



JRC TECHNICAL REPORTS

Marine Beach Litter in Europe – Top Items

A short draft summary

Georg Hanke

2016

This publication is a Technical Report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policy-making process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

Contact information

Name: Georg Hanke

Address: European Commission, Joint Research Centre (JRC), Directorate D Sustainable Resources, Water and Marine Resources Unit, Enrico Fermi 2749, 21027 Ispra, Italy

E-mail: georg.hanke@jrc.ec.europa.eu

Tel.: +39 0332 78 5586

JRC Science Hub

<https://ec.europa.eu/jrc>

© European Union, 2016

Contents

Marine Litter – The top ten items	1
Introduction	1
Identification of top ten litter items	1
European Regional Seas	5
OSPAR	6
HELCOM	8
MARLIN Project	9
Mediterranean Action Plan	11
Black Sea Commission	14
EEA Marine Litterwatch	15
Top Ten item identification	16
Tentative ranking across item lists	18
Conclusions	20
Discussion Annex:	21
Beach Litter origin	21
Beaches as Litter sinks and sources	21
Considerations regarding data quality and coverage:	22
Acknowledgements	23
References	23

Marine Litter – The top ten items

Introduction

In order to advance actions against marine litter and to facilitate the selection and implementation of the most effective reduction measures, the most frequently occurring litter items have been identified by analysing beach-clean-up and monitoring data from beaches and other marine matrices.

This compilation of ranking lists should provide an update based on latest information and provide a consideration of beach litter as part of the overall problem of marine litter, including the implications of beach litter assessments for policy measures. Now only an initial overview can be provided, further in-depth analysis will be done, as planned for the Marine Litter baseline development, within the MSFD Technical Group on Marine Litter.

Identification of top ten litter items

The counting of litter is based on its identity as item. Pieces, including fragments, are individually counted. The item identification is based on an agreed item list as provided by the MSFD Guidance for the Monitoring of Marine Litter (JRC 2013), preceded by a UNEP/OSPAR list, on which it is based, still in use at OSPAR.

A review and collection of Top litter item information has been made by ARCADIS 2013 (page 85-89). Monitoring based on the OSPAR guidelines had been performed in different European regions and was the basis of the ARCADIS review. This investigation, while of limited spatial and temporal coverage, provided a useful overview, as the surveys have been made with one methodology, thus providing comparable results.

- North Sea (n=151)
The top fifteen beach litter items for the North Sea are reported in Table 12 and Figure 6 and account for 80% of the total number of beach litter items reported in the 151 OSPAR screenings. Plastic/polystyrene pieces, small (18%) and medium (14%) size are the dominant fraction, followed by string and cord items (12%) and plastic caps/lids (7%).
- Baltic Sea (n=152)
The top fifteen items for the Baltic Sea are reported in Table 9 and Figure 3 and account for 73% of the total number of beach litter items reported in the 152 OSPAR screenings. Plastic pieces with sizes between 2,5 cm and 50 are the dominant fraction (24%) having an average frequency of 34 items per 100 m coast line, followed by cigarette butts (10%) and other items such as plastic bottle caps/lids (5%), foam sponges (5%), ceramic/pottery items (5%) and plastic (shopping) bags (4%).
- Mediterranean Sea (n=33)
The top fifteen beach litter items for the Mediterranean Sea are reported in Table 11 and Figure 5 and account for 89% of the total number of beach litter items reported in the 33 OSPAR screenings. Plastic cutlery/trays/straws are the dominant fraction (17%) with an average frequency of 131 items per 100m, followed by cigarette butts (14%), plastic caps/lids (14%) and plastic drink bottles (12%).

- Black Sea (n=7)

The top fifteen beach litter items for the Black Sea are reported in Table 10 and Figure 4 and account for 86 % of the total number of beach litter items reported in the 7 OSPAR screenings. Cigarette butts are the dominant fraction (36 %) having an average frequency of 326 items per 100m coast line, followed by crisp/sweet packets and lolly sticks (9 %) and drink bottles (9%) and other items as plastic pieces (6 %), plastic caps/lids (5%), drink cans (5 %), etc.

Table: Top fifteen beach litter items for the North Sea and their share and average frequency per 100m coast line based on 151 OSPAR screenings.

OSPAR code	Description	Average # /100m	Share
46	Plastic/polystyrene pieces 2.5 cm > < 50cm (total)	104	18%
117	plastic/polystyrene pieces 0-2,5 cm	81	14%
32	String and cord (diameter less than 1 cm)	68	12%
15	Caps/lids (total)	43	7%
59	Other textiles	26	4%
98	Cotton bud sticks	25	4%
19	Crisp/sweet packets and lolly sticks (total)	23	4%
31	Rope (diameter more than 1 cm)	20	3%
115	Nets and pieces of net < 50 cm	19	3%
6	Food incl. fast food containers	11	2%
4	Drink bottles (total)	10	2%
3	Small plastic bags, e.g., freezer bags	10	2%
64	Cigarette butts	9	2%
40	Industrial packaging, plastic sheeting	8	1%
45	Foam sponge (total)	8	1%
Total		466	80%

Table: Top fifteen beach litter items for the Baltic Sea and their share and average frequency per 100m coast line, based on 152 OSPAR screenings.

OSPAR code	Description	average # /100m	Share
46	Plastic/polystyrene pieces 2.5 cm > < 50cm (total)	34	24%
64	Cigarette butts	14	10%
15	Caps/lids (total)	7	5%
45	Foam sponge (total)	7	5%
96	Other ceramic/pottery items	7	5%
2	Bags (e.g. shopping)	5	4%
6	Food incl. fast food containers	4	3%
77	Bottle caps	4	3%
22	Cutlery/trays/straws (total)	3	2%
70	Wood Crates	3	2%
19	Crisp/sweet packets and lolly sticks (total)	3	2%
65	Cups	3	2%
31	Rope (diameter more than 1 cm)	3	2%
59	Other textiles	2	2%
67	Other paper items	2	2%
Total		102	73%

Table: Top fifteen beach litter items for the Mediterranean Sea and their share and average frequency per 100m coast line, based on 33 OSPAR screenings.

OSPAR code	Description	Average # /100m	Share
22	Cutlery/trays/straws (total)	131	17%
64	Cigarette butts	112	14%
15	Caps/lids (total)	110	14%
4	Drink bottles (total)	91	12%
2	Bags (e.g. shopping)	43	5%
98	Cotton bud sticks	37	5%
60	Bags	35	4%
46	Plastic/polystyrene pieces 2.5 cm > < 50cm (total)	30	4%
91	Bottles	28	4%
19	Crisp/sweet packets and lolly sticks (total)	26	3%
6	Food incl. fast food containers	15	2%
63	Cigarette packets	12	2%
16	Cigarette lighters	11	1%
78	Drink cans	11	1%
102	Other sanitary items	9	1%
Total		701	89%

Table: Top fifteen beach litter items for the Black Sea and their share and average frequency per 100m coast line, based on 7 OSPAR screenings.

OSPAR code	Description	Average # /100m	Share
64	Cigarette butts	326	36%
19	Crisp/sweet packets and lolly sticks (total)	86	9%
4	Drink bottles (total)	85	9%
46	Plastic/polystyrene pieces 2.5 cm > < 50cm (total)	57	6%
15	Caps/lids (total)	49	5%
78	Drink cans	44	5%
3	Small plastic bags, e.g., freezer bags	31	3%
93	Other glass items	26	3%
53	Other rubber pieces	16	2%
6	Food incl. fast food containers	12	1%
21	Cups	12	1%
54	Clothing	11	1%
77	Bottle caps	10	1%
81	Foil wrappers	10	1%
22	Cutlery/trays/straws (total)	9	1%
Total		784	86%

Table: Sum of all items across ARCADIS surveys

OSPAR Code	Item	Average n/100 m
64	Cigarette butts	461
46	Plastic/polystyrene pieces 2.5 cm > < 50cm (total)	225
15	Caps/lids (total)	209
4	Drink bottles (total)	186
22	Cutlery/trays/straws (total)	143
19	Crisp/sweet packets and lolly sticks (total)	138
117	plastic/polystyrene pieces 0-2,5 cm	81
32	String and cord (diameter less than 1 cm)	68
98	Cotton bud sticks	62
78	Drink cans	55
2	Bags (e.g. shopping)	48
6	Food incl. fast food containers	42
3	Small plastic bags, e.g., freezer bags	41
60	Bags	35
59	Other textiles	28
91	Bottles	28
93	Other glass items	26
31	Rope (diameter more than 1 cm)	23
115	Nets and pieces of net < 50 cm	19
53	Other rubber pieces	16
45	Foam sponge (total)	15
77	Bottle caps	14
21	Cups	12
63	Cigarette packets	12
16	Cigarette lighters	11
54	Clothing	11
81	Foil wrappers	10
102	Other sanitary items	9
40	Industrial packaging, plastic sheeting	8
96	Other ceramic/pottery items	7
65	Cups	3
70	Wood Crates	3
67	Other paper items	2

A total of 33 item categories is present among the top fifteen items from the 4 Regional Seas.

European Regional Seas

While the assessment of top ten (or a longer ranking list) items has been applied by several organizations in the past, Regional Sea Conventions, also in view of the MSFD implementation and their Regional Action Plans have compiled available information about their areas and analysed data, so that information collected from the 4 Regional Sea Conventions around Europe should provide an up to date assessment of the situation. The 4 RSCs (OSPAR, HELCOM, Mediterranean Action Plan and Black Sea Commission) have therefore been contacted and provided latest data. With further work ongoing in the Regional Sea Conventions, additional data and information may become soon available.

OSPAR

OSPAR has a long standing record of beach litter monitoring. The data is analysed by the Litter Analyst software (<http://www.amo-nl.com/wordpress/software/litter-analyst/>).

Table: Item abundancy ranking list 2014 +2015

Reporting units L2.2.2 & L2.2.5 Southern North Sea				
Item	median	average	SD	% of total number of items
Plastic polystyrene pieces < 50 cm [301]	80.6	176.7	220.3	41.10%
Nets and ropes [300]	99.1	98.2	38	22.80%
Plastic: Caps and lids [15]	28.6	32.5	19.7	7.60%
Plastic: Drinks bottles and containers [4]	10.1	10.4	7.3	2.40%
Plastic: Foam sponge [45]	5.2	9.3	6.6	2.20%
Plastic: Crisp/sweet packets and lolly sticks [19] H	9.3	8.0	3.9	1.90%
Wood: Other items < 50 cm [74]	3	7.8	10	1.80%
Plastic: Food containers incl. fast food containers [6]	7.2	6.4	2.8	1.50%
Plastic: Tangled nets/cord/rope and string [33] H	6.4	5.3	2	1.20%
Plastic: Plastic/polystyrene pieces > 50 cm [47] H	2.2	5.1	6.6	1.20%
Rubber: Balloons [49]	5.3	4.9	1.8	1.10%
Plastic: Industrial packaging, plastic sheetingl [40] H	3.9	4.6	1.3	1.10%
Plastic: Shotgun cartridges [43]	3.6	4.0	2.2	0.90%
Plastic: Small plastic bags, e.g., freezer bags [3]	3.3	4.0	2	0.90%
Glass: Other items [93]	2.5	3.7	3.6	0.80%
Reporting unit L2.2.7 & L2.2.1 Northern North Sea				
Nets and ropes [300]	2024.3	2024.3	0	33.20%
Plastic polystyrene pieces < 50 cm [301]	1497.7	1497.7	0	24.60%
Plastic: Caps and lids [15]	763.6	763.6	0	12.50%
San: Cotton bud sticks [98] H	414.6	414.6	0	6.80%
Plastic: Shotgun cartridges [43]	117	117.0	0	1.90%
Plastic: Crisp/sweet packets and lolly sticks [19] H	109.3	109.3	0	1.80%
Plastic: Small plastic bags, e.g., freezer bags [3]	104.9	104.9	0	1.70%
Plastic: Food containers incl. fast food containers [6]	96.4	96.4	0	1.60%
Rubber: Balloons [49]	94	94.0	0	1.50%
San: Other items [102]	81.4	81.4	0	1.30%
Plastic: Strapping bands [39]	60.5	60.5	0	1.00%
Plastic: Cutlery/trays/straws [22]	55.6	55.6	0	0.90%
Plastic: Tangled nets/cord/rope and string [33] H	52.8	52.8	0	0.90%
Plastic: Plastic/polystyrene pieces > 50 cm [47] H	49.6	49.6	0	0.80%
San: Sanitary towels/panty liners/backing strips [99]	46	46.0	0	0.80%
Reporting unit L1.4 Bay of Biscay & Iberian coast				
Plastic polystyrene pieces < 50 cm [301]	88.3	81.4	28.7	21.30%
Nets and ropes [300]	50.5	52.5	11.1	13.80%

Paper: Cigarette butts [64]	29.5	39.1	23.9	10.20%
Plastic: Caps and lids [15]	26.3	27.8	12.6	7.30%
San: Cotton bud sticks [98] H	22.1	22.0	8.8	5.80%
Plastic: Other items [48]	23.1	21.0	12	5.50%
Plastic: Drinks bottles and containers [4]	12.1	15.0	8	3.90%
Plastic: Crisp/sweet packets and lolly sticks [19] H	12.2	11.6	5.4	3.00%
Plastic: Foam sponge [45]	7.3	8.7	4.5	2.30%
Plastic: Small plastic bags, e.g., freezer bags [3]	6.3	6.9	3.7	1.80%
Plastic: Food containers incl. fast food containers [6]	4.8	5.4	2.4	1.40%
Plastic: Cutlery/trays/straws [22]	4.9	5.3	1.2	1.40%
Plastic: Tangled nets/cord/rope and string [33] H	5.2	4.9	2.8	1.30%
Wood: Other items < 50 cm [74]	4.1	4.9	2.3	1.30%
Metal: Industrial scrap [83]	0.3	4.7	8.8	1.20%
Reporting unit L1.3 Celtic Seas				
Plastic polystyrene pieces < 50 cm [301]	105.7	161.1	109.5	31.50%
Nets and ropes [300]	72.2	68.6	8.8	13.40%
Plastic: Drinks bottles and containers [4]	26.3	33.2	12	6.50%
Plastic: Caps and lids [15]	19.6	32.5	27.1	6.40%
San: Cotton bud sticks [98] H	13.9	27.5	26.7	5.40%
Plastic: Crisp/sweet packets and lolly sticks [19] H	25.9	24.3	5.1	4.70%
Metal: Drink cans [78]	12.3	12.1	1	2.40%
Plastic: Food containers incl. fast food containers [6]	11.2	11.6	1.7	2.30%
All gloves [304]	8.2	8.8	2.5	1.70%
Plastic: Bags (e.g. shopping) [2]	9	8.1	2.5	1.60%
Plastic: Fishing_line [35]	9	7.1	4.6	1.40%
Plastic: Shotgun cartridges [43]	4.2	7.0	5.7	1.40%
Plastic: Tangled nets/cord/rope and string [33] H	5.1	6.4	2.8	1.30%
Plastic: Cutlery/trays/straws [22]	7.5	6.2	3.1	1.20%
Rubber: Other items [53]	7.2	6.2	2.2	1.20%
Reporting units L2.1.1 & L2.1.4 Arctic Seas				
<p>The small number of surveys and of sites in this region does not allow for an analysis of the top items for the total of all survey sites.</p> <p>Nevertheless the top two items on all sites were nets and ropes (OSPAR ID 300) and plastic and polystyrene fragments (OSPAR ID 301).</p>				

The data analysis in the sub-regions of North Sea and Atlantic exhibits different litter items with highest abundance indicating different use patterns and littering behaviour.

Table: OSPAR item sums across sub-regions

Item	average
Nets and ropes [300]	2243.6
Plastic polystyrene pieces < 50 cm [301]	1916.9
Plastic: Caps and lids [15]	856.5
San: Cotton bud sticks [98] H	464.2
Plastic: Crisp/sweet packets and lolly sticks [19] H	153.1
Plastic: Shotgun cartridges [43]	128.0
Plastic: Food containers incl. fast food containers [6]	119.9
Plastic: Small plastic bags, e.g., freezer bags [3]	115.8
Rubber: Balloons [49]	98.9
San: Other items [102]	81.4
Plastic: Tangled nets/cord/rope and string [33] H	69.4
Plastic: Cutlery/trays/straws [22]	67.1
Plastic: Strapping bands [39]	60.5
Plastic: Drinks bottles and containers [4]	58.6
Plastic: Plastic/polystyrene pieces > 50 cm [47] H	54.7
San: Sanitary towels/panty liners/backing strips [99]	46.0
Paper: Cigarette butts [64]	39.1
Plastic: Other items [48]	21.0
Plastic: Foam sponge [45]	18.0
Wood: Other items < 50 cm [74]	12.7
Metal: Drink cans [78]	12.1
All gloves [304]	8.8
Plastic: Bags (e.g. shopping) [2]	8.1
Plastic: Fishing line [35]	7.1
Rubber: Other items [53]	6.2
Metal: Industrial scrap [83]	4.7
Plastic: Industrial packaging, plastic sheeting [40] H	4.6
Glass: Other items [93]	3.7

The top fifteen ranking list for each of the 4 sub-regions comprises a total of 29 litter item categories.

HELCOM

The main groups of items found on beaches in the Baltic Sea are discarded short-life or single-use goods, mostly consisting of sanitary and household waste, such as cotton bud sticks, bottles, food and snack packaging and cigarette butts. Fishing nets and micro-particles (fibers and remnants of car tires) are assumed to be important groups of marine litter. **The top items found are cigarette butts, unidentified pieces of plastics, glass fragments, cotton bud sticks, bottles, food and snack packaging**

(food containers, candy wrappers, plastic bottle caps and lids), fishing nets, plastic bags, foamed plastic and micro-particles.

The first two sectors/activities account for high shares of marine litter found in beach surveys (exceeding 30 or 40%). The type of the items found indicate direct disposal (intentionally or through neglect) on the beach or further inland (i.e. through flushing, depositing waste on river banks, or through dumpsites) as the main input pathways. The amount of sanitary items indicate over-capacity incidents in waste water treatment plants when high amounts of storm waters cause sewage overflows .

The yearly report of the Naturewatch Baltic network (WWF) describes plastic bottles as the most common type (31-34%) of litter pieces found. Plastic bags were only registered in some years and constituted 19-27 % of litter, when reported. Data collected by the EUCC from Beach Litter monitoring carried out at beaches along the German Baltic Coast in 2012 demonstrated that 69% of the items found constituted of plastics and polystyrene.

Table: HELCOM information about Top items

Source (Literature)	Items/Consistency (beaches; top five)	Type of material (beaches, if not mentioned otherwise)
ARCADIS 2013; Riga/Baltic Sea)	Cotton bud sticks (294 items) Small plastic bags (i.e. freezer bags) (163 items) Crisp/sweets packets (142 items) Plastic/polystyrene pieces >2,5cm (135 items) Cigarette buds (104 items) Others (383 items)	Plastics: 51%
Öko-Institut (2012; figures mainly from UNEP 2009; original data: Ocean Conservancy/ICC 2002-2006 and Coastwatch Estonia 1999 - 2006)	Cigarette butts/filters: 37,4% Caps/lids: 8,8% Food package: 7,7% Beverage bottles (plastic): 6,5% Beverage bottles (glass): 5,9% Others: 15,9%	Plastics: 56% (UNEP: 52%) Glass: 19% Metal: 16% Paper/Cardboard: 8%
WWF (Naturewatch Baltic 1998 – 2005; cited in UNEP 2009, Öko-Institut 2012 and ARCADIS 2013c)	Plastic Bottles: 40% (UNEP: 31-43%) Glass bottles: 18% Cans: 14% Bags (paper and plastic): 10% (UNEP: 19-27%, only plastic)	Plastics (including plastic bags): 50-63%

MARLIN Project

The MARLIN project performed beach litter monitoring in the Baltic Sea area.

Table: MARLIN project top ten litter items across all beach types

Material type	Litter type	%
Plastic	Other	25,3
Glass & ceramics	Fragments	5,1
Plastic	Bottle caps and lids	4,8
Plastic	Plastic bags	4,3
Foamed plastic	Foam (insulation and packaging)	4,2

Plastic	Food containers, candy wrappers	3,2
Metal	Bottle caps, lids and pull tabs	2,8
Plastic	Knives, forks, spoons, straws, stirrers	2,4
Wood	Processed timber and pallet crates	2,4
Paper & cardboard	Cups, food trays, food wrappers, cigarette packs, drink containers	2,1

Some differences between urban and rural beaches in the top 10 lists are worth highlighting. At urban beaches many of the items are related to our take away-lifestyle such as bottle caps, plastic bags, plastic food containers and wrappers, and plastic cutlery. But one thing that is notable is that plastic bottles are not found on the top 10 list at urban beaches.

The top 10 list for rural beaches includes less of take away-lifestyle litter and more of “industrial” litter. Plastic ropes constitute 4.8 % of all litter found and construction material 3%. Notable is that plastic bottles that were not found at urban beaches are instead found at rural beaches. There is a strong understanding that most of the bottles found at rural beaches are without deposit. This indicates that the refund-system for plastic bottles has positive impact in reducing the litter and that refund system could be expanded to other litter types as well.

Cigarette butts

In the MARLIN method, cigarette butts are counted in a separate monitoring area (area 1) since it is smaller than the size range 2.5 cm-50 cm. Thus this category is not included in the previous results. Cigarette butts are the most numerically frequent form of litter in the world, which is also supported by the results of the MARLIN project. The average number of cigarette butts is 153,3 butts/100 m (urban beaches 301,9 butts/100 meters, peri-urban beaches 111.5/100 m and at rural beaches 49,4/100m).

Table: Average amount of cigarette butts per 100 m

Beach type	Average amount of cigarette butts/100 m
All beach types	153,3
Urban	301,9
Peri-urban	111,5
Rural	49,4

Mediterranean Action Plan

Top-10 item list as provided by the 2015 UNEP/MAP Assessment report deriving from the International Coastal Clean-up campaign 2014 in 8 different Mediterranean countries.

	1	2	3	4	5	6	7	8	9	10
	Cigarette butts	Straws/stirrers	Caps	Plastic bottles	Food wrappers	cans	Grocery bags (plastic)	Other plastic bags	Glass bottles	Paper bags
%	54,3%	13,7%	9,1%	6,2%	3,8%	3,5%	3,5%	2,6%	1,9%	1,3%
number /100m	175	44	29	20	12	11	11	8	6	4

Note that UNEP/MAP top-10 lists, also those included in the MAP 2015 report are not yet approved and adopted by the Contracting Parties.

Table: Main types of marine litter in the Mediterranean (ICC after UNEP, 2011)

Plastics: bags, balloons, beverage bottles, caps/lids, food wrappers/ containers, six-pack holders, straws/stirrers, sheeting/tarps, tobacco packaging and lighters
Glass: beverage bottles, light bulbs
Paper and cardboard of all types
Metals: aluminium beverage cans, pull tabs, oil drums, aerosol containers, tin cans, scrap, household appliances, car parts
Polystyrene: cups/plates/cutlery, packaging, buoys
Cloth: clothing, furniture, shoes
Rubber: gloves, boots/soles, tires
Fishing related waste: abandoned/lost fishing nets/line and other gear
Munitions: shotgun shells/wadding
Wood: construction timber, crates and pallets, furniture, fragments of all the previous
Cigarette filters and cigar tips
Sanitary or sewage related litter: condoms, diapers, syringes, tampons
Other: rope, toys, strapping bands

Table: Top ten items in the Mediterranean Sea (International Coastal Clean-up, ICC, 2014). Total number is the number of items collected on 59.2 miles of beaches from 8 different countries.

	cigarette butts	food wrappers	plastic bottles	caps	straws/ stirrers	Grocery bags (plast.)	glass bottles	other plastic bags	paper bags	cans
Total collected number	98117	6796	11295	16490	24724	6350	3443	4706	2436	6405
number /100m	175	12	20	29	44	11	6	8	4	11

Table: Composition/ sources of marine litter in the Mediterranean (After Interwies et al., 2013)

Source (Literature)	Items/Consistency (beaches; top five)	Type of material	Sources
ARCADIS 2014)	<ul style="list-style-type: none"> - Cotton bud sticks - Plastic/polystyrene pieces - Crisp/sweets/chips - Other sanitary items - Charcoal (201 items) <p>Ports:</p> <p>1: Crisp/sweets packets and lolly sticks</p> <p>2: Cigarette butts</p> <p>3: Cotton bud sticks</p>	<p>Beaches:</p> <p>Plastics: 50%</p> <p>by volume: 80%</p> <p>(Barcelona Provincial Government, cited in ARCADIS)</p> <p>Ports: 29% plastics, 22% wood, 21% organic matter</p>	<p>Recreational & tourism:40%</p> <p>Households(combined):40%</p> <p>Coastal tourism: 32,3%</p> <p>Toilet/sanitary: 26,2%</p> <p>Household: 11,2%</p> <p>Waste collection: 6%</p> <p>Recreational: 5,6%</p>
Öko-Institut (2012; figures mainly from UNEP, 2009)	<ul style="list-style-type: none"> -Cigarette butts: 29,1% - Caps/lids: 6,7% - Beverage cans: 6,3% - Beverage bottles (glass): 5,5% - Cigarette lighters: 5,2% 	<p>Beaches: 37-80% plastics</p> <p>Floating: 60-83% plastics</p> <p>Sea-floor: 36-90% plastics</p>	<p>Recreational/shoreline activities: >50%,</p> <p>Increase in tourism season</p>
UNEP/MAP (cited in ARCADIS 2014)	<ul style="list-style-type: none"> -Cigarette butts/filters: 27% -Cigar Tips: 10% -Plastic bottles: 9,8% Plastic - bags: 8,5% - Aluminum cans: 7,6% 	<p>Floating: 83% plastics</p>	

Table: Top ten items by country (International Coastal Clean-up, ICC 2014) expressed as number of items/100m of beach

	Number of items per 100 m									
COUNTRY	Cigarette butts	Food wrappers	Beverage bottles (plastic)	Bottle caps (plastic)	Straws Stirrers	Grocery bags (plastic)	Beverage bottles (glass)	Other plastic bags	Paper bags	Beverage cans
Croatia	1540	97	21	86	0	83	34	74	36	22
Egypt	1	2	40	18	1	15	33	6	0	6
Greece	116	6	11	15	13	4	3	3	2	5
Italy	0	0	2	0	0	4	14	0	0	7
Malta	0	15	22	40	13	0	7	3	0	0
Slovenia	21	5	3	6	6	1	1	2	0	2
Spain	79	9	15	23	57	13	5	9	4	8
Turkey	785	14	29	73	22	26	18	4	4	26

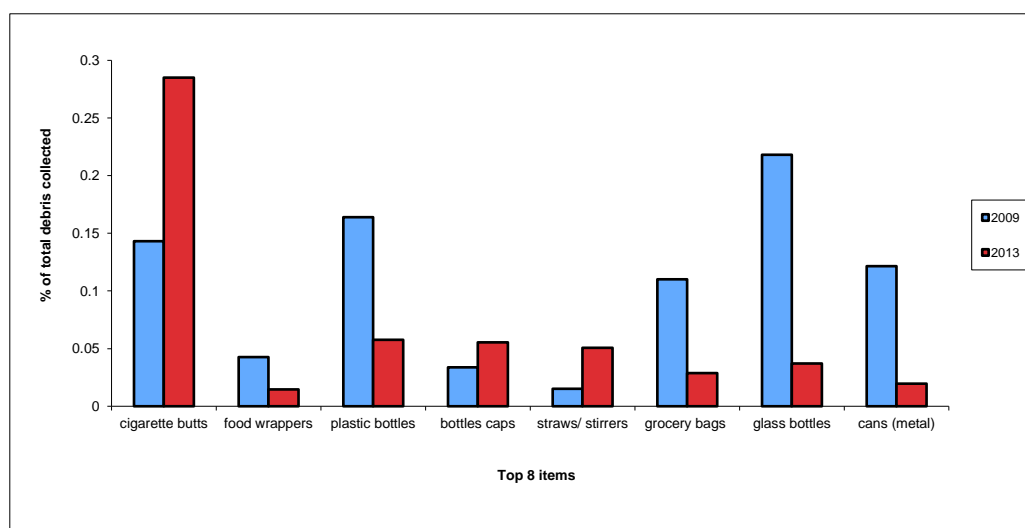


Figure: Changes in percentages of the top 8 items in the Mediterranean Sea between 2009 and 2013. Data from Ocean Coastal Cleanup on types of debris of 303522 items and 110698 items collected in 2009 and 2013 respectively on beaches from Greece, Turkey, Egypt and Spain (data from <http://www.oceanconservancy.org/>)

Items: Only three sources refer to the main items found in the Black Sea region, but the results are coherent: disposable packaging and short life or single use plastic goods (i.e. bottles, bags, crisp/sweets packaging, cans, caps/lids) are predominant (UNEP 2009, ARCADIS 2013b; Topcu et al. 2012).

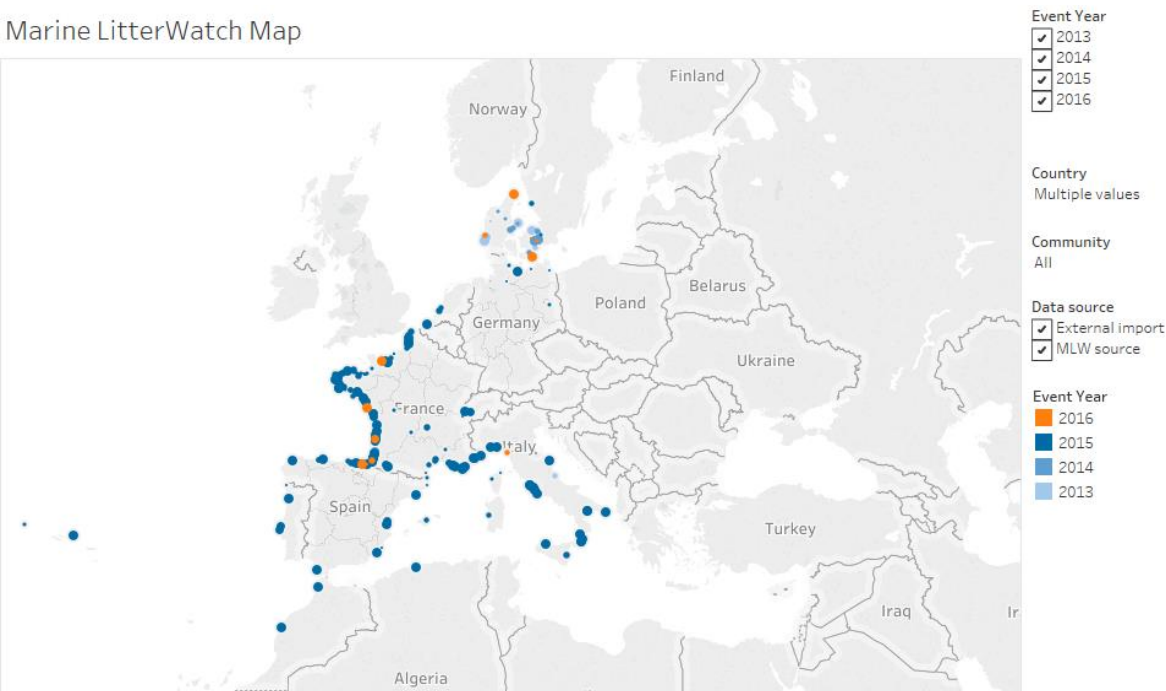
Sources: Local surveys and studies (BSC 2007, UNEP 2009, Topcu et al. 2012) state municipal waste/sewage and badly managed landfills as the most important source of marine litter, followed by marine transport and ports and recreational activities in coastal areas (Topcu et al. 2012 found only a small share of litter originating from tourism/recreation. Contrary, ARCADIS 2013b concluded from the items found at beaches near Constanta that recreational and tourism activities (both land- and sea-based) represent the most important source, with a huge amount of litter originating from recreational fishing (45%), followed by household and sanitary sources. In ARCADIS 2013b, there is no indication that shipping/ports are a major source (only 8%).

Source (Literature)	Items/Consistency (beaches; top five)	Type of material
ARCADIS (2013b; Constanta/ Black Sea)	Packaging (combined): 70% Packaging (consumer goods combined): 48% Drinking bottles (594 items) Crisp/sweets/chips packaging (583 items) Plastic/polystyrene pieces >2,5cm (393 items) Drink cans (310 items) Caps/lids (295 items) Others (1.066 items)	Beaches: Plastics: 65%
Topcu et al. (2012) and Topcu/Öztürk (2010)	Unidentifiable (eroded) items: 52% Identifiable litter: beverage packaging (19%), foam/sponge particles (9%), ropes (5%) and nylon packaging (4%) (bags, food wrappings, etc.).	62.7% hard plastic, 15.8% soft plastic, 4.4% synthetic fibers, 4.3% Styrofoam, 3.9% polyurethane.

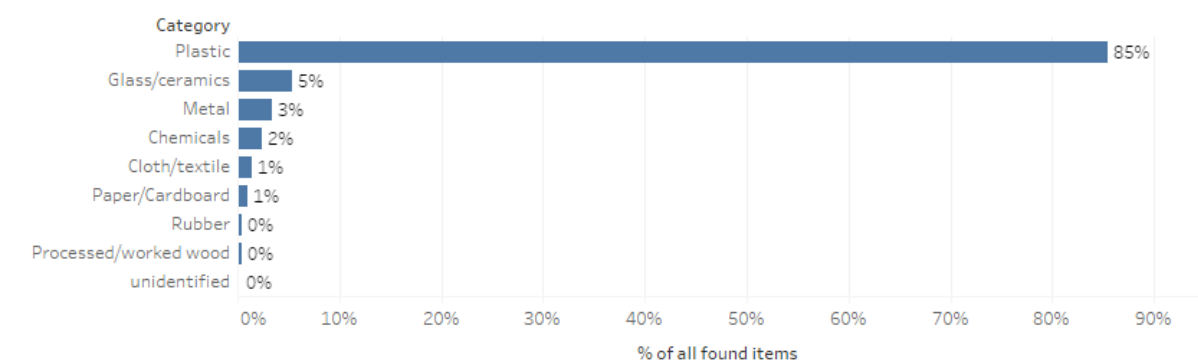
EEA Marine Litterwatch

The European Environmental Agency collects through the MARINE LITTERWATCH project data from beach clean-up events.

Marine LitterWatch Map



Distribution by category



Top 10 items

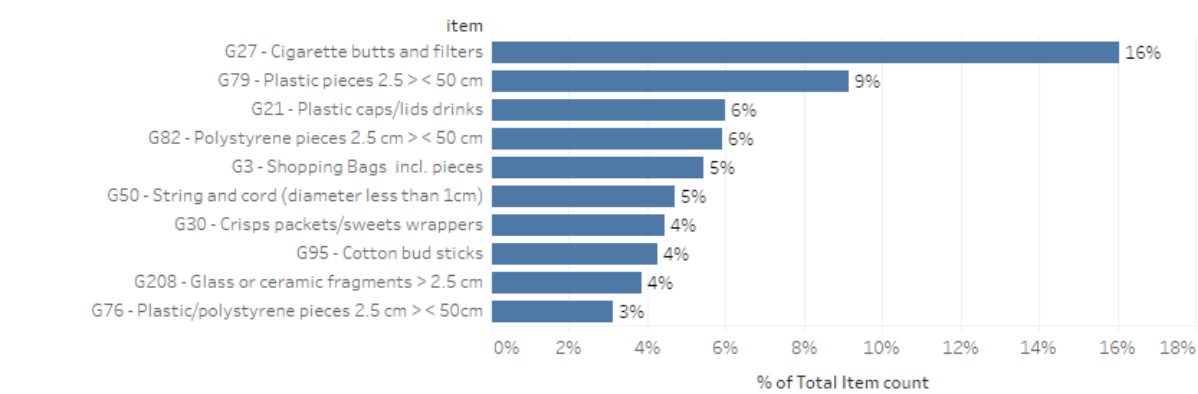


Table: MLW item occurrence from 2014-2016

Collected overall		Total item count: 394672	
materials	Item label	item %	Item numbers
Plastic	Cigarette butts and filters	16.7	66000
Plastic	Plastic pieces 2.5 > < 50 cm	8.7	34514
Plastic	Polystyrene pieces 2.5 cm > < 50 cm	5.9	23372
Plastic	Plastic caps/lids drinks	5.9	23234
Plastic	Shopping Bags incl. pieces	5.6	22288
Plastic	String and cord (diameter less than 1cm)	5.1	20232
Plastic	Crisps packets/sweets wrappers	4.8	19058
Plastic	Cotton bud sticks	4	15664
Glass/ceramics	Glass or ceramic fragments > 2.5 cm	3.8	15112
Plastic	Plastic/polystyrene pieces 2.5 cm > < 50cm	3.1	12083
Plastic	Drink bottles <=0.5l	3	11976
Plastic	Food containers incl. fast food containers	2.6	10098
Plastic	Drink bottles >0.5l	2.2	8799
Plastic	Tangled nets/cord	2.2	8706
Plastic	Lolly sticks	2.1	8145
Metal	Cans (beverage)	2.1	8107
Plastic	Straws and stirrers	2	7824
Plastic	Cups and cup lids	1.5	5806
Glass/ceramics	Bottles incl. pieces	1.3	5309
Plastic	Small plastic bags, e.g. freezer bags incl. pieces	1.3	5049
Plastic	Cutlery and trays	1.1	4390
Plastic	Shotgun cartridges	1.1	4295
Metal	Other metal pieces < 50 cm	0.9	3572
Plastic	Other plastic/polystyrene items (identifiable)	0.8	3217
Plastic	Fishing line/monofilament (angling)	0.8	3067
Cloth/textile	Clothing / rags (clothing, hats, towels)	0.7	2847
Plastic	Plastic pieces > 50 cm	0.6	2377

Top Ten item identification

While, due to the assessment methodology, litter item abundance cannot be seen as an exact measurement, it provides an indication of litter category amounts. This is valuable information for the planning and implementation of actions against litter.

In order to analyse the homogeneity of the identified top items and to compare the different surveys across Europe, a combined list of the top items from OSPAR surveys, the ARCADIS surveys and the EEA Marine Litterwatch has been compiled. While, due to the different aggregation procedures, sample number (for Arcadis + OSPAR top 15, for EEA top 29 items considered) and beach types this cannot be a quantitative assessment, it indicates that the overall spread of the top litter items is not very big. A total of 52 categories rank among the top items across Europe and the shared seas.

The list contains both, identifiable objects and fragments of larger items which cannot be identified.

Table: OSPAR + ARCADIS + EEA combined top items

All gloves [304]
Bags [60]
Bottle caps [77]
Bottles [91]
Cigarette lighters [16]
Cigarette packets [63]
Clothing [54]
Cups [21]
Cups [65]
Drink bottles <=0.5l
Drink bottles >0.5l
Foil wrappers [81]
Glass or ceramic fragments > 2.5 cm
Glass: Other items [93]
Metal: Drink cans [78]
Metal: Industrial scrap [83]
Nets and pieces of net < 50 cm [115]
Nets and ropes [300]
Other ceramic/pottery items [96]
Other paper items [67]
Other textiles [59]
Paper: Cigarette butts [64]
Plastic Crisps packets/sweets wrappers
Plastic Lolly sticks
Plastic Plastic pieces 2.5 > < 50 cm
Plastic polystyrene pieces < 50 cm [301]
Plastic Polystyrene pieces 2.5 cm > < 50 cm
Plastic String and cord (diameter less than 1cm)
Plastic/polystyrene pieces 0-2,5 cm
Plastic: Bags (e.g. shopping) [2]
Plastic: Caps and lids [15]
Plastic: Crisp/sweet packets and lolly sticks [19] H
Plastic: Cutlery/trays/straws [22]
Plastic: Drinks bottles and containers [4]
Plastic: Fishing_line [35]
Plastic: Foam sponge [45]
Plastic: Food containers incl. fast food containers [6]
Plastic: Industrial packaging, plastic sheetingl [40] H
Plastic: Other items [48]
Plastic: Plastic/polystyrene pieces > 50 cm [47] H
Plastic: Shotgun cartridges [43]
Plastic: Small plastic bags, e.g., freezer bags [3]
Plastic: Strapping bands [39]
Plastic: Tangled nets/cord/rope and string [33] H
Rope (diameter more than 1 cm) [31]
Rubber: Balloons [49]

Rubber: Other items [53]
San: Cotton bud sticks [98] H
San: Other items [102]
San: Sanitary towels/panty liners/backing strips [99]
Wood Crates [70]
Wood: Other items < 50 cm [74]

Note that the item naming and numbering of the items is not always consistent. Further harmonization is needed, as well as an adaption of the category lists so that they support the policy actions in the best way. The MSFD TG ML is currently investigating a revision of the MSFD master item category list.

Tentative ranking across item lists

Table with rankings from different lists in comparison:

OSPAR + ARCADIS + MLW + MAP + BSC	Ospar	Arcadis	MLW	MAP	BSC	R	n	nR
Nets and ropes [300]	1					1	1	1
Plastic Plastic pieces 2.5 > < 50 cm		2	2			4	2	2
Plastic polystyrene pieces < 50 cm [301]			3			3	1	3
Plastic: Caps and lids [15]	3	3	4	3	7	20	5	4
Plastic Polystyrene pieces 2.5 cm > < 50 cm	2	2	10		5	19	4	4.75
Paper: Cigarette butts [64]	17	1	1	1		20	4	5
Plastic Crisps packets/sweets wrappers	5		7		4	16	3	5.33
Plastic: Crisp/sweet packets and lolly sticks [19] H		6				6	1	6
Plastic String and cord (diameter less than 1cm)		8	6			14	2	7
Plastic/polystyrene pieces 0-2,5 cm		7				7	1	7
San: Cotton bud sticks [98] H	4	9	8			21	3	7
Drink bottles <=0.5l			11	4		15	2	7.5
Drink bottles >0.5l			13	4		17	2	8.5
Glass or ceramic fragments > 2.5 cm			9			9	1	9
Plastic: Drinks bottles and containers [4]	14	4				18	2	9
Plastic: Food containers incl. fast food containers [6]	7	12	12	5		36	4	9
Rubber: Balloons [49]	9					9	1	9
Plastic: Cutlery/trays/straws [22]	12	5	19	2		38	4	9.5
Plastic: Bags (e.g. shopping) [2]	23	11	5	7		46	4	11.5
Metal: Drink cans [78]	21	10	16	6	6	59	5	11.8
Plastic: Small plastic bags, e.g., freezer bags [3]	8	13	20	8		49	4	12.3
Plastic: Tangled nets/cord/rope and string [33] H	11		14			25	2	12.5
Plastic: Strapping bands [39]	13					13	1	13
Bags [60]		14				14	1	14
Plastic: Shotgun cartridges [43]	6		22			28	2	14
Plastic: Other items [48]	18		24		2	44	3	14.7
Other textiles [59]		15				15	1	15
Plastic Lolly sticks			15			15	1	15
Bottles [91]		16				16	1	16

San: Sanitary towels/panty liners/backing strips [99]	16					16	1	16
Rope (diameter more than 1 cm) [31]		18				18	1	18
Glass: Other items [93]	28	17	19	9		73	4	18.3
Nets and pieces of net < 50 cm [115]		19				19	1	19
Plastic: Industrial packaging, plastic sheeting [40] H	27	29			1	57	3	19
San: Other items [102]	10	28				38	2	19
Plastic: Foam sponge [45]	19	21				40	2	20
Wood: Other items < 50 cm [74]	20					20	1	20
Cups [21]		23	18			41	2	20.5
Plastic: Plastic/polystyrene pieces > 50 cm [47] H	15		27			42	2	21
Other paper items [67]		33		10		43	2	21.5
All gloves [304]	22					22	1	22
Bottle caps [77]		22				22	1	22
Rubber: Other items [53]	25	20				45	2	22.5
Cigarette packets [63]		24				24	1	24
Metal: Industrial scrap [83]	26		23			49	2	24.5
Plastic: Fishing line [35]	24		25			49	2	24.5
Cigarette lighters [16]		25				25	1	25
Clothing [54]		26	26			52	2	26
Foil wrappers [81]		27				27	1	27
Other ceramic/pottery items [96]		30				30	1	30
Cups [65]		31				31	1	31
Wood Crates [70]		32				32	1	32

R= sum of rankings in list, n= number of ranking in lists, nR= normalized ranking (=sum of rankings/number of rankings)

Note that the direct comparison of different lists is not scientifically sound, as they have different lengths, furthermore different category descriptions made a cross comparison in some cases not possible. This table must therefore be seen as a tentative way to indicate the fact that some items rank high on the different lists. Further data treatment and elaboration would be necessary to allow a thorough ranking of item frequencies across Europe.

While this is an ad hoc assessment with currently available data, please note that currently there are major efforts underway, from RSCs as well as from EEA and from dedicated research projects to provide a better quantification of items found on beaches.

Conclusions

Considerable efforts have been made across Europe and in the Regional Sea conventions in particular by NGOs, as well as in research projects in order to quantify litter items on beaches. Data from a large number of monitoring events are now available.

- Data allows to derive the overall abundance of the most frequent litter items
- The most frequent litter items vary between regions and locations (e.g. rural versus urban)
- Across the category lists of OSPAR (2014-2015), ARCADIS (2013) and EEA (2014-2016) a total of 52 categories is ranked as top item.
- Of the identifiable items (i.e. excluding plastic fragments, the following objects rank high, as top ten, across the different lists:
 - Nets+ ropes
 - Plastic caps and lids
 - Cigarette butts
 - Crisp and sweet wrappers
 - Lolly sticks
 - String and cord < 1 cm diameter
 - Cotton bud sticks
 - Plastic drink bottles
 - Plastic food containers

Followed by

- Balloons
- Plastic cuttlery
- Plastic bags

Discussion Annex:

Beach Litter origin

Litter items on shorelines and beaches can arrive there through different pathways. They represent basically three arrival pathway categories:

- a) Items that have been at sea, then beached by tidal action, waves and currents
- b) Items that have been lost or dropped on the beach
- c) Items that have been transported by run-off, wind or other relocation from inland onto the beach

Beached items can also include items which have not been dropped locally, but have been relocated only a short distance, e.g. from a neighbouring beach or estuary.

Items dropped locally on a beach will have a distinct item pattern related to the beach use, as e.g. cigarette butts, food packaging, plastic cutlery, beverage containers, etc., often also directly related to the present infrastructure.

While attempt have been made to attribute litter items to their regional source, e.g. by investigating indicators of origin (as e.g. language on packaging), indicators of weathering, still a distinction of pathways is hardly possible. Litter arriving through different pathway types can have fundamentally different sources and origins which require very different policy measure options.

High resolution modelling coupling oceanographic models with specific tracers for litter, taking physical processes into account (see chapter below), may be a way forward.

Beaches as Litter sinks and sources

The beaching of litter items will depend on their transportation by currents and wind, it is influenced by the beach exposure and wind/current directions. While local wind regimes can directly influence the transport of litter items with an elevated windage (i.e. those who are protruding from the water surface), also larger scale current regimes, such as upwelling zones and gyres determine litter pathways.

Properties of the shoreline and adjacent sea, as well as litter item properties determine if the item, once arrived to shore, remains on the beach, undergoes disintegration, or will be set afloat again. This is the result of complex physical/mechanical interactions. Among the factors influencing the processes are e.g. oceanographic situation, wind, tidal water movement, wave action, beach morphology, its exposure direction to the sea, shore seabed properties, steepness, sand properties (granulometry, shape), surface structure, etc. as well as the mechanical properties (e.g. density, shape and surface structure) of the litter items themselves. The outgoing part of tidal cycles in particular can be expected to lead to beaching of material brought in by wind and wave action. In a similar way the setting afloat of previously beached or dropped items will be influenced by the conditions and properties.

The type and quantity of litter found on a beach is the result of these interactions and beaches are therefore not necessarily a quantitative scavenger for litter.

While a thorough literature review would still be required, the topic of litter/shoreline interaction appears to be less investigated.

Considerations regarding data quality and coverage:

Beach litter monitoring is no exact science. Furthermore data often had been derived from beach-clean-ups, not originally intended for a quantitative monitoring. Besides there are a number of issues which can add to variability. E.g. it should be noted that beach litter monitoring focuses on sand surface visible items, therefore there might be a bias towards more lightweight, low density items, which do not sink rapidly into the soft sand surface. This will depend on the sand substrate in the different areas.

A different spread in the top item percentage, as seen e.g. among ARCADIS surveys and OSPAR surveys could possibly indicate a bias in the sampling procedure.

Data do not cover a geographically even spread, e.g. available MLW data appears to be mostly deriving from France. The efforts for streamlining monitoring and reporting of beach litter data have led to an improved comparability and thus allow a better analysis of data. There are still some incompatibilities in the reporting procedures, as e.g. litter categories and reporting units.

The provided information is based on item or fragment counts and therefore are not representative of the litter material, or weight. Rankings are not risk based, items with lower occurrence frequency might exhibit a larger risk than some with a higher occurrence frequency.

From the compiled information, beside the valuable information about top items also some critical conclusions can be drawn:

- Object abundance is not risk related, i.e. a litter abundance may not be related to the harm it inflicts potentially
- Objects are quantified by number, not by weight, i.e. there is no direct link to the amount of litter.
- There is no information about litter items being dropped locally versus beached items, though this denotes a significant different policy need
- Category list items are not fully compatible between lists
- More detail for item category description is desirable in to improve source attribution, the more information, the better the consideration for measures.
- The quantitative assessment of litter fragments is currently not possible, as objects between 2.5 and 50 cm are reported in once category. As proposed for floating litter, the additional recording of the fragment size would be useful. This would allow an approximate link to plastic waste fragment mass.

Acknowledgements

Many thanks to Christos Ioakemidis, Tatjana Hema, (MAP), Lex Oosterbaan, John Mouat, Mareike Erfeling, Stefanie Werner (OSPAR), Marta Ruiz, Ulla Li Zweifel, Stefanie Werner (HELCOM), Irina Makarenko (BSC) and Constança Belchior (EEA) for their kind short term availability to provide the requested information. Daniel Gonzalez has contributed to this report (JRC Rimmel project).

References

ARCADIS 2013 - Marine Litter study to support the establishment of an initial quantitative headline reduction target - SFRA0025 European Commission DG Environment Project number BE0113.000668

MAP 2015 – Marine Litter Assessment in the Mediterranean 2015, ISBN No. 978-92-807-3564-2

ICC - <http://www.oceanconservancy.org/our-work/international-coastal-cleanup/>

MARLIN –Final report 2011-2013

MSFD Guidance for the Monitoring of Marine Litter (JRC 2013) EUR 26113

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.



EU Science Hub

ec.europa.eu/jrc



@EU_ScienceHub



EU Science Hub - Joint Research Centre



Joint Research Centre



EU Science Hub