries, i.e. 1–4).

Figure 2: Median litter levels in four regional EU seas from 2013–2020



There were also regional differences in the most abundant litter types. Plastics are the most abundant litter group, reaching more than a 80 % share of beach litter in all seas apart from the Baltic Sea (67.3 %). Whilst the share of SUP is highest in the Black Sea (65.3 %) and the Mediterranean (53.3 %), fishery and shipping related litter is highest in the North Atlantic Ocean (15.2 %) among EU seas (Figure 3). This shows that SUP related measures should be primarily considered in the Black Sea and the Mediterranean Sea, and more action should be taken in the north Atlantic Ocean region for preventing litter sourced from the fishery. Packaging related litter had a range of 17.7 % – 27.9 % in European seas. The differences in litter levels among the regions could be mainly due to the behavioral habits of populations living in coastal areas and river basins.

Map 1: Median number of beach litter per 100 m by marine sub-region/region and median number in each beach site (as circles)

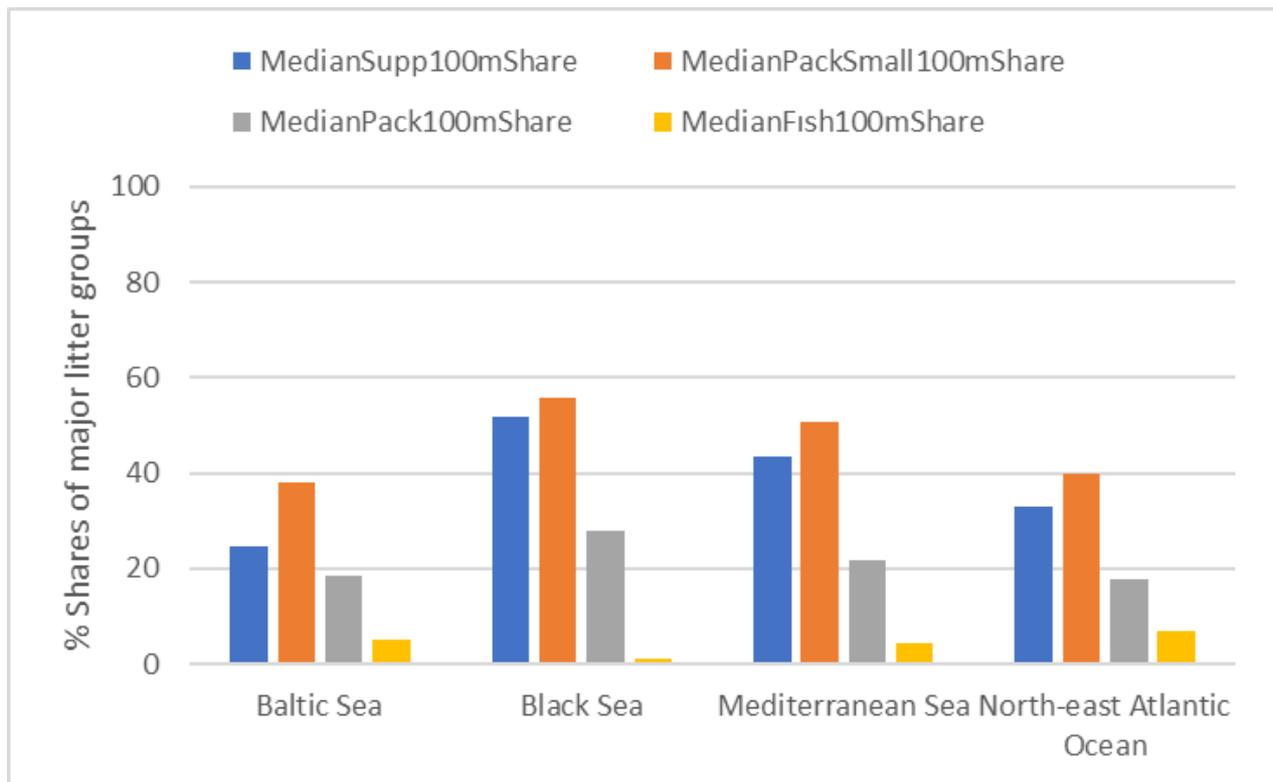


Beach site - Items per 100 m

- >1000
- >500 - 1000
- >250 - 500
- >100 - 250
- ≤100

Note: The median number of items per 100 m of beach, averaged by regional sea and illustrated with graduated colouring for each sea, is given in parentheses.

Figure 3: Shares of Packaging+Small non-packaging, Single Used Plastics (SUP), Packaging and Fishery related (FISH) items in beach litter (per 100 m) of the European seas (2013–2020)



5 The prospects of beach litter

Eight years of data from the MLW is not sufficient to undertake statistical analysis to show any long-term trend. However, Figure 4 hints that the evolution of the litter abundance showed an upward trend until 2017, after which gradual decreases are observed for some regions (such as the Baltic and the Mediterranean seas). Such a decrease was also evident at the EU level when the Black Sea, having the highest beach litter values within Europe, was excluded (see Figure 4). This is similar to the findings of Kideys & Aydın (2020b) using only MLW-monitoring data. The lowest annual values were generally observed in 2020, most probably because the COVID lockdowns. In 2020, the median values estimated from the MLW database for the Baltic Sea and the northeast Atlantic Ocean (about 32 items/100 m) were close to the threshold set for the EU beaches (20 items/100 m beach; Van Loon et al. 2020). This indicates that, except the Black Sea, COVID restrictions have generally positively affected litter levels on European beaches. The reason for high values in the Black Sea could be due to the continuous input from some hot spots, especially along the Turkish coasts where there are remnants of solid waste depositions in some areas right on the coast (see <https://www.sozcu.com.tr/hayatim/yasam-haberleri/deniz-kiyisinda-cop-dagi/>).

Figure 4: Annual median values of beach litter (per 100 m) in each of the four regional seas, for the entire EU and without the Black Sea (Note the different scale for the Black Sea)

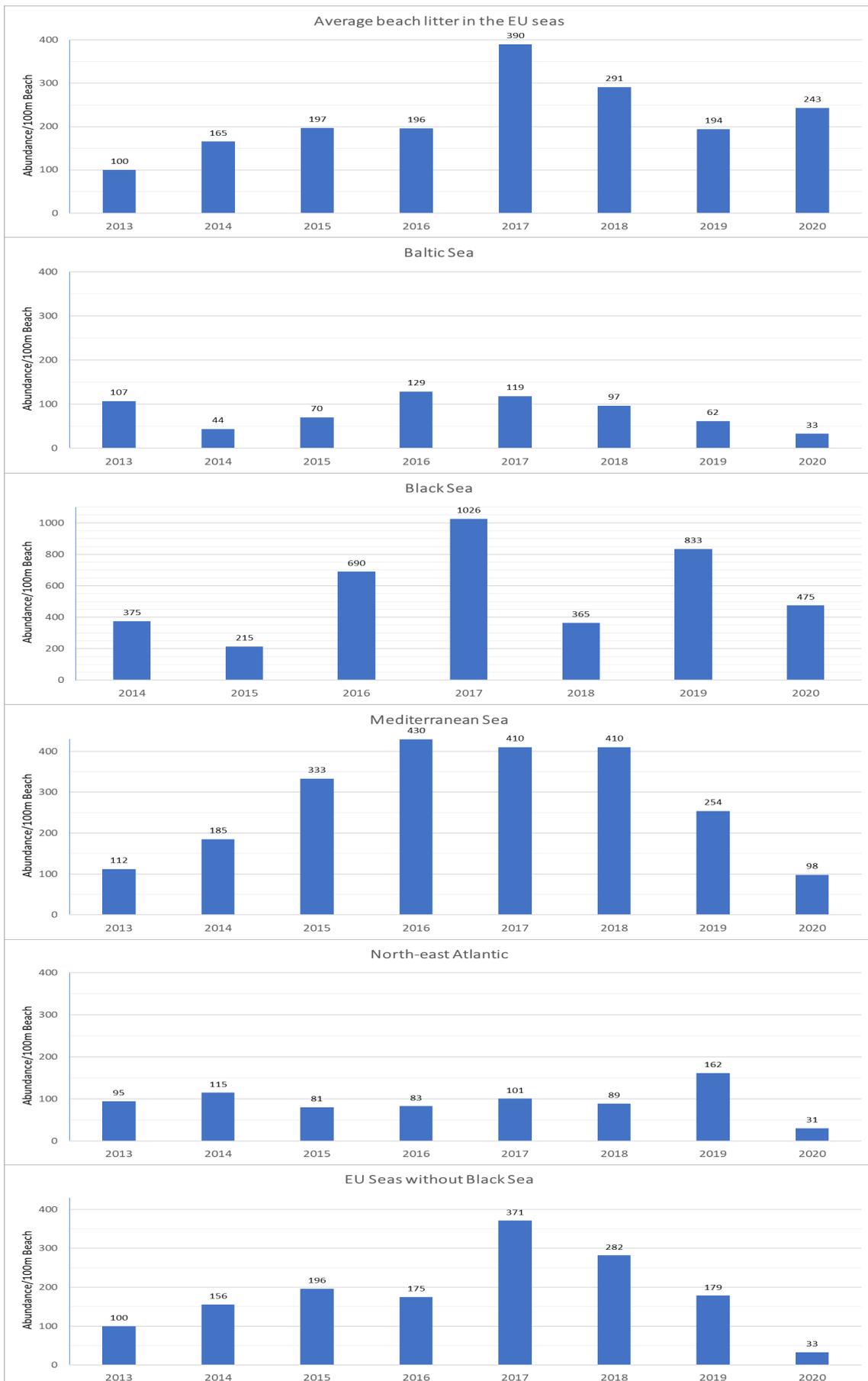
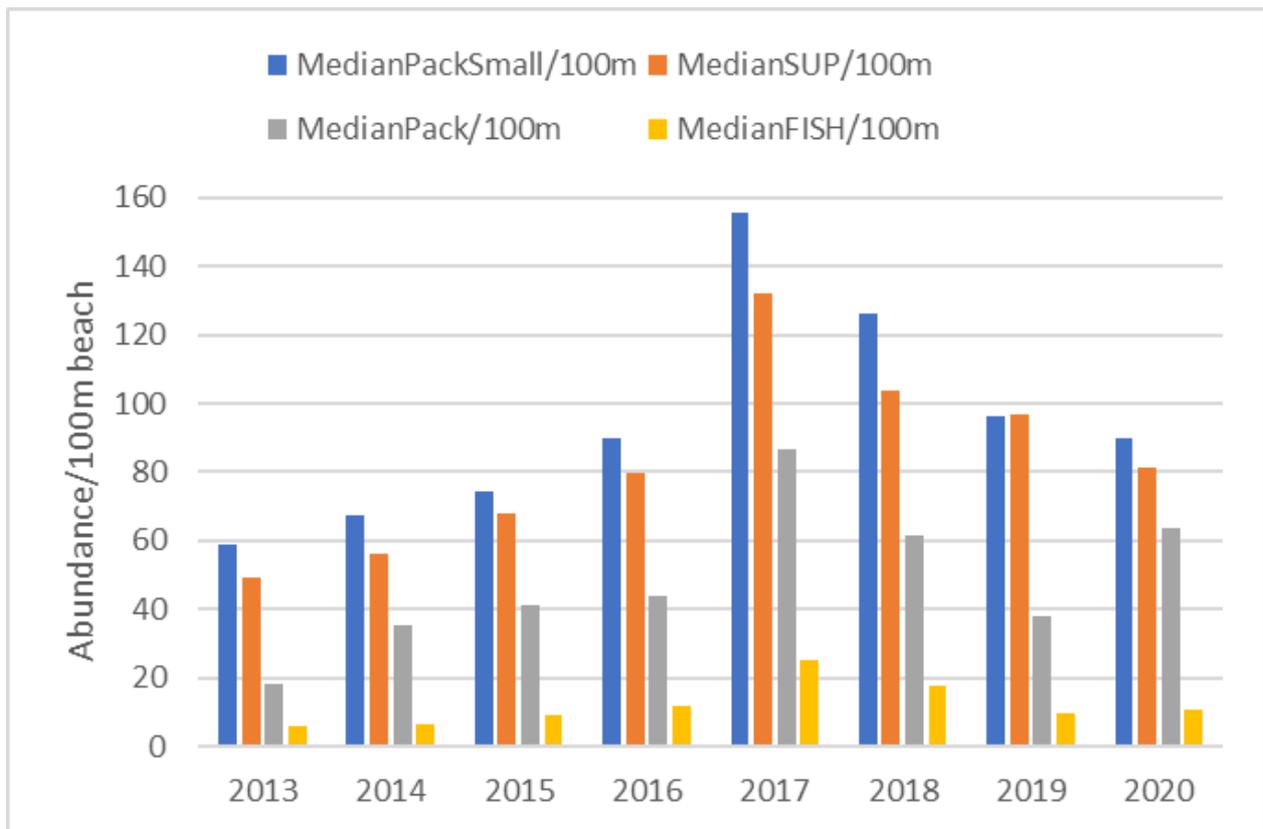


Figure 5: Annual median values of Packaging+Small non-packaging, Single Used Plastics (SUP), Packaging and Fishery related (FISH) items in beach litter (per 100 m) of the European seas



Levels and evolution of packaging, small non-packaging and SUPs were very similar to each other through the years; gradually increasing to reach the maxima (156 and 132 items/100 m of beach, respectively) in 2017, after which steadily decreasing. Packaging items also showed a similar pattern, except for the year 2020, when they had the second-highest value (64 items/100 m) throughout the series. The shares of fishery-related items were always low in marine litter and again showed the highest values in 2017 (25 items/100 m of beach).

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