



MARINE LITTER IN MEDITERRANEAN COASTAL AND MARINE PROTECTED AREAS HOW BAD IS IT?

**A snapshot assessment report on the
amount, composition and sources of marine litter found on beaches**

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Cover photo: Lavezzi archipelago © Thomais Vlachogianni

This document has been produced within the framework of the Interreg Med funded project entitled ACT4LITTER. The document reflects the author's views and does not commit the donors.

Citation:

Vlachogianni, Th., 2019. Marine Litter in Mediterranean coastal and marine protected areas – How bad is it. A snapshot assessment report on the amounts, composition and sources of marine litter found on beaches, Interreg Med ACT4LITTER & MIO-ECSDE.

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1. INTRODUCTION

The Mediterranean Sea is one of the areas most affected by marine litter worldwide. Marine litter is found lying on the shores, as well as floating anywhere from the surface to the bottom of the sea. Even in pristine environments of the Mediterranean, such as coastal and marine protected areas, marine litter is building up threatening habitats and species. Impacts vary from entanglement and ingestion, to bio-accumulation and bio-magnification of toxics released from litter items, facilitation of introduction of invasive species, damages to benthic habitats, etc. MPA managers stand at the forefront of this issue and sadly they lack the tools, knowledge, and often the resources to effectively tackle it. As a result, the achievement of the conservation goals set is hampered.

Even though beach surveys for macro-litter (items > 2.5 cm) assessment are the most common mode of marine litter monitoring in the Mediterranean, systematic efforts to collect data on the amounts, distribution, composition and sources of marine litter along the coastline of Mediterranean coastal and marine protected areas are rather limited. In terms of the geographical distribution of the data collected, these refer mainly to the coastal and marine protected areas located in the Adriatic and Ionian Seas (Munari et al., 2016; Vlachogianni et al., 2018;) and the Pelagos Sanctuary in Italy (Giovacchini et al., 2018).

This document presents the results of the beach litter surveys performed within the framework of the Interreg Med ACT4LITTER project with the aim to carry out a snapshot assessment of the marine litter deposited on the beaches of Mediterranean coastal and marine protected areas. This is one of the very few efforts that have assessed beach litter in such a large number of locations in 16 coastal and marine protected a consistent and harmonized way. The results and findings provide fit-for-purpose data for the effective management of marine litter in Mediterranean MPAs and PAs.

2. ACT4LITTER IN A NUTSHELL

Within a period of almost two years, ACT4LITTER, an Interreg Med funded project, has provided essential support to managers of marine protected areas to fast-track actions against marine litter. Within this period, MPA managers and marine litter experts from 26 entities and 11 different countries – namely Albania, Belgium, Croatia, Cyprus, France, Greece, Italy, Montenegro, Slovenia, Spain and Tunisia – have been brought together and evolved into a taskforce with a joint mission to curb marine litter.

The main lines of actions of the ACT4LITTER project included:

- 1** - Filling out the knowledge gaps on the amounts, composition and sources of marine litter in Mediterranean marine protected areas via a participatory-science campaign.
- 2** - Identifying targeted measures to address marine litter in Mediterranean MPAs, with special emphasis on upstream preventive measures.
- 3** - Setting up a decision-making tool to help managers identify the most effective and feasible measures to be implemented in the marine protected areas.
- 4** - Developing nine action plans to fast-track actions aiming to prevent and mitigate marine litter.
- 5** - Elaborating a joint plan that sets the baseline for a common urgent response by Mediterranean MPAs to deal with the lurking marine litter threat.

Table 1.1. Key facts and figures for the ACT4LITTER project

Title	ACT4LITTER
Funding instrument	Interreg Mediterranean Programme
Thematic axis	Protecting and promoting Mediterranean natural and cultural resources
Objective	To maintain biodiversity and natural ecosystems through strengthening the management and networking of protected areas
Duration	1 February 2017 – 31 October 2018 (21 months)
Project budget	530,000 €
Partnership	<p>Implementing Partners</p> <ul style="list-style-type: none"> – Catalan Waste Agency – Regional Activity Centre for Sustainable Consumption and Production (Spain) – Sant’ Anna School of Advanced Studies (Italy) – MedPAN – Network of Marine Protected Area Managers in the Mediterranean (France) – Mediterranean Information Office for Environment, Culture and Sustainable Development (Greece) <p>Associate Partners</p> <ul style="list-style-type: none"> – Association for the Protection of Aquatic Wildlife of Albania (Albania) – Autonomous University of Barcelona (Spain) – Blue World Institute of Marine Research and Conservation (Croatia) – City of Marseille (France) – City of San Benedetto del Tronto (Italy) – Consortium for the Management of Portofino MPA (Italy) – French Agency for Marine Protected Areas (France) – Management Body of Samaria National Park (Greece) – Mediterranean Centre for Environmental Monitoring (Montenegro) – MerTerre / Observatoire des Déchets en Milieux Aquatiques (France) – Ministry of Agriculture, Food and Environment (Spain) – Ministry of Agriculture, Rural Development and Environment (Cyprus) – Nice Cote D’Azur Metropole (France) – PlasticsEurope (Belgium) – Public Institute Landscape Park Strunjan (Slovenia) – Public Institution National Park Kornati (Croatia) – Public Institution Nature Park Lastovo Islands (Croatia) – Regional Activity Centre for Specially Protected Areas (Tunisia) – Regional Ministry of Environment and Spatial Planning of Andalusia (Spain) – Shoreline (Italy) – Spanish Association of Marine Litter (Spain) – Thermaikos Gulf Protected Areas Management Authority (former Axios – Loudias – Aliakmonas Management Authority)(Greece)
Website	https://act4litter.interreg-med.eu

3. DEFINITIONS AND POLICY CONTEXT

Within this document marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment. The main legislative frameworks related to marine litter monitoring in Mediterranean MPAs are the EU Marine Strategy Framework Directive (2008/56/EC, 2010/477/EC, 2017/848/EC) and the Barcelona Convention Ecosystem Approach (COP19 IMAP Decision IG.22/7) (see Box 1.1 and Box 1.2).

Box 3.1. *The Marine Litter Descriptor, criteria, and respective Indicators within the framework of the EU MSFD.*

Marine Litter within the EU MSFD

Properties and quantities of marine litter do not cause harm to the coastal and marine environment (Descriptor 10)

Criteria D10C1 - Primary: The composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment.

- ✓ amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where possible, source (10.1.1)
- ✓ amount of litter in the water column (including floating at the surface) and deposited on the seafloor, including analysis of its composition, spatial distribution and, where possible, source (10.1.2)

Criteria D10C2 - Primary: The composition, amount and spatial distribution of micro-litter on the coastline, in the surface layer of the water column, and in seabed sediment, are at levels that do not cause harm to the coastal and marine environment.

- ✓ amount, distribution and, where possible, composition of microparticles (in particular microplastics) (10.1.3)

Criteria D10C3 - Secondary: The amount of litter and micro-litter ingested by marine animals is at a level that does not adversely affect the health of the species concerned.

- ✓ amount and composition of litter ingested by marine animals (10.2.1)

Criteria D10C4 - Secondary: The number of individuals of each species which are adversely affected due to litter, such as by entanglement, other types of injury or mortality, or health effects.

Box 3.2. *The Marine Litter Operational Objectives and respective Indicators within the framework of the Barcelona Convention Ecosystem Approach and the Integrated Monitoring and Assessment Programme (IMAP)*

Marine Litter and the Barcelona Convention Ecosystem Approach

Ecological Objective 10 (EO10): Marine and coastal litter do not adversely affect the coastal and marine environment.

IMAP Common Indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines (including analysis of its composition, spatial distribution and, where possible, source).

IMAP Common Indicator 23: Trends in the amount of litter in the water column including micro plastics and on the seafloor.

IMAP Candidate Indicator 24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles.

4. THE ACT4LITTER MARINE LITTER WATCH MONTH

ACT4LITTER, under the coordination of MIO-ECSDE, setup and implemented a participatory-science campaign entitled 'ACT4LITTER Marine Litter Watch Month'. The ACT4LITTER Marine Litter Watch Month offered to managers and marine litter experts a unique opportunity to join forces and carry out beach litter surveys in order to elaborate a snapshot assessment report on marine litter found on beaches in Mediterranean coastal and marine protected areas. The ACT4LITTER Marine Litter Watch Month transformed MPA managers into a taskforce that generated reliable, accurate and comparable beach litter data. The project provided a set of well-designed and well-tested webinars aiming to enhance the managers' skills on how to monitor marine litter in a harmonized way by using a standardized beach litter monitoring protocol. The project run four editions of the Marine Litter Watch Month: winter 2017 (mid-December 2017 to mid-January 2018), spring 2018 (April 2018), summer 2018 (mid-June to mid-July), autumn 2018 (mid-September to mid-October).

The ACT4LITTER Marine Litter Watch Month has been an effective tool to gather essential marine litter data. Not only does it provide valuable baseline information on the amounts and the full spectrum of marine litter deposited on the beaches of protected areas in the Mediterranean, but it also serves as a useful blueprint for the setup of participatory-science campaigns. The initiative will carry on within the framework of the follow-up project entitled Plastic Busters MPAs, also funded by the Interreg Med.

5. THE BEACH LITTER MONITORING METHODOLOGY

All beach litter surveys were performed in line with the guidelines described in the EU MSFD TG10 "Guidance on Monitoring of Marine Litter in European Seas" (Galgani et al., 2013).

The survey sites were selected taking into consideration the following criteria: they had a minimum length of 100 meters in order to allow a fixed 100-metre stretch to be surveyed; they were characterized by a low to moderate slope (~1.5-4.5 °); they had clear access to the sea (not blocked by breakwaters or jetties); they were accessible to survey teams throughout the year. In each survey, the sampling unit used was a 100-metre stretch from the strandline to the back of the beach (Fig. 5.1). The back of the beach was identified using coastal features such as the presence of vegetation, dunes, cliff base, road, fence or other anthropogenic structures such as seawalls (either piled boulders or concrete structures). Two (2) sections of a 100-metre stretch on the same beach were monitored, separated at least by a distance of 50m. During the surveys, all macroscopic beach litter items larger than 2.5 cm in the longest dimension were collected, counted and categorized in accordance with the 'MSFD TG10 Master List of Categories of Litter Items' (Annex I).

The macro-litter density was calculated as follows (Lippiatt et al., 2013): $CM = n / (w * l)$, where CM is the density of litter items per m²; n is the number of litter items recorded; w and l are the width and length of the sampling unit, respectively. The number of items per 100-metre stretch was also calculated. The beach cleanliness was assessed through the Clean Coast Index (CCI) (Alkalay et al., 2007): $CCI = CM * K$, where CM is the density of litter items per m²; and K is a constant that equals to 20. According to the CCI scale: values from 0-2 indicate very clean beaches, 2-5 clean, 5-10 moderately clean, 10-20 dirty and > 20 extremely dirty.

The attribution-by-litter type method was used to determine the sources of marine litter (Tudor and Williams, 2004). Within the present study, the assignment of specific sources to each litter item found was made in line with the approach described by Vlachogianni et al., 2018. The sources of marine litter were classified into eight major categories: (1) shoreline, including poor waste management practices, tourism and recreational activities; (2) fisheries and aquaculture; (3) shipping; (4) fly-tipping; (5) sanitary and sewage-related; (6) medical related; (7) agriculture; (8) non-sourced.

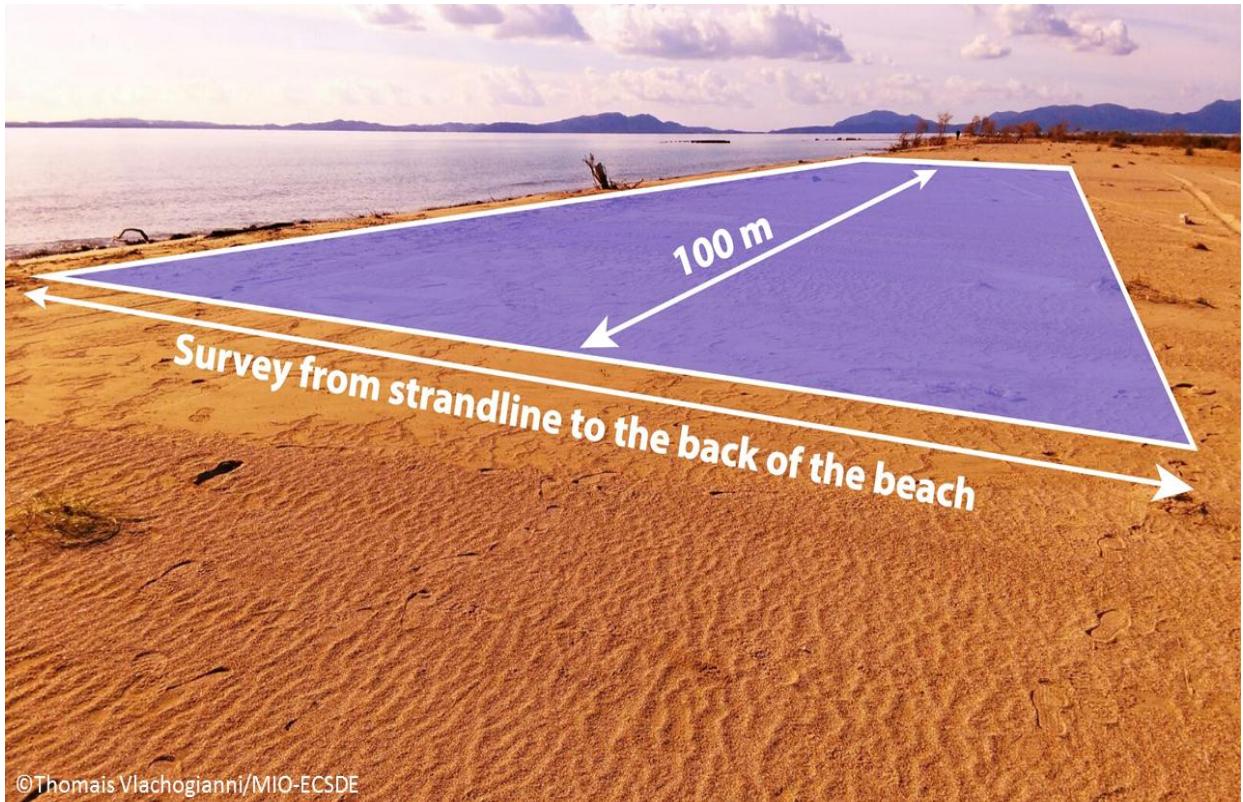


Figure 5.1. The sampling unit.

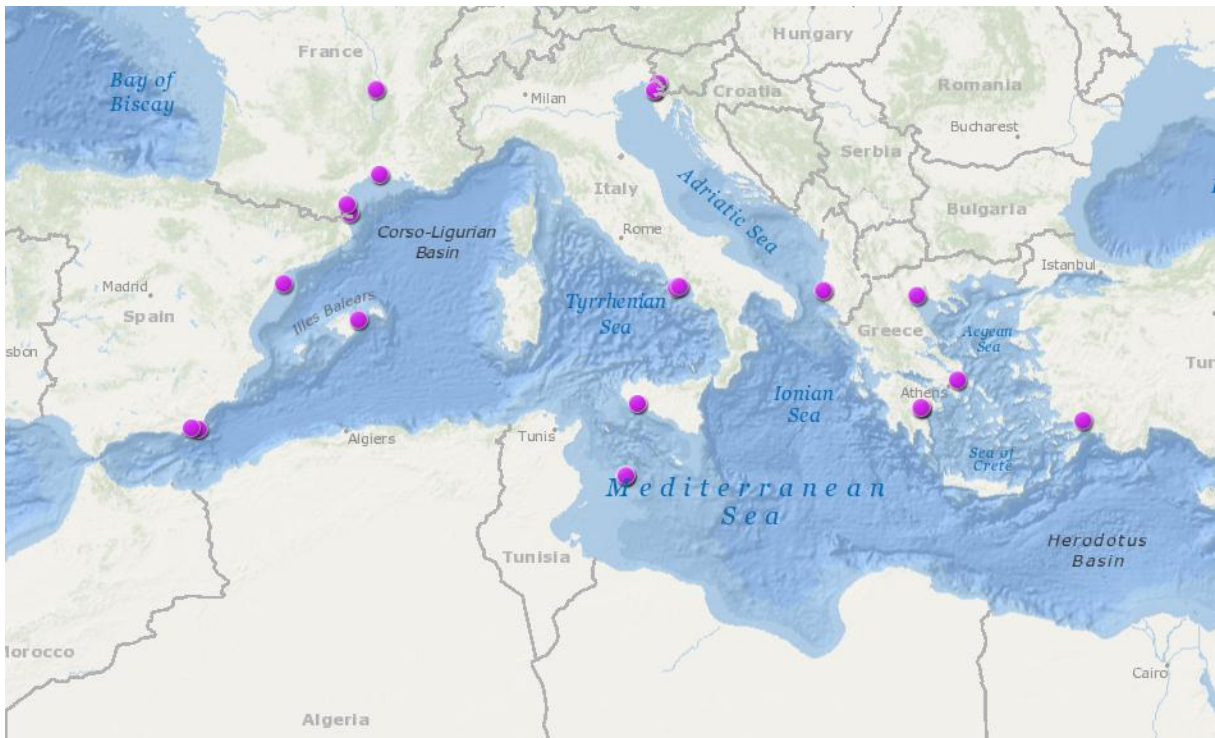


Figure 5.2. Map with the assessed beaches.

6. RESULTS

Within this section the results obtained by the winter edition of the ACT4LITTER Marine Litter Watch Month are presented. The latter run from mid-December 2017 to mid-January 2018; a total of 28 beach litter surveys were performed in 22 beaches. The beaches were located in 16 coastal and marine protected areas of Albania, France, Greece, Italy, Slovenia, Spain and Turkey (Table 6.1, Annex II). The beach litter transects extended over a distance of 2,830 m and covered an area of 53,446 m². A total of 17,344 marine litter items were classified, recorded and removed.

6.1. Abundance of marine litter

Table 6.1. Location of the beaches surveyed in each country and surveying organization.

Country	Coastal and marine protected area	Beach	Data owner/data producer
Albania	Karaburun-Sazan MPA	Zvernec	Management Body of the Karaburun-Sazan MPA
France	Gulf of Lion MPA	Fourat	Management Body of the Gulf of Lion MPA
		Crouste	
	Espiguette Natura 2000	Espiguette	NGO Institut Marin SEaquarium/ Community of Le GRAU du Roi
Greece	Cote Languedocienne Natura 2000	Boucanet	
	Marathon and Schinias National Park	Schinias	MEDSOS
	Thermaikos Gulf Protected Areas	Alyki Kitrous	Management Authority of the Thermaikos Gulf Protected Areas
	Parnon and Moustos Natura 2000	Cherronisi	MIO-ECSDE
		Kazarba	
Italy	MPA Punta Campanella	Marina del Cantone	Consortium Management of the MPA Punta Campanella
		Tordigliano	
	MPA Miramare	Miramare	WWF / Management Body of the Miramare MPA
	MPA Secche di Tor Paterno	Capo San Marco	MAREVIVO
	MPA Pelagie Islands	Cala Palme	Management body of the MPA of Pelagie Islands
		Cala Pisana	
Slovenia	Strunjan Landscape Park	Bele Skale	Institute of Water of the Republic of Slovenia
		Strunjan	
Spain	Cabo de Gata-Níjar Natural Park/UNESCO Global geopark	Embarcadero de los Escullos	Management Body of the Cabo de Gata-Níjar Natural Park/UNESCO Global geopark
		Torre Garcia	
	MPA Levante de Mallorca-Cala Ratjada	Cala Mesquida	Management Body of the Levante de Mallorca-Cala Ratjada MPA
	Ebro Delta Nature Park	Serrallo	Management Body of the Ebro Delta Nature Park
Turkey	Gökova Special Environmental Protection Area	Akcapinar	Mediterranean Conservation Society

On the 28 sites surveyed a total of 17,344 items were recorded, removed and classified. Items varied widely in abundance and types. The average litter density was calculated to be 1048 items/100m ranging from 46 items/100m to 12,896 items/100m. The highest litter density of 12,896 items/100m was recorded in Alyki Kitrous (Greece), followed by a density of 2,050 items/100m recorded in Miramare (Italy). High litter densities were recorded also in Crouste (France) with 1,182 items/100m and Cala Mesquida (Spain) with 1134 items/100m. The lowest densities in terms of items found on 100-metre stretch of coastline were recorded in Kazarba (Greece) with 61 items/100m and Serrallo (Spain) with 46 items/100m.

Table 6.2. The average density of litter items recorded in the 22 surveyed beaches assessed in number of items per 100-metre stretch. The superscript * indicates that data were normalized by multiplying with a scaling factor to make the effective length of the sampling unit 100 m.

Beach code	Beach name	Average number of items per 100m stretch
GRE-ALI	Alyki Kitrous	12896*
ITA-MIR	Miramare	2050
FRA-CRO	Crouste	1182
SPA-MES	Cala Mesquida	1134
ITA-TOR	Tordigliano	752
ITA-MAR	Marina del Cantone	681
ITA-PAL	Cala Palme	535
SPA-TGA	Torre Garcia	467*
ALB-ZVE	Zvernec	444
ITA-PIS	Cala Pisana	430
ITA-CAP	Capo San Marco	405
TUR-ACK	Akcapinar	399
SLO-STR	Strunjan	323
SLO-BEL	Bele Skale	315
SPA-EMB	Embarcadero de los Escullos	296
GRE-SCH	Schinias	174
GRE-CHE	Cherronisi	167
FRA-ESP	Espiguette	113
FRA-FOU	Fourat	106
FRA-BOU	Boucanet	78
GRE-KAZ	Kazarba	61
SPA-SER	Serrallo	46

The average litter density was calculated to be 0.61 items/m². The abundance of litter items expressed in items/m² was found to be the highest in Alyki Kitrous (Greece) with a density of 6.45 items/m² (12,896/100m). The second highest abundance of litter items was recorded at Cala Palme (Italy) with the average number of items being 1.07 items/m² (535 items/100m), followed by Tordigliano (Italy) with 1.01 items/m² (752 items/100m), Cala Pisana (Italy) with 1.01 items/m² (430 items/100m), Miramare (Italy) with 0.86 items/m² (2050 items/100m). The lowest abundances of litter items were found on the beaches of Fourat (France) with 0.05 items/m² (106 items/100m), Kazarba (Greece) with 0.05 items/m² (61 items/100m), Espiguette (France) with 0.05 items/m² (113 items/100m) and Serrallo (Spain) with 0.03 items/m² (46 items/100m) (Tab. 6.2-6.3).

Table 6.3. The average density of litter items recorded in the 22 surveyed beaches assessed in number of items per square metre. The superscript *n* indicates that data were normalized by multiplying with a scaling factor to make the effective length of the sampling unit 100 m.

Beach code	Beach name	Average number of items per square metre (items/m ²)
GRE-ALI	Alyki Kitrous	6,45
ITA-PAL	Cala Palme	1,07
ITA-TOR	Tordigliano	1,01
ITA-PIS	Cala Pisana	0,86
ITA-MIR	Miramare	0,86
ITA-MAR	Marina del Cantone	0,53
SLO-STR	Strunjan	0,32
SLO-BEL	Bele Skale	0,32
SPA-EMB	Embarcadero de los Escullos	0,30
FRA-CRO	Crouste	0,30
ITA-CAP	Capo San Marco	0,27
SPA-MES	Cala Mesquida	0,26
SPA-TGA	Torre Garcia	0,20
TUR-ACK	Akcapinar	0,16
ALB-ZVE	Zvernec	0,13
GRE-SCH	Schinias	0,11
GRE-CHE	Cherronisi	0,11
FRA-BOU	Boucanet	0,07
FRA-FOU	Fourat	0,05
GRE-KAZ	Kazarba	0,05
FRA-ESP	Espiguette	0,05
SPA-SER	Serrallo	0,03

The Clean Coast Index classified Alyki Kitrous (Greece), Cala Palme (Italy) and Tordigliano (Italy) as ‘Very dirty’ beaches with CCI values 129, 21.4 and 20.3 respectively. The beaches of Cala Pisana (Italy), Miramare (Italy) and Marina del Cantone (Italy) were classified as ‘Dirty’ with CCI values 17.2, 17.1 and 10.6 respectively. The remaining beaches ranked as ‘Moderately clean’, ‘Clean’ and ‘Very clean) as shown in table 6.4. Only four beaches ranked as very clean; one located in Spain, one located in Greece and the rest located in France. These were the beach of Fourat (France), Kazarba (Greece), Espiguette (France) and Serrallo (Spain), with CCI values 1.1, 0.9, 0.9 and 0.6 respectively.

As shown on figure 6.1, almost one fifth (18%) of the surveyed beaches were characterized by very low litter densities and where classified as very clean, while 27% were classified as clean. 27 % of the beaches were moderately littered. Very high litter densities were found for 14% of the surveyed beaches and were classified as very dirty, while a 14% were classified as dirty.

Table 6.4. Beach cleanliness classification of survey sites according to the Clean Coast Index.

Beach code	Beach name	Clean Coast Index (CCI)	Cleanliness
GRE-ALI	Alyki Kitrous	129,0	Very dirty
ITA-PAL	Cala Palme	21,4	Very dirty
ITA-TOR	Tordigliano	20,3	Very dirty
ITA-PIS	Cala Pisana	17,2	Dirty
ITA-MIR	Miramare	17,1	Dirty
ITA-MAR	Marina del Cantone	10,6	Dirty
SLO-STR	Strunjan	6,5	Moderately clean
SLO-BEL	Bele Skale	6,3	Moderately clean
SPA-EMB	Embarcadero de los Escullos	5,9	Moderately clean
FRA-CRO	Crouste	5,9	Moderately clean
ITA-CAP	Capo San Marco	5,4	Moderately clean
SPA-MES	Cala Mesquida	5,3	Moderately clean
SPA-TGA	Torre Garcia	4,1	Clean
TUR-ACK	Akcapinar	3,2	Clean
ALB-ZVE	Zver nec	2,5	Clean
GRE-SCH	Schinias	2,3	Clean
GRE-CHE	Cherronisi	2,2	Clean
FRA-BOU	Boucanet	1,5	Clean
FRA-FOU	Fourat	1,1	Very clean
GRE-KAZ	Kazarba	0,9	Very clean
FRA-ESP	Espiguette	0,9	Very clean
SPA-SER	Serrallo	0,6	Very clean

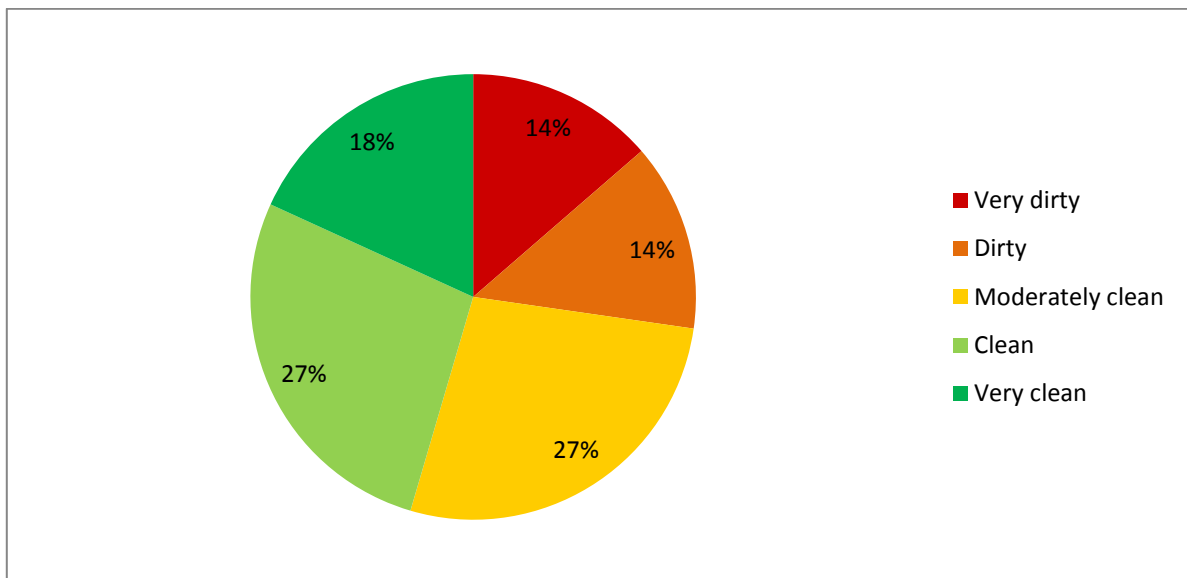


Figure 6.1. Distribution of the studied beaches based on cleanliness.

6.2. Composition of marine litter

The marine litter items recorded were classified into 8 major groups of material types on aggregated basis (Fig. 6.2). The majority of litter items (82%) were made out of artificial polymer materials, a category of litter dominant on beaches all over the world. The second most abundant group of litter items found were glass/ceramics (7%) and processed wood (6%). Items made of rubber accounted for 2%, while metal for 1%, paper for 1% and cloth/textile for 1%. Only 10 items were classified as unidentified items and/or chemicals. It should be noted that the percentage of plastic items differed in each site; the lowest amount of plastic items was found in Fourat (France) with plastics accounting for some 40% of all litter collected and the highest amount of plastic items was found in Embarcadero de los Escullos (Spain) with plastics accounting for some 94% of all litter collected.

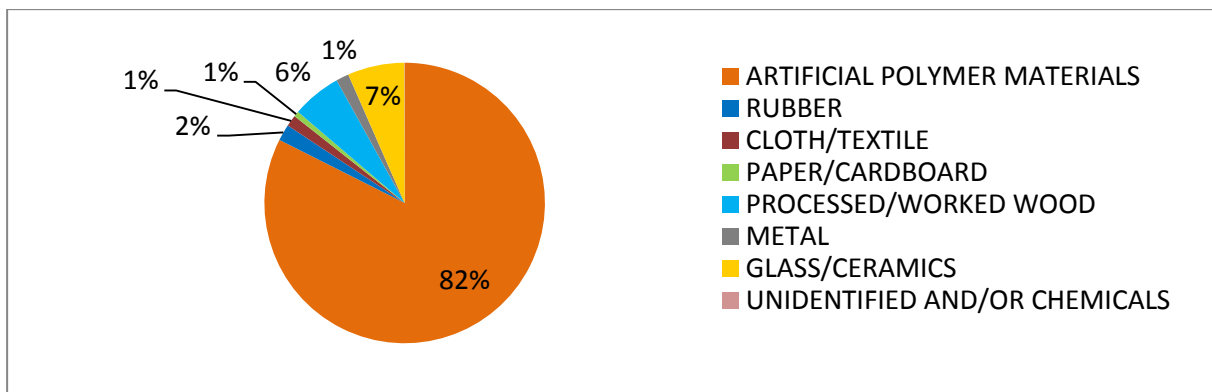


Figure 6.2. Aggregated results of the percentage (%) of total litter items per category type (artificial polymer material; rubber; cloth/textile; paper/cardboard; processed/worked wood; metal, glass/ceramics).

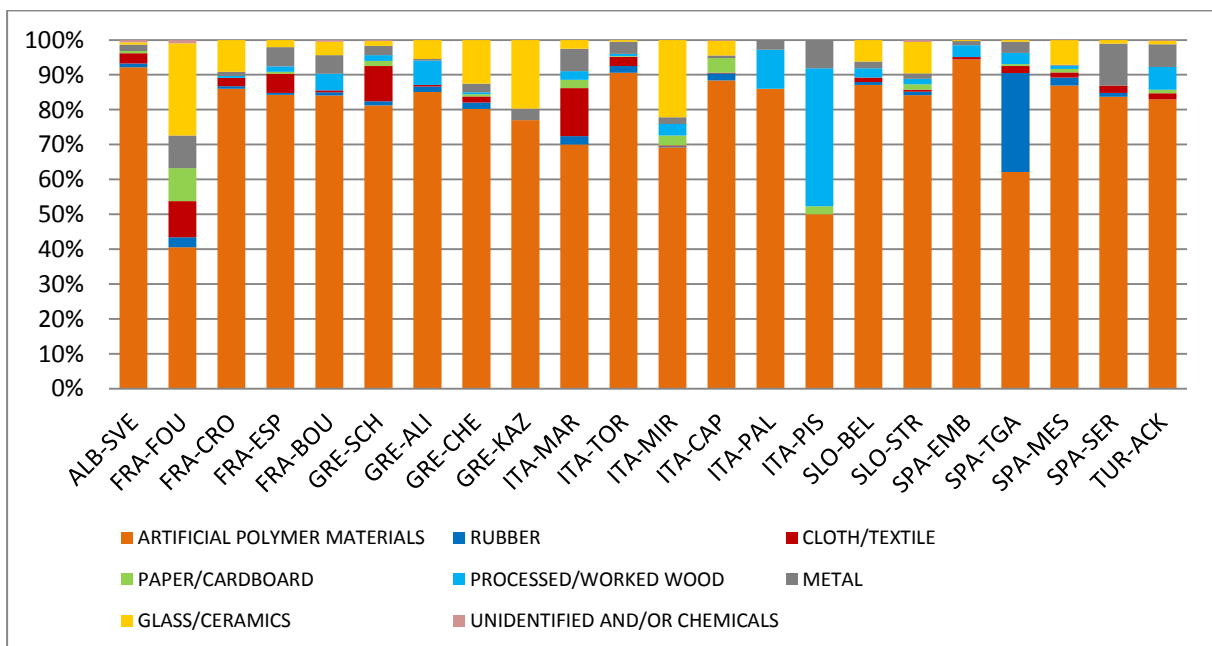


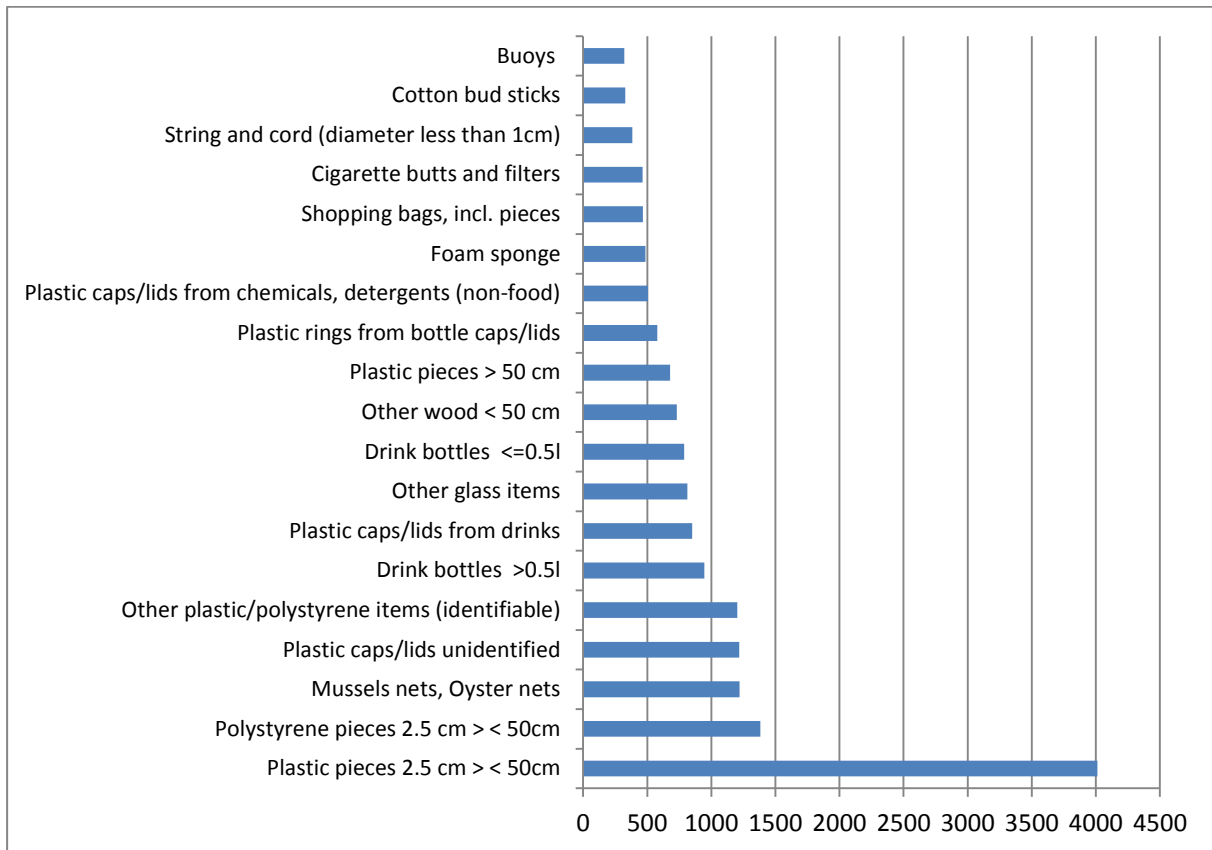
Figure 6.3. Percentage (%) of total litter items per category type (artificial polymer material; rubber; cloth/textile; paper/cardboard; processed/worked wood; metal, glass/ceramics) in the 22 surveyed beaches.

Among the 159 litter categories, plastic pieces 2.5 cm > < 50 cm (G79) accounted for the highest percentage 16.3% (4,012 items) of the total litter items recorded in all surveys, followed by polystyrene pieces 2.5 cm > < 50 cm (G82) with 5.6% (Tab. 6.5, Fig. 6.4). The third most abundant items were mussel & oyster nets (G45) with 5.0% and unidentified plastic caps/lids (G23) with a 5.0%. Other identifiable plastic/polystyrene items (G124), plastic drink bottles >0.5l (G8), plastic caps/lids from drinks (G21), other glass items (G210), plastic drink bottles ≤0.5l (G9) and other wood < 50 cm (G171) were among the top 10 items found. The top 10 items for each beach is presented in Annex III.

Table 6.5. Top 20 items found on the 22 surveyed beaches of Mediterranean coastal and marine, protected areas calculated on an aggregated basis of total litter counts in all beaches.

	Item code	Item name	Items count	%
1	G79	Plastic pieces 2.5 cm > < 50cm	4012	16,3
2	G82	Polystyrene pieces 2.5 cm > < 50cm	1382	5,6
3	G45	Mussels nets, Oyster nets	1221	5,0
4	G23	Plastic caps/lids unidentified	1217	5,0
5	G124	Other plastic/polystyrene items (identifiable)	1203	4,9
6	G8	Drink bottles >0.5l	946	3,8
7	G21	Plastic caps/lids from drinks	850	3,5
8	G210	Other glass items	814	3,3
9	G7	Drink bottles ≤0.5l	789	3,2
10	G171	Other wood < 50 cm	731	3,0
11	G80	Plastic pieces > 50 cm	679	2,8
12	G24	Plastic rings from bottle caps/lids	579	2,4
13	G22	Plastic caps/lids from chemicals, detergents (non-food)	507	2,1
14	G73	Foam sponge	487	2,0
15	G3	Shopping bags, incl. pieces	466	1,9
16	G27	Cigarette butts and filters	464	1,9
17	G50	String and cord (diameter less than 1cm)	383	1,6
18	G95	Cotton bud sticks	329	1,3
19	G63	Buoys	322	1,3
20	G200	Bottles, including pieces	309	1,3

Figure 6.3. Top 20 items found on the 22 surveyed beaches of Mediterranean coastal and marine, protected areas calculated on an aggregated basis of total litter counts in all beaches.



The collected marine litter items were also classified into 3 major groups of items: single use plastics, non-single use plastics and non-plastic marine litter items. Results are presented at aggregated level and also at beach level (Fig. 6.4-6.5). As single-use plastics the following items were considered: shopping bags, including pieces (G3), drink bottles <=0.5l (G7), drink bottles >0.5l (G8), food containers including fast food containers (G10), plastic caps/lids from drinks (G21), cigarette butts and filters (G27), crisps packets/sweets wrappers (G30), lolly sticks (G31), cups and cup lids (G33), cutlery and trays (G34), straws and stirrers (G35), cotton bud sticks (G95) and sanitary towels/panty liners/backing strips (G96), toilet fresheners (G97).

At aggregated level, single-use plastics accounted for one fifth (21%) of the items recorded. At beach level the abundance of single-use plastics varied from 10-81%. The highest abundance of single-use plastics was recorded at Cala Palme (Italy) with 81%, followed by Boucanet (France) with 73%. The lowest abundance of single-use plastics was recorded at Fourat (France) with 11% and Tordigliano (Italy) with 10%.

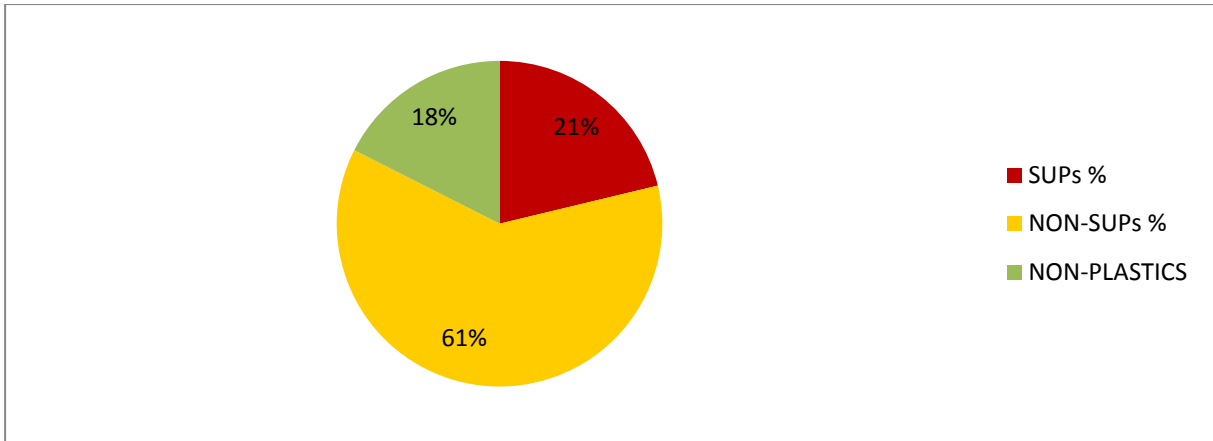


Figure 6.4. The abundance of single-use plastics (SUPs) and non-single-use plastics (non-SUPs) at aggregated level.

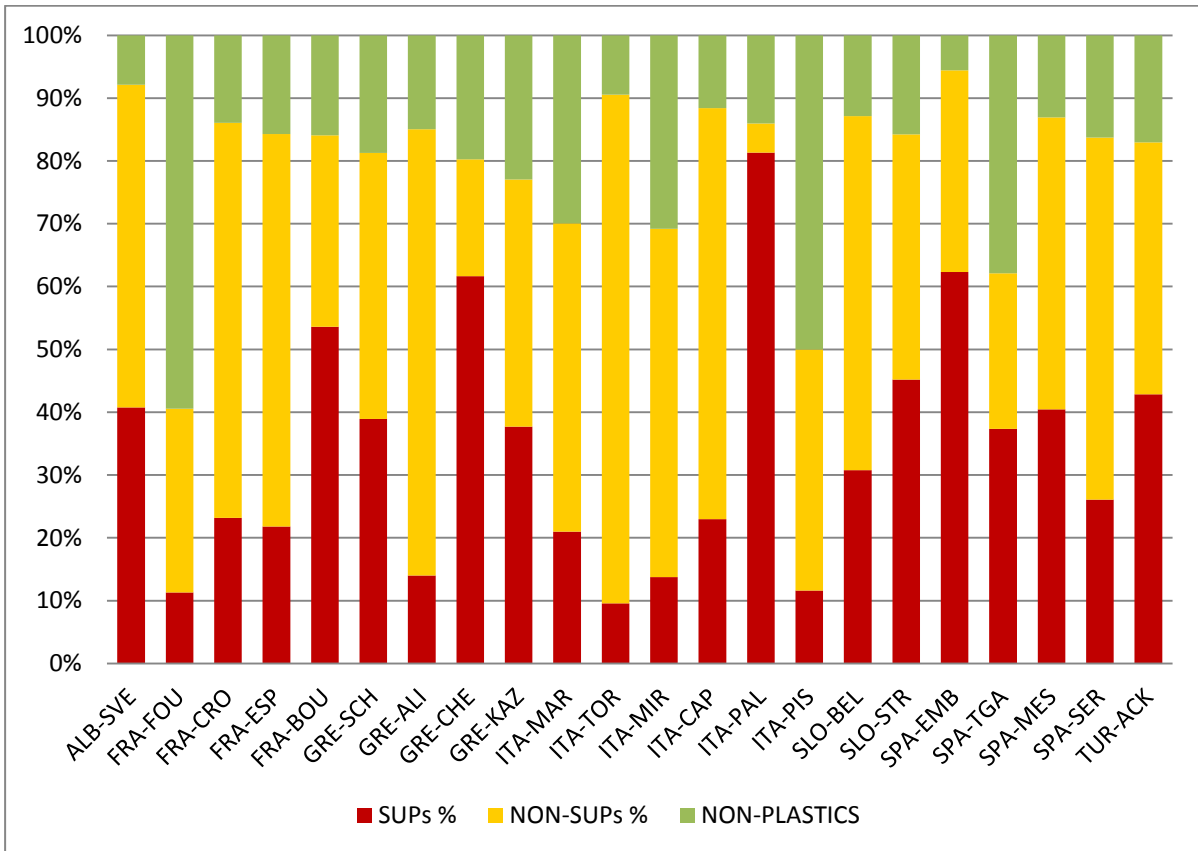


Figure 6.5. Abundance variations of single-use plastics (SUPs) and non-single-use plastics in the surveyed beaches.

When it comes to smoking activities as a source of marine litter items, on an aggregated basis 3% of the total litter items collected fell under one of the following category types of litter: tobacco pouches / plastic cigarette box packaging (G25), cigarette lighters (G26), cigarette butts and filters (G27) and paper cigarette packets (G152) (Fig. 6.6). The highest percentage of smoking-related items was recorded in Cheronisi (Greece), where they accounted for 50% of sampled items, followed by Strunjan (Slovenia) with 37% and Embarcadero de los Escullos (Spain) with 26% and Boucanet (France) with 23%. The lowest percentage of smoking-related items was observed for Tordigliano (Italy) and Zvernec (Albania), where no smoking related items were recorded.

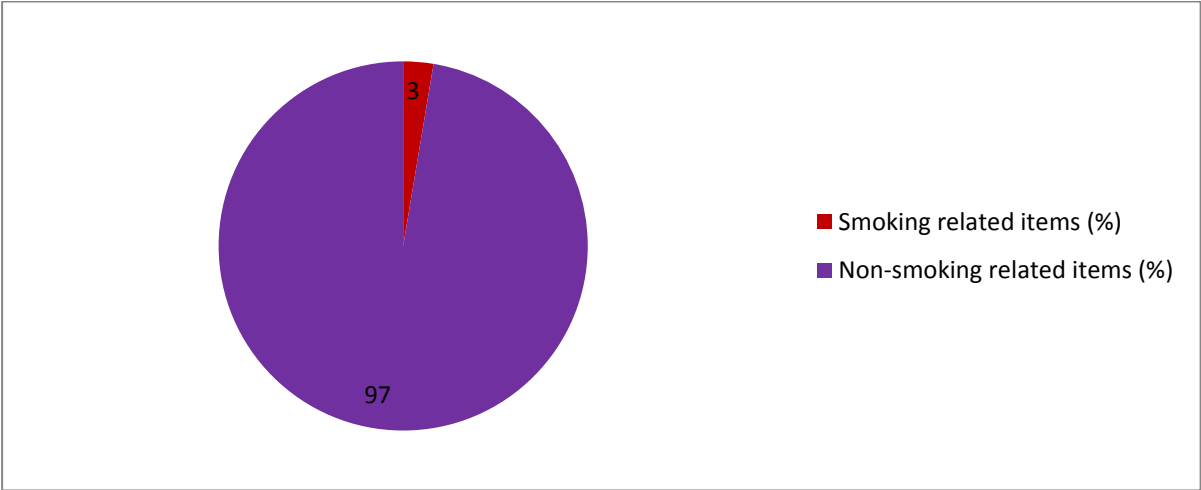


Figure 6.6. Abundance (%) of smoking related items on the basis of aggregated results.

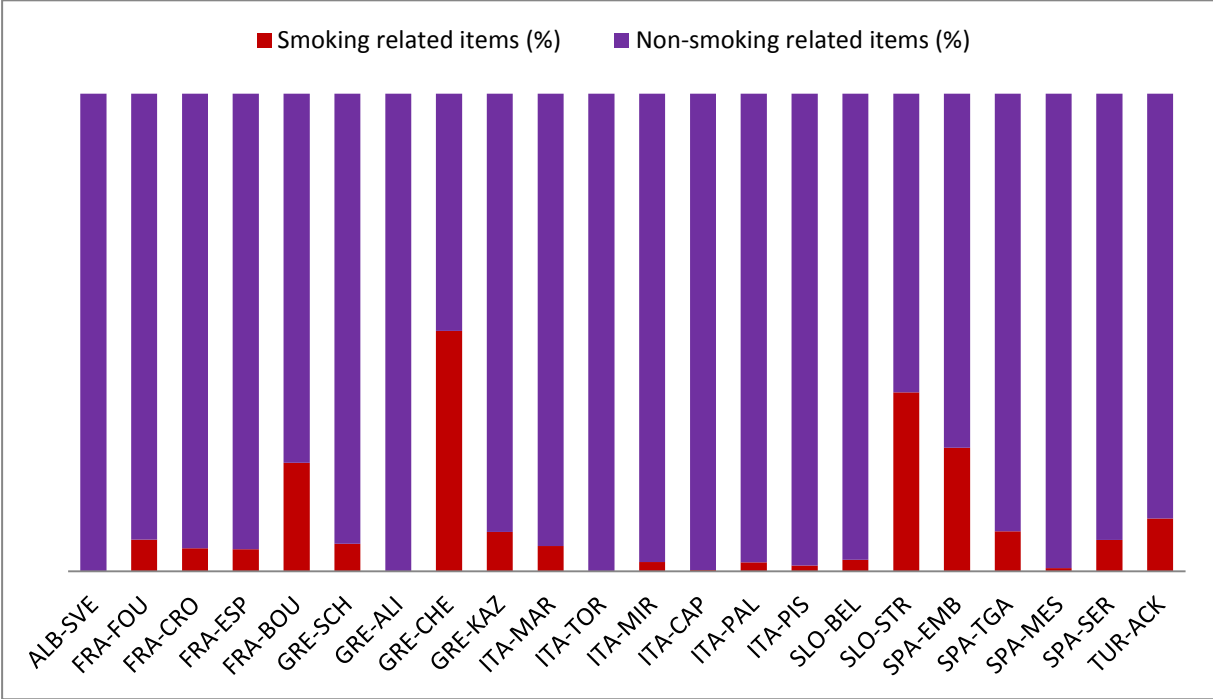


Figure 6.7. Abundance (%) of smoking in each of the surveyed beaches.

6.3. Sources of marine litter

Within the present study, the assignment of specific sources to each litter item found was made in line with the approach described by Vlachogianni et al., 2018. The sources of marine litter were classified into the following eight major categories.

- 1** - Shoreline, including poor waste management practices, tourism and recreational activities. Litter items that are attributed to this source include those generated by land-based activities, such as tourism and recreation (beachgoers, sports and recreation businesses, beach bars, hotels, festivals, mismanaged waste at the beaches, etc.) as well as litter produced inland and carried by winds, storms and rivers as a result of poor waste management by municipalities. Indicative items are shopping bags, drink bottles, food containers, straws and stirrers, etc.
- 2** - Fisheries and aquaculture. Litter items that are attributed to this source include those items that are exclusively generated from commercial and recreational fishing and aquaculture farms. Indicative items are crab and lobster pots, octopus' pots, mussel nets and oyster nets, fishing nets, fish boxes, etc.
- 3** - Shipping. Litter items that are attributed to this source include those items that have been generated by any kind of vessel such as recreational boats, fishing boats, cruise ships, ferries, etc. Indicative items are engine oil bottles and containers, jerry cans, gloves (industrial/professional rubber gloves), oil drums, etc.
- 4** - Fly-tipping. Litter items that are attributed to this source include those items that have been disposed illegally. Indicative items are car parts, traffic cones, construction waste, appliances (refrigerators, washing machines, etc.), etc.
- 5** - Sanitary and sewage related. Litter items that are attributed to this source include sanitary, personal hygiene and care items that have been disposed improperly. These items may come from consumers who dispose them on the coast or flush them down the toilet, thus reaching the coastal and marine environment through the sewage outlets and systems. They may also come from mismanaged waste on the coast or at sea. Indicative items are cotton bud sticks, diapers and nappies, condoms (incl. packaging), tampons and tampon applicators, etc.
- 6** - Medical related. Litter items that are attributed to this source include items that come from improper disposal of pharmaceutical and medical products, either by individuals or medical units and mismanaged hospital waste. Indicative items are syringes and needles, medical and pharmaceuticals containers, etc.
- 7** - Agriculture. Litter items that are attributed to this source are generated by agricultural activities. Indicative items are: fertilizer and animal feed bags, olive harvesting nets, greenhouse sheeting, flower pots from retailer plant nurseries, etc.
- 8** - Non-sourced. Classified within this category are all items that cannot be attributed to any of the aforementioned sources, either because they could have been generated by several sources, or they are too small or damaged/weathered to be identified. Indicative items are foam sponge, buckets, gloves, small plastic or polystyrene pieces, etc.

Litter from shoreline sources, such as tourism and recreational activities and poor waste management practices, accounted for 27% of all litter collected; while **the amount of litter from fisheries and aquaculture was at a level of 10%** (Fig.6.8). Sanitary and sewage related items accounted for 2%, while shipping, fly-tipping and medical related items accounted for 1% each. More than half of the litter items collected could not be attributed to a source.

At individual beach level, the inputs of litter from the different sectors and their comparative importance varied substantially (Fig. 6.9). The highest marine litter inputs from shoreline sources, including tourism and recreational activities and poor waste management practices were recorded for Cale Palme (Italy) with 86%, followed by Cheronissi (Greece) with 66.5%. The highest marine litter

inputs from fisheries and aquaculture were recorded at Schinias (Greece) with 21%, Espiguette (France) with 17% and Serallo (Spain) with 16%. High levels of sanitary and sewage related waste were recorded at Torre Garcia (Spain) with 16%, Embarcadero de los Escullos (Spain) with 12% and Cala Mesquida (Spain) with 12%. Some 13% of litter items coming from tipping were recorded in Cheronissi (Greece) followed by Schinias (Greece) with some 5%. The highest percentage of medical related items was found in Kazarba (Greece) with 16% and Crouste (France) with 8%.

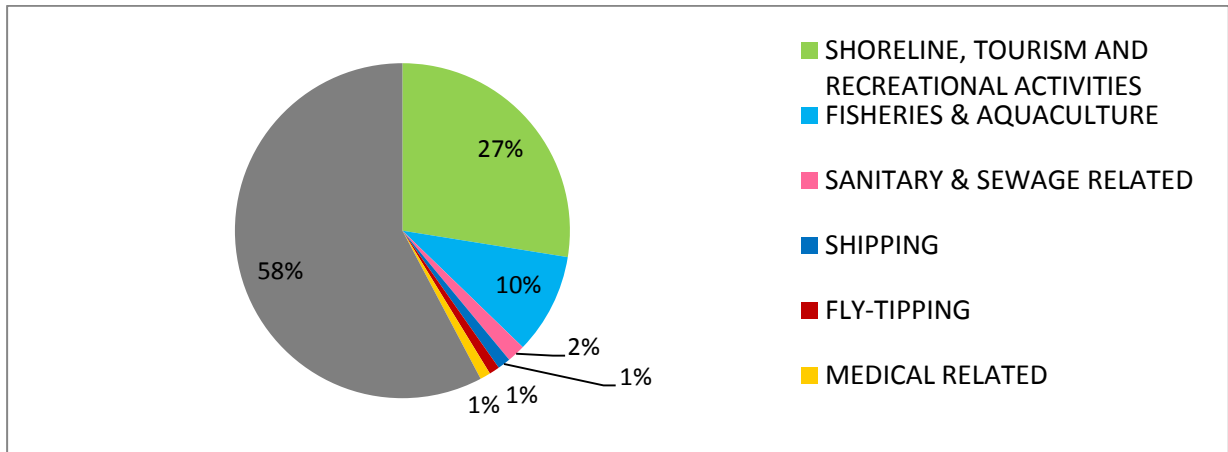


Figure 6.8. Sources of marine litter on the basis of aggregated results at national level and at regional level.

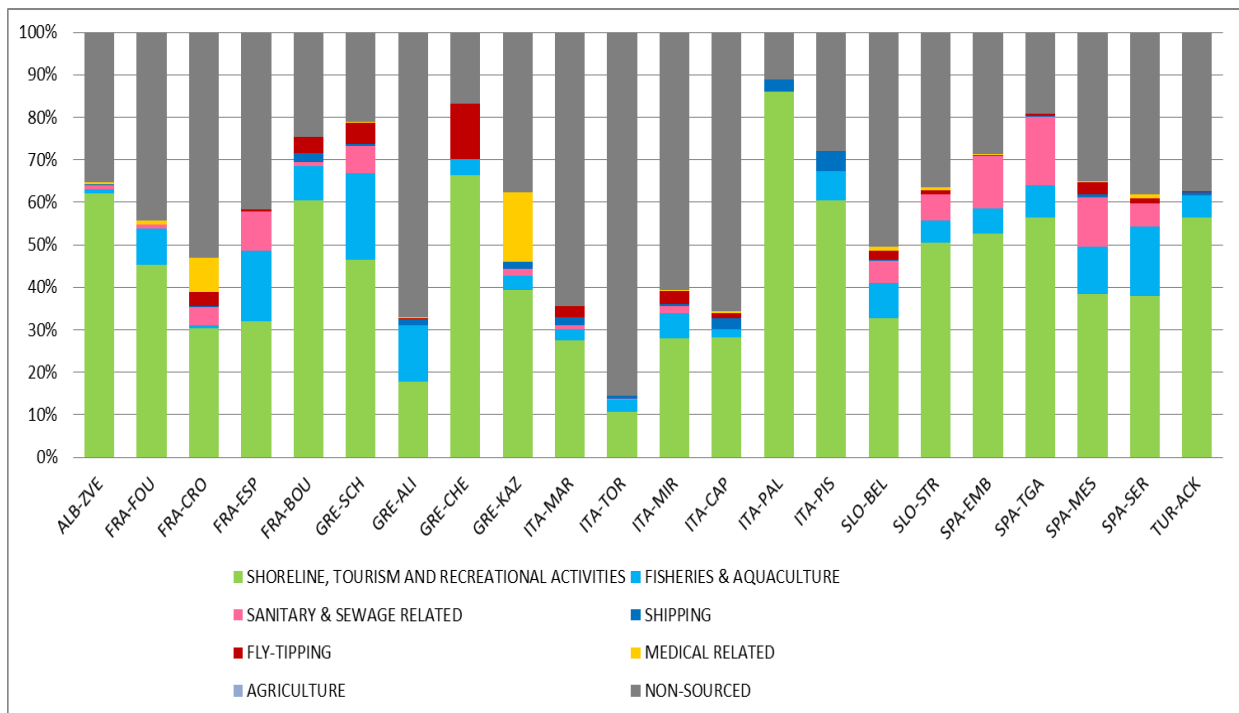


Figure 6.9. Sources of marine litter on the basis of aggregated results at national level and at regional level.

7. DISCUSSION AND CONCLUSION

Systematic efforts to collect data on the amount, distribution, composition and sources of marine litter along the coastline of Mediterranean coastal and marine protected areas are rather limited. In terms of the geographical distribution of the data collected, these refer mainly to the coastal and marine protected areas located in the Adriatic and Ionian Seas (Munari et al., 2016; Vlachogianni et al., 2018) and the Pelagos Sanctuary in Italy (Giovacchini et al., 2018) (see Table 7.1).

Table 7.1. Summary of beach litter densities reported

Study areas	Classification list	Litter densities	Reference
Protected areas located in Italy: Po River Delta Park and several locations in Natura 2000 sites	UNEP/IOC Litter classification list	0.2 items/m ²	<i>Munari et al., 2016</i>
Several coastal sites located at the Pelagos Sanctuary, Italy	OSPAR List	1.06 items/m ²	<i>Giovacchini et al., 2018</i>
Mljet National Park (Croatia), Protected Area of Kalamas-Acherontas-Corfu (Greece); MPA Torre del Cerrano (Italy); the Strunjan Landscape Park (Slovenia)	MSFD TG10 Masterlist	92 - 10,554 items/100m; 0.09 - 0.41 items/m ²	<i>Vlachogianni et al., 2018</i>
Coastal and marine protected areas located in Albania, Croatia, France, Greece, Italy, Slovenia, Spain and Turkey	MSFD TG10 Masterlist	1,054 items/100m; 0.61 items/m ²	<i>Present study</i>

To-date, the ACT4LITTER Marine Litter Watch Month has been one of the most comprehensive efforts to assess marine litter deposited on the beaches of coastal and marine protected areas. According to the results of the winter edition marine litter seems to be 'building up' in what should be pristine coastal and marine protected areas of the Mediterranean. More than one fourth of the twenty two beaches surveyed were characterized by high litter densities ranging from 430 to 12,896 items per 100-metre stretch. This amounts to a relatively high average litter density of 1,048 items/100m stretch or 0.61 items/m².

The majority of litter items were made of artificial polymer materials which accounted for 82% of all litter collected. Litter from shoreline sources, such as tourism and recreational activities and poor waste management practices, accounted for 28% of all litter collected; while the amount of litter from fisheries and aquaculture was in the range of some 10%. The most frequently found items included small plastic and polystyrene pieces (22%), unidentified plastic caps and lids (5%) and mussel nets (5%).

Similar results were obtained by Giovacchini et al (2018) who performed beach litter surveys in several sites located at the Pelagos Sanctuary in Italy. A density of 1.06 items/m² was reported. Plastic was found to be the prevailing material.

The IPA-Adriatic DeFishGear project (Vlachogianni et al., 2018) also surveyed beach litter at several coastal and marine protected areas of the Adriatic and Ionian Seas, namely the Mljet National Park (Croatia), the Protected Area of Kalamas-Acherontas-Corfu (Greece); the MPA Torre del Cerrano (Italy) and the Strunjan Landscape Park (Slovenia). The recorded litter densities varied from 92 to 10,554 items/100m stretch and 0.09 - 0.41 items/m². Similarly high amounts of mussel nets were recorded.

Munari et al. (2016) carried out beach litter surveys in the Po River Delta Park and several sites located in Italian Natura 2000 sites, namely: Rosolina in the Veneto Regional Park, Volano, Bellocchio, Casalboretto, and Bevano in the Emilia Romagna Regional Park. The average density was 0.2 litter items/m² which was a bit lower than the densities found in the aforementioned studies, including the present one. Some 80% of the items recorded were made of plastic. The most abundant items were

cigarette butts which accounted for 22.9% of items collected. Smoking related items in the present study accounted only for some 3% of all items collected, a value which is much lower than the aforementioned value.

Regarding the sources, the present study clearly illustrates that these depend on the specificities of the surveyed beaches and thus targeted and localized measures are needed to address marine litter effectively. Litter from shoreline sources, such as tourism and recreational activities and poor waste management practices accounted for 27% of all litter collected; a value which is similar to the values found in the other studies carried out in the Adriatic coastline (Munari et al., 2016; Vlachogianni et al., 2018).

Within the present study single-use plastic items accounted for 21% of all litter items collected. This highlights the need to recognize the fact that marine litter is not merely a waste management issue. One of the root causes of waste accumulation on land and at sea is the linear use of resources from their production, to a short-lived, single-use, to final disposal (Veiga et al., 2016). In this respect, the EU Strategy on Plastics and the recent landmark agreement to ban single-use plastic cutlery, plastic plates, plastic straws, cotton bud sticks and other items is expected to drastically reduce the use and impact of single-use plastic items.

In conclusion, the present study provides fit-for-purpose data and baseline information on the amounts, composition and sources of marine litter in coastal and marine protected areas of the Mediterranean. It provides a useful tool for MPA managers to gear up their efforts in the combat against the marine litter threat and identify targeted measures to tackle this threat at its source.

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9. LIST OF ACRONYMS

D10	Descriptor 10 (Marine Litter)
DeFishGear	Derelict Fishing Gear Management System in the Adriatic Region
EC	European Commission
EcAp	Ecosystem Approach
EO	Ecological Objective
EU	European Union
GES	Good Environmental Status
IMAP	Integrated Monitoring and Assessment Programme
IPA	Instrument for Pre-accession Assistance
MAP	Mediterranean Action Plan
MEDPOL	Mediterranean Pollution Monitoring Programme
MPAs	Marine Protected Areas
MSFD	Marine Strategy Framework Directive
MSFD TG10	MSFD Technical Sub-Group on Marine Litter
NGO	Non-Governmental Organisation
UNEP	United Nations Environment Programme

10. ANNEX I. MARINE LITTER ITEMS CLASSIFICATION LIST

Code	Items name
G1	4/6-pack yokes, six-pack rings
G3	Shopping bags, incl. pieces
G4	Small plastic bags, e.g. freezer bags, including pieces
G5	Plastic bag collective roll
G7	Drink bottles ≤0.5l
G8	Drink bottles >0.5l
G9	Cleaner/cleanser bottles & containers
G10	Food containers incl. fast food containers
G11	Beach use related cosmetic bottles and containers
G12	Other cosmetics bottles & containers
G13	Other bottles & containers (drums)
G14	Engine oil bottles & containers <50 cm
G15	Engine oil bottles & containers > 50 cm
G16	Jerry cans (square plastic containers with handle)
G17	Injection gun containers
G18	Crates and containers / baskets
G19	Car parts
G21	Plastic caps/lids from drinks
G22	Plastic caps/lids from chemicals, detergents (non-food)
G23	Plastic caps/lids unidentified
G24	Plastic rings from bottle caps/lids
G25	Tobacco pouches / plastic cigarette box packaging
G26	Cigarette lighters
G27	Cigarette butts and filters
G28	Pens and pen lids
G29	Combs/hair brushes/sunglasses
G30	Crisps packets/sweets wrappers
G31	Lolly sticks
G32	Toys and party poppers
G33	Cups and cup lids
G34	Cutlery and trays
G35	Straws and stirrers
G36	Fertilizer/animal feed bags
G37	Mesh vegetable bags
G40	Gloves (washing up)
G41	Gloves (industrial/professional rubber gloves)
G42	Crab/lobster pots and tops
G43	Tags (fishing and industry)
G44	Octopus pots
G45	Mussels nets, Oyster nets
G46	Oyster trays (round from oyster cultures)
G47	Plastic sheeting from mussel culture (Tahitians)
G49	Rope (diameter more than 1cm)
G50	String and cord (diameter less than 1cm)

G53	Nets and pieces of net < 50 cm
G54	Nets and pieces of net > 50 cm
G56	Tangled nets/cord
G57	Fish boxes - plastic
G58	Fish boxes - expanded polystyrene
G59	Fishing line/monofilament (angling)
G60	Light sticks (tubes with fluid) incl. packaging
G62	Floats for fishing nets
G63	Buoys
G64	Fenders
G65	Buckets
G66	Strapping bands
G67	Sheets, industrial packaging, plastic sheeting
G68	Fiberglass/fragments
G69	Hard hats/Helmets
G70	Shotgun cartridges
G71	Shoes/sandals
G72	Traffic cones
G73	Foam sponge
G79	Plastic pieces 2.5 cm > < 50cm
G80	Plastic pieces > 50 cm
G82	Polystyrene pieces 2.5 cm > < 50cm
G83	Polystyrene pieces > 50 cm
G84	CD, CD-boxes
G85	Salt packaging
G86	Fin trees (from fins for scuba diving)
G87	Masking tape
G88	Telephone (incl. parts)
G89	Plastic construction waste
G90	Plastic flower pots
G91	Biomass holder from sewage treatment plants
G92	Bait containers/packaging
G93	Cable ties
G95	Cotton bud sticks
G96	Sanitary towels/panty liners/backing strips
G97	Toilet fresheners
G98	Diapers/nappies
G99	Syringes/needles
G100	Medical/Pharmaceuticals containers/tubes
G101	Dog faeces bags
G102	Flip-flops
G124	Other plastic/polystyrene items (identifiable)
G125	Balloons and balloon sticks
G126	Balls
G127	Rubber boots
G128	Tyres and belts

G129	Inner-tubes and rubber sheets
G130	Wheels
G131	Rubber bands (small, for kitchen/household/post use)
G132	Bobbins (fishing)
G133	Condoms (incl. packaging)
G134	Other rubber pieces
G137	Clothing / rags (clothes, hats, towels)
G138	Shoes and sandals (e.g. leather, cloth)
G139	Backpacks & bags
G140	Sacking (hessian)
G141	Carpet & furnishing
G142	Rope, string and nets
G143	Sails, canvas
G144	Tampons and tampon applicators
G145	Other textiles (incl. rags)
G147	Paper bags
G148	Cardboard (boxes & fragments)
G150	Cartons/Tetrapack Milk
G151	Cartons/Tetrapack (others)
G152	Cigarette packets
G153	Cups, food trays, food wrappers, drink containers
G154	Newspapers & magazines
G155	Tubes for fireworks
G156	Paper fragments
G158	Other paper items
G159	Corks
G160	Pallets
G161	Processed timber
G162	Crates
G163	Crab/lobster pots
G164	Fish boxes
G165	Ice-cream sticks, chip forks, chopsticks, toothpicks
G166	Paint brushes
G167	Matches & fireworks
G171	Other wood < 50 cm
G172	Other wood > 50 cm
G174	Aerosol/Spray cans
G175	Cans (beverage)
G176	Cans (food)
G177	Foil wrappers, aluminium foil
G178	Bottle caps, lids & pull tabs
G179	Disposable BBQs
G180	Appliances (refrigerators, washers, etc.)
G181	Tableware (plates, cups & cutlery)
G182	Fishing related (weights, sinkers, lures, hooks)
G184	Lobster/crab pots

G186	Industrial scrap
G187	Drums, e.g. oil
G188	Other cans (< 4 L)
G189	Gas bottles, drums & buckets (> 4 L)
G190	Paint tins
G191	Wire, wire mesh, barbed wire
G193	Car parts / batteries
G194	Cables
G195	Household Batteries
G198	Other metal pieces < 50 cm
G199	Other metal pieces > 50 cm
G200	Bottles, including pieces
G201	Jars, including pieces
G202	Light bulbs
G203	Tableware (plates & cups)
G204	Construction material (brick, cement, pipes)
G205	Fluorescent light tubes
G206	Glass buoys
G207	Octopus pots
G208	Glass or ceramic fragments >2.5cm
G210	Other glass items
G211	Other medical items (swabs, bandaging, adhesive plaster, etc.)
G213	Paraffin/Wax

11. ANNEX II. SURVEYORS LIST

Country	Coastal and marine protected area	Beach	Data owner/data producer	Surveyors
Albania	Karaburun-Sazan MPA	Zvernec	Management Body of the Karaburun-Sazan MPA	Aurora ZYLAJ, Sajmir BEQIRAJ, Lorela LAZAJ
France	Gulf of Lion MPA	Fourat	Management Body of the Gulf of Lion MPA	Marc DUMONTIER, Emmanuelle JEAN, Isabelle MASINSKI, Gilles ESPOSITO, Xavier ROZEC, Jeremie JOURDAN
		Crouste		
	Espiguette Natura 2000	Espiguette	NGO Institut Marin SEaquarium/ Community of Le GRAU du Roi	Loic PETENIEFF, Pauline CONSTANTIN
	Cote Languedocienne Natura 2000	Boucanet		
Greece	Marathon and Schinias National Park	Schinias	MEDSOS	Natalia ROUMELIOTI, Christina KONTAXI, Konstantinos KOUMPIS
	Thermaikos Gulf Protected Areas	Alyki Kitrous	Management Authority of the Thermaikos Gulf Protected Areas	Stella VARELTZIDOU, Vasilios GIAMOZIS
	Parnon and Moustos Natura 2000	Cherronisi	MIO-ECSDE	Thomas VLACHOGIANNI
		Kazarba		
Italy	MPA Punta Campanella	Marina del Cantone	Consortium Management of the MPA Punta Campanella	Carmela GUIDONE
		Tordigliano		
	MPA Miramare	Miramare	WWF / Management Body of the Miramare MPA	Carlo FRANZOSINI
	MPA Secche di Tor Paterno	Capo San Marco	MAREVIVO	Federico DIPENTA, Danilo SCANNELLA, Stefano SIRACUSA, Luisa CAMAIETTA
	MPA Pelagie Islands	Cala Palme	Management body of the MPA of Pelagie Islands	Giulia VISCONTI
Cala Pisana				
Slovenia	Strunjan Landscape Park	Bele Skale	Institute of Water of the Republic of Slovenia	Uroš ROBIČ, Sabina CEPUŠ
		Strunjan		
Spain	Cabo de Gata-Níjar Natural Park/UNESCO Global geopark	Embarcadero de los Escullos	Management Body of the Cabo de Gata-Níjar Natural Park/UNESCO Global geopark	Gloria GARCIA HOYO
		Torre Garcia		
	MPA Levante de Mallorca-Cala Ratjada	Cala Mesquida	Management Body of the Levante de Mallorca-Cala Ratjada MPA	Javier LLORENTE PALAO
	Ebro Delta Nature Park	Serrallo	Management Body of the Ebro Delta Nature Park	Xavier ABRIL I FERRER, Ignasi MATEO, Lucille GUIHENEUF, Lluís ARBÓ
Turkey	Gökova Special Environmental Protection Area	Akcapinar	Mediterranean Conservation Society	Esra OZTURK YIGIT

12. ANNEX III. TOP 10 ITEMS FOUND IN EACH SURVEYED BEACH

Table 11.1. Top 10 items found in Zvernec (Albania).

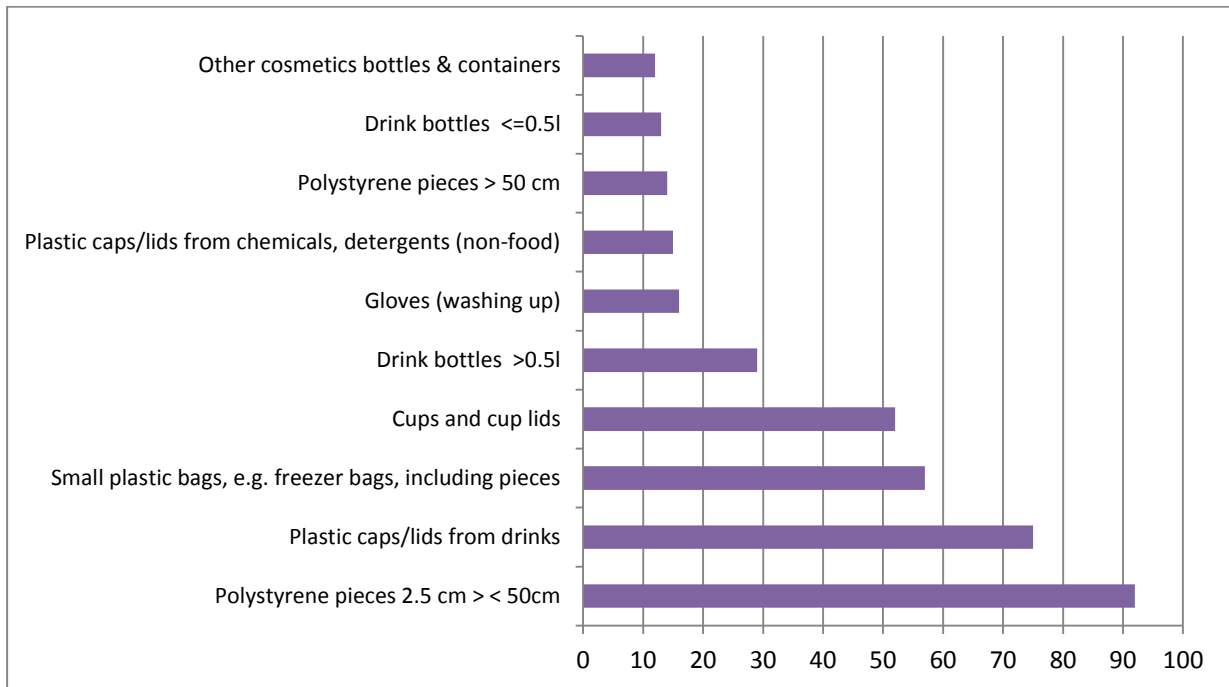


Table 11.2. Top 10 items found in Fourat (France).

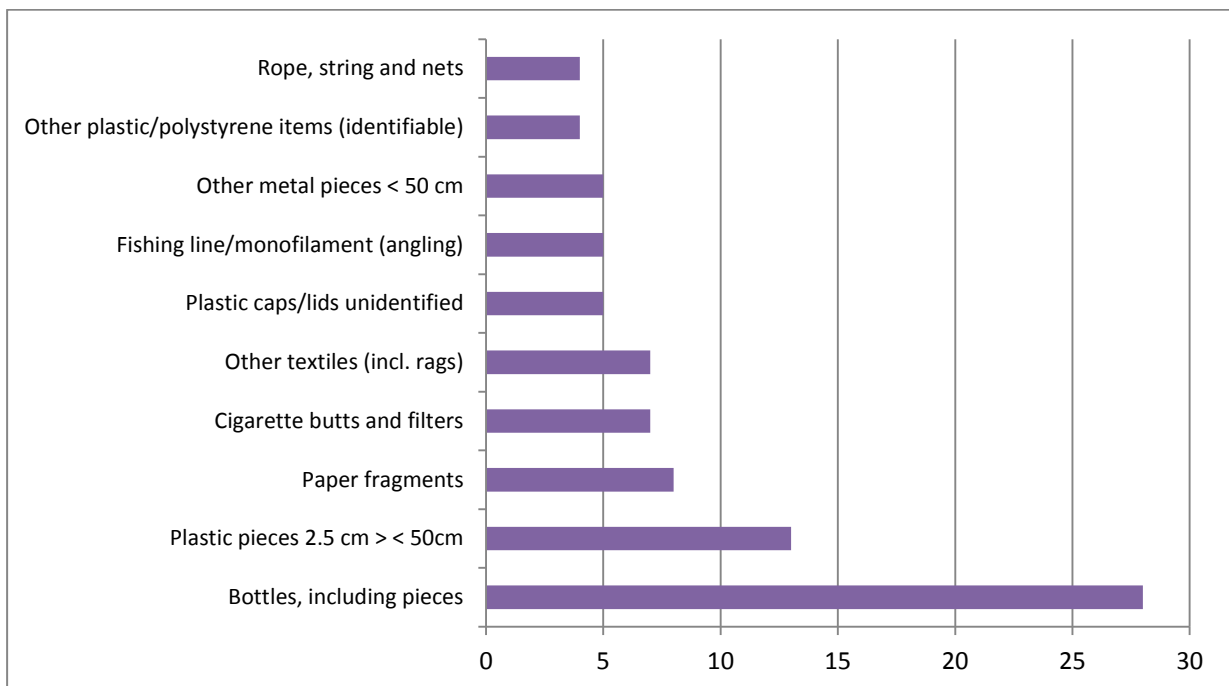


Table 11.3. Top 10 items found in Crouste (France).

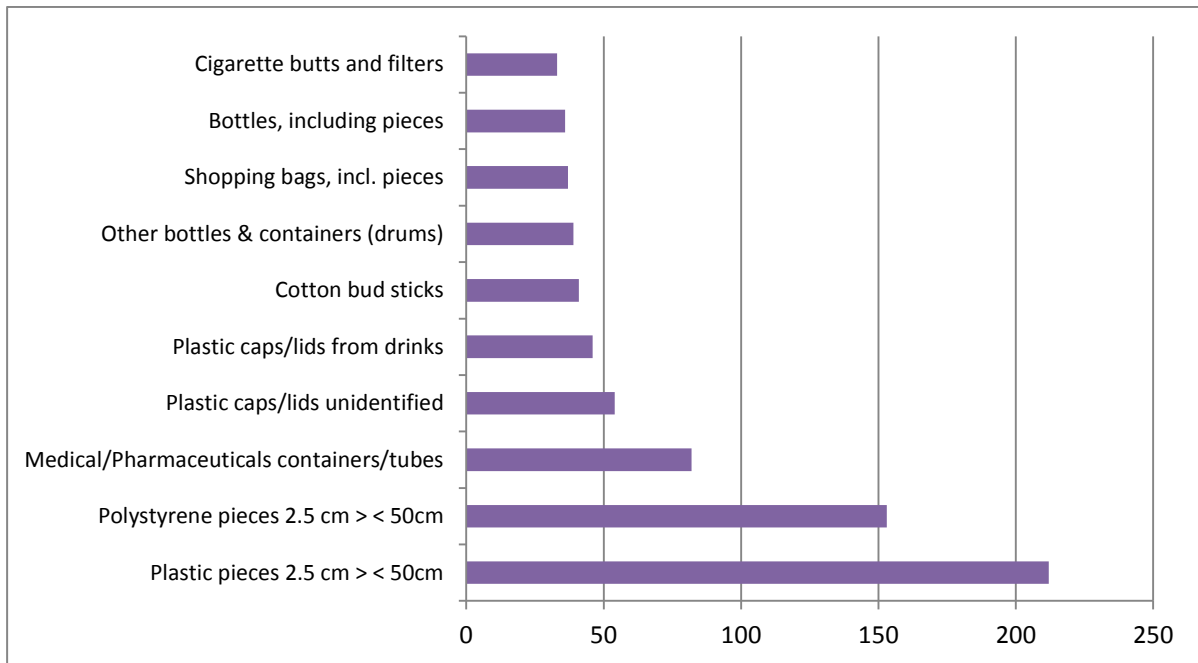


Table 11.4. Top 10 items found in Espiguette (France).

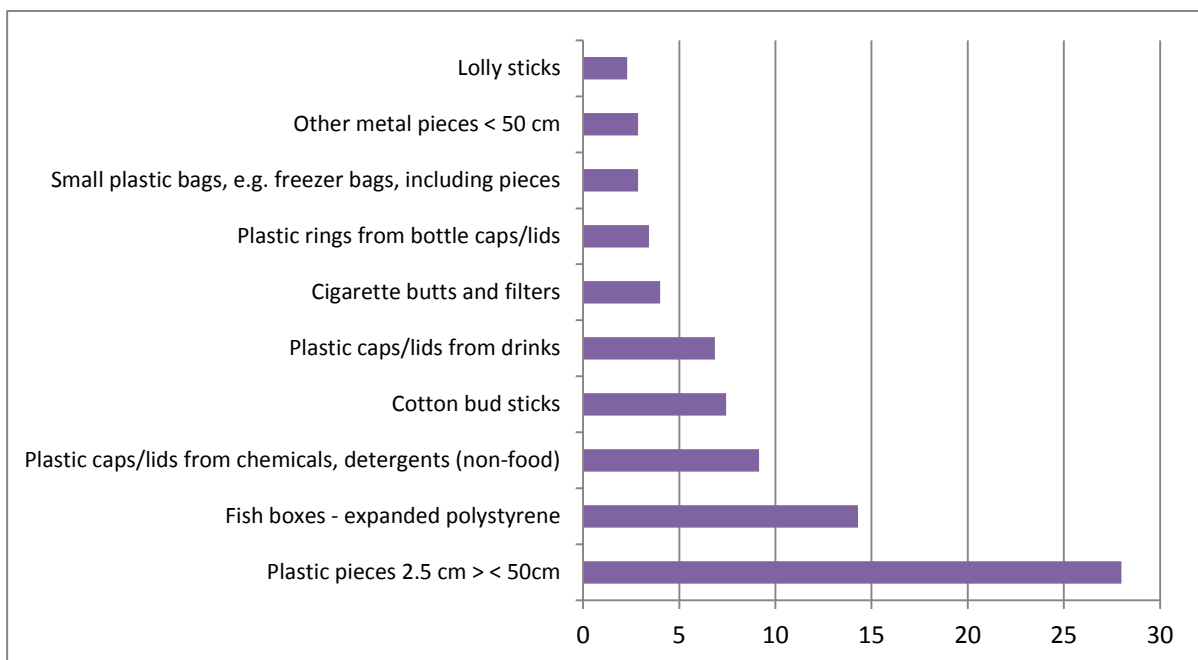


Table 11.5. Top 10 items found in Boucanet (France).



Table 11.6. Top 10 items found in Schinias (Greece).

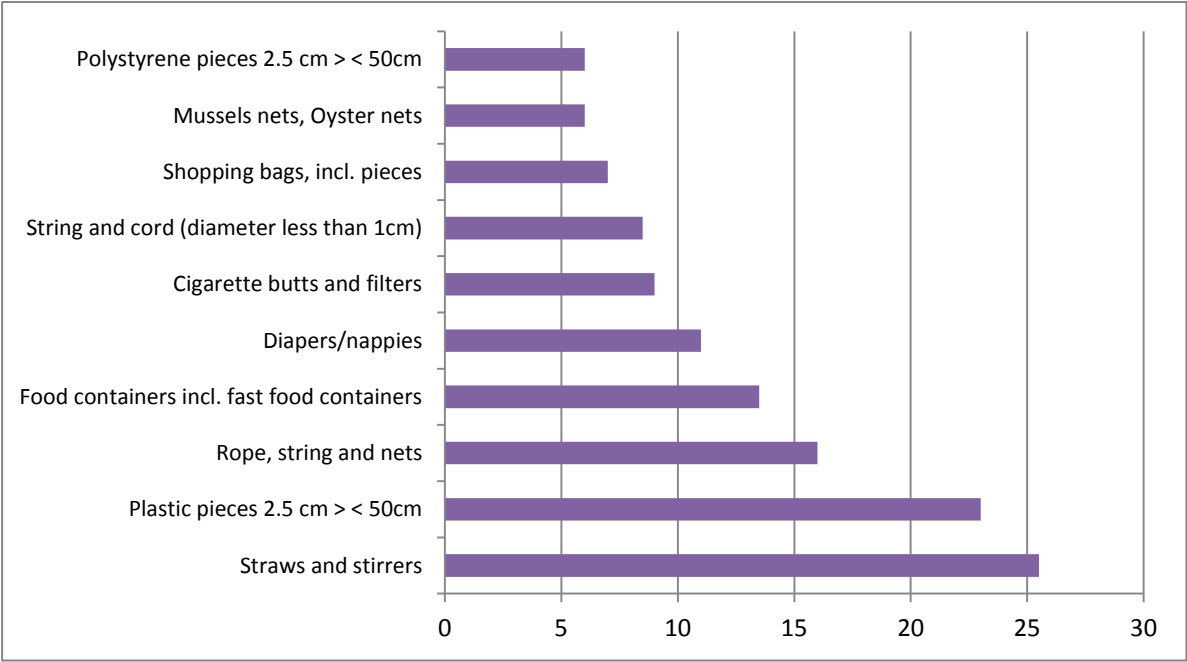


Table 11.7. Top 10 items found in Alyki Kitrous (Greece).

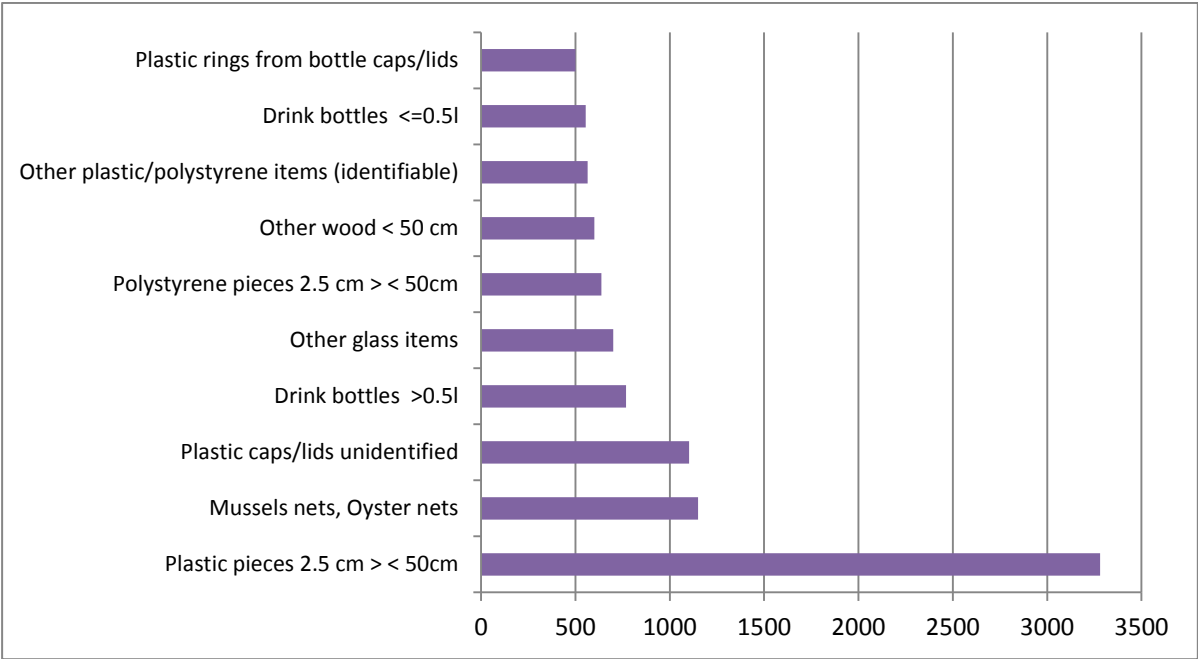


Table 11.8. Top 10 items found in Cherronisi (Greece).

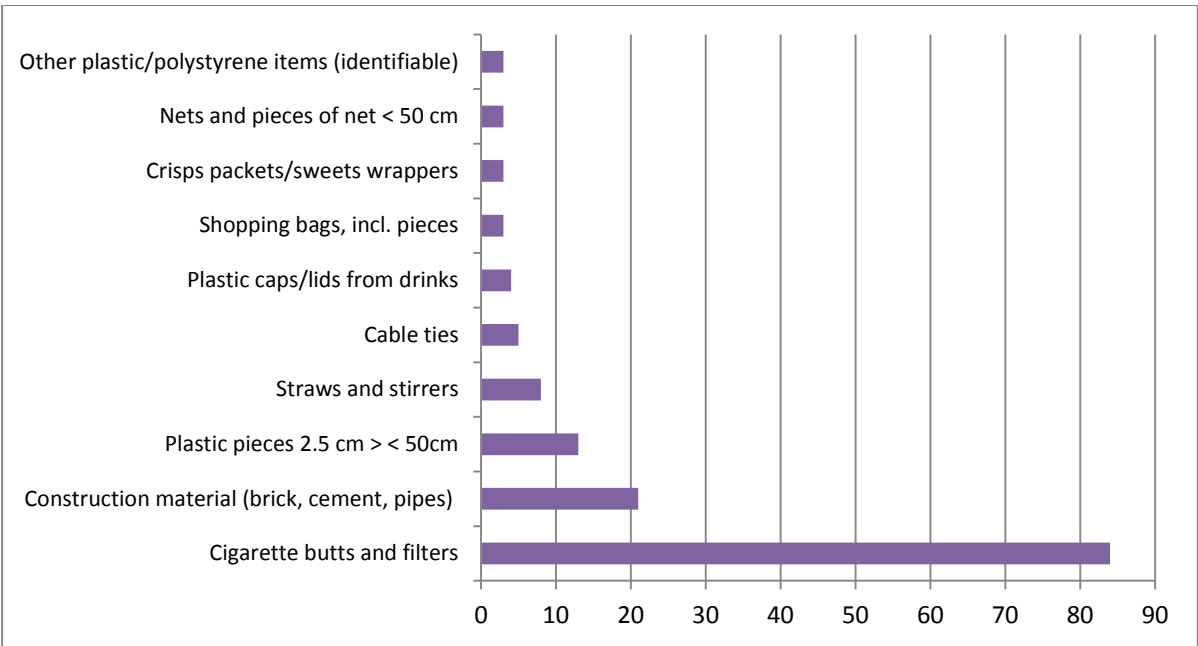


Table 11.9. Top 10 items found in Kazarba (Greece).

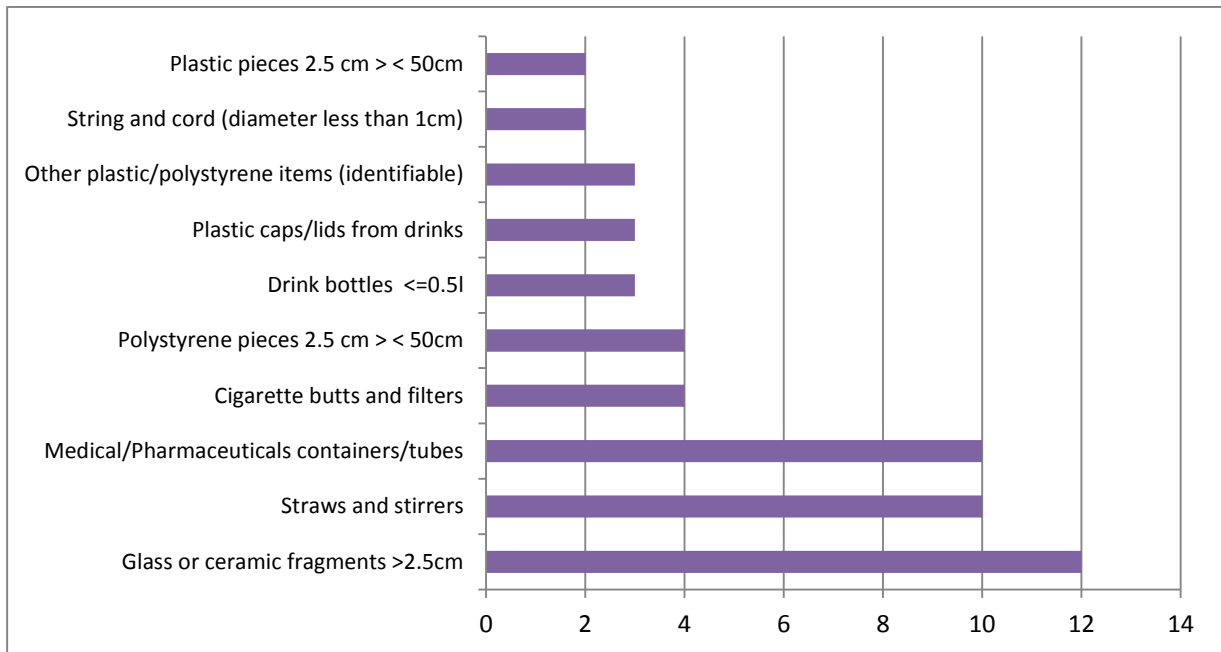


Table 11.10. Top 10 items found in Marina del Cantone (Italy).

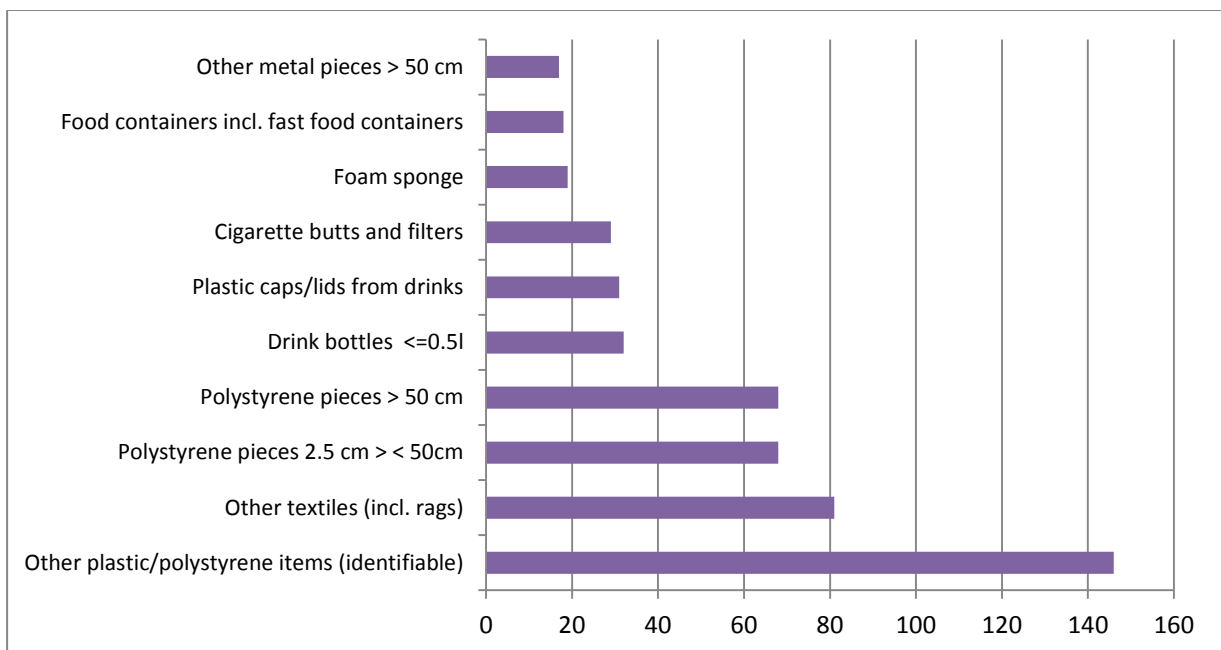


Table 11.11. Top 10 items found in Tordigliano (Italy).

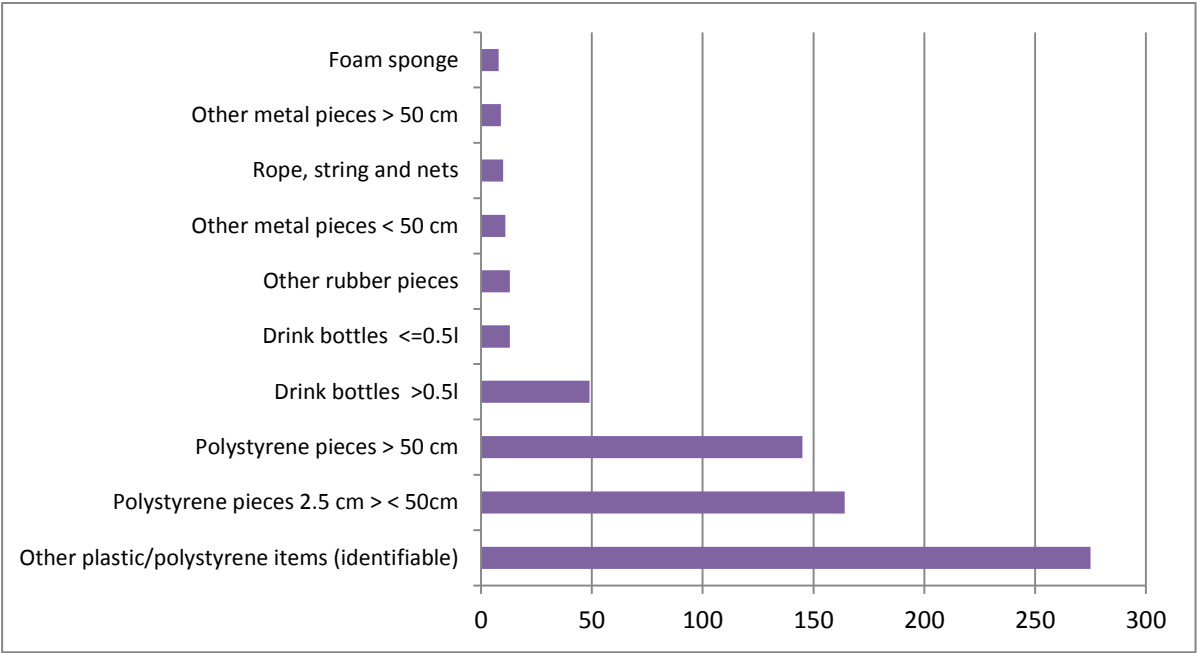


Table 11.12. Top 10 items found in Miramare (Italy).

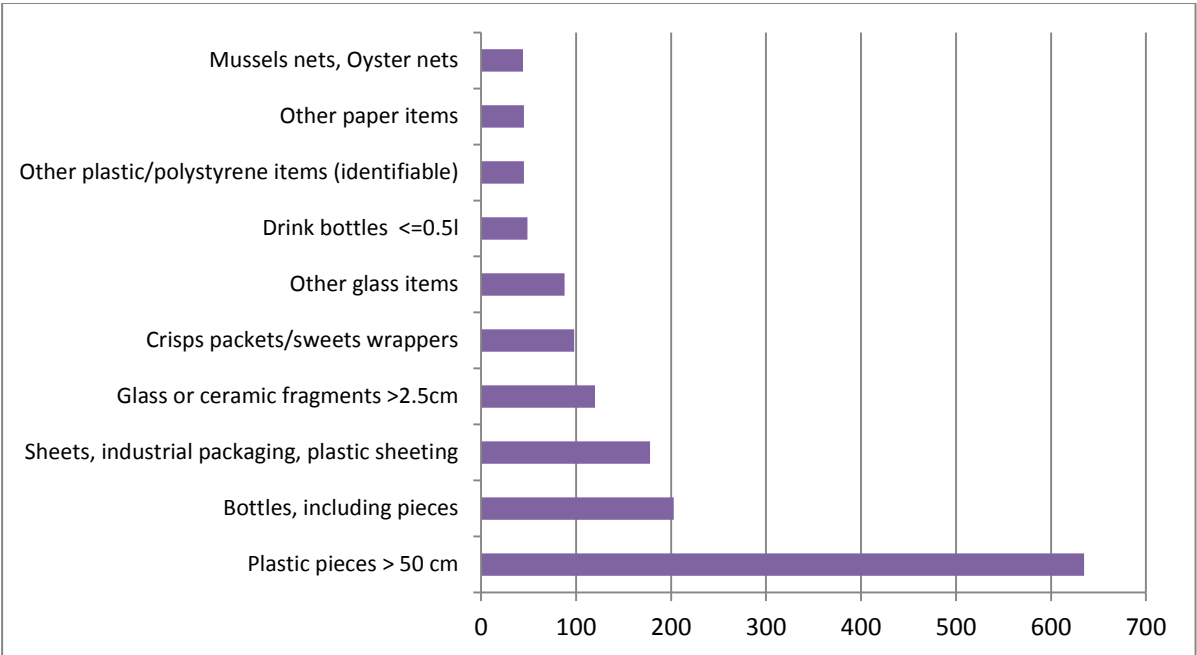


Table 11.13. Top 10 items found in Capo San Marco (Italy).

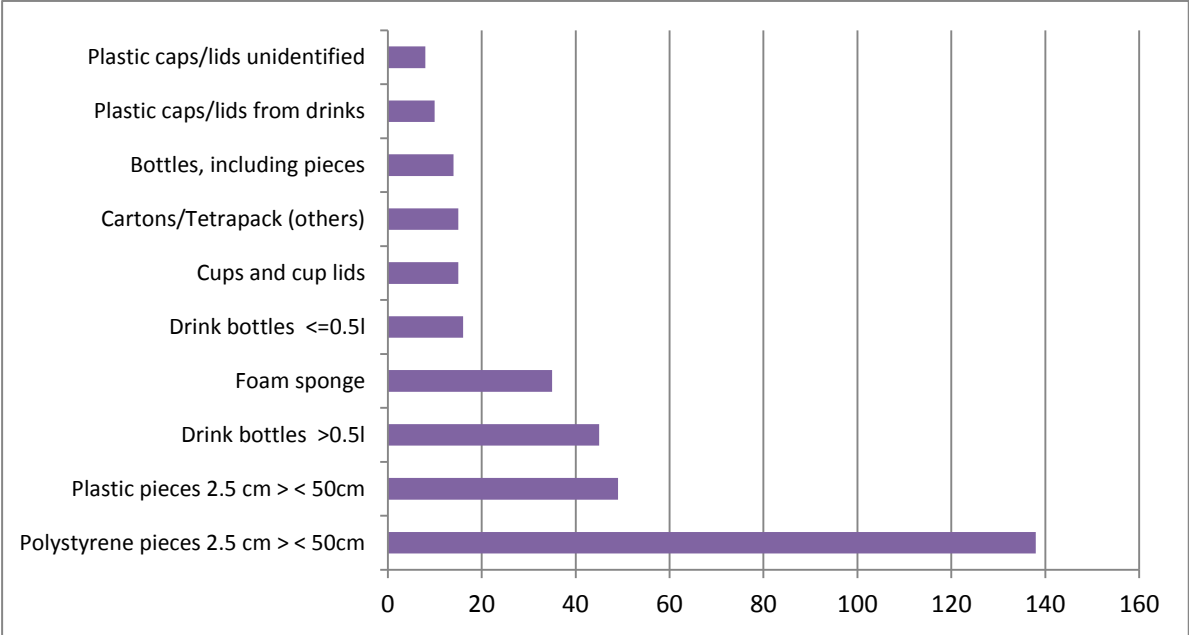


Table 11.14. Top 10 items found in Cala Palme (Italy).

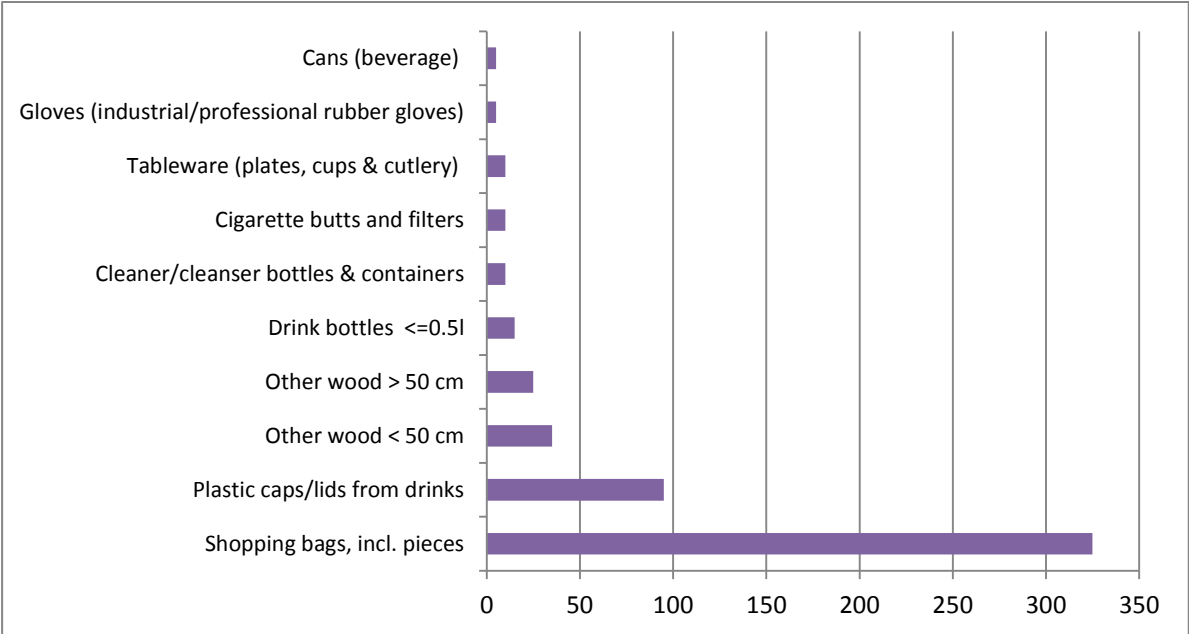


Table 11.15. Top 10 items found in Cala Pisana (Italy).

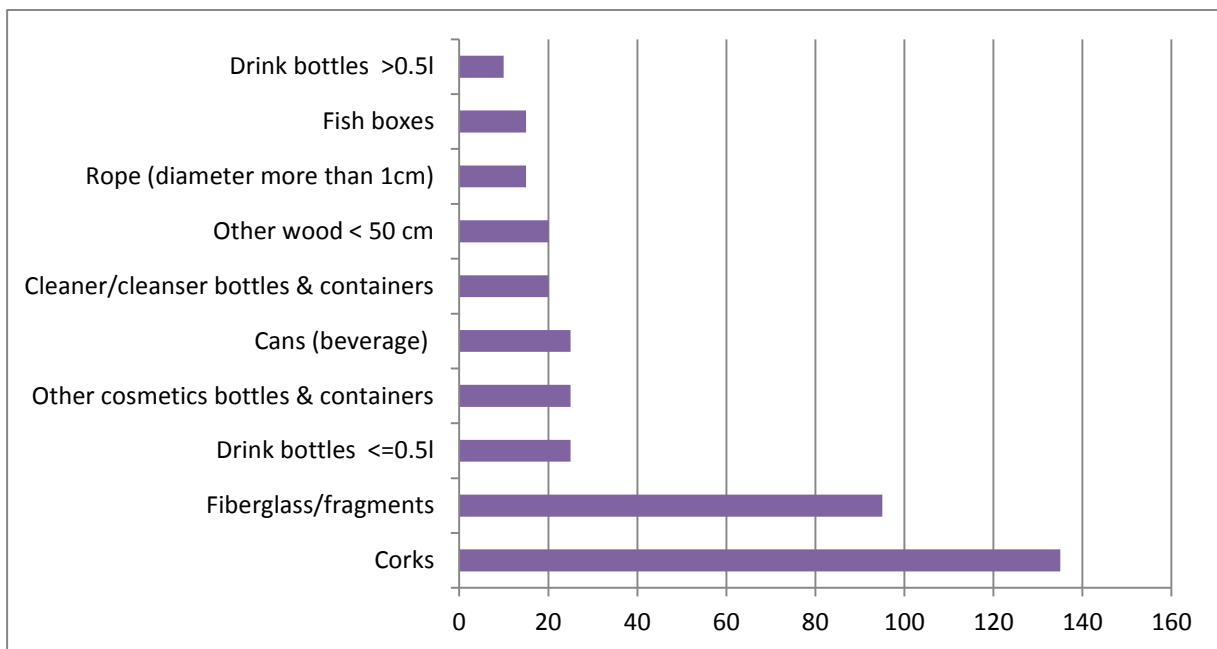


Table 11.16. Top 10 items found in Bele Skale (Slovenia).

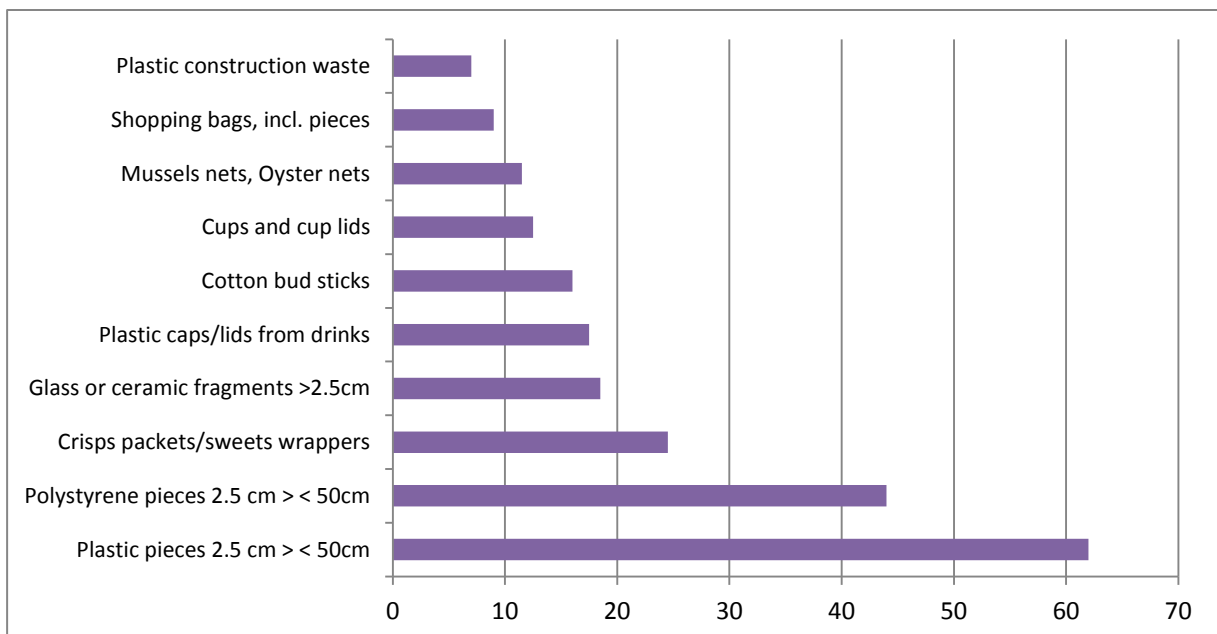


Table 11.17. Top 10 items found in Strunjan (Slovenia).

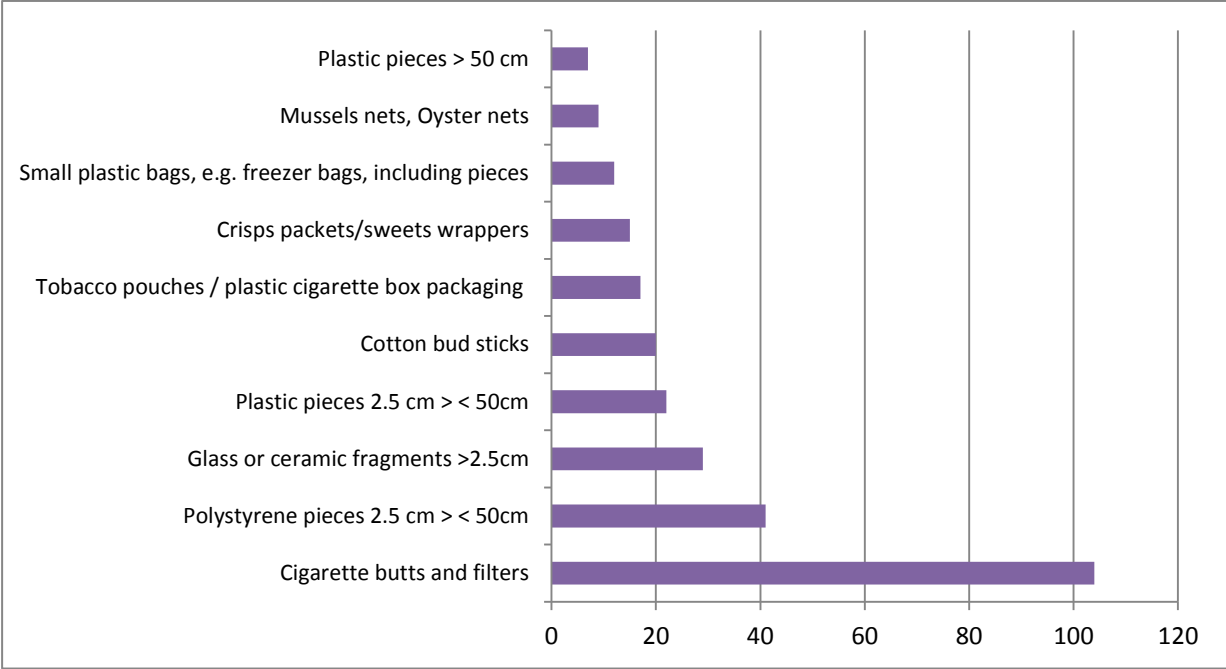


Table 11.18. Top 10 items found in Embarcadero de los Escullos (Spain).

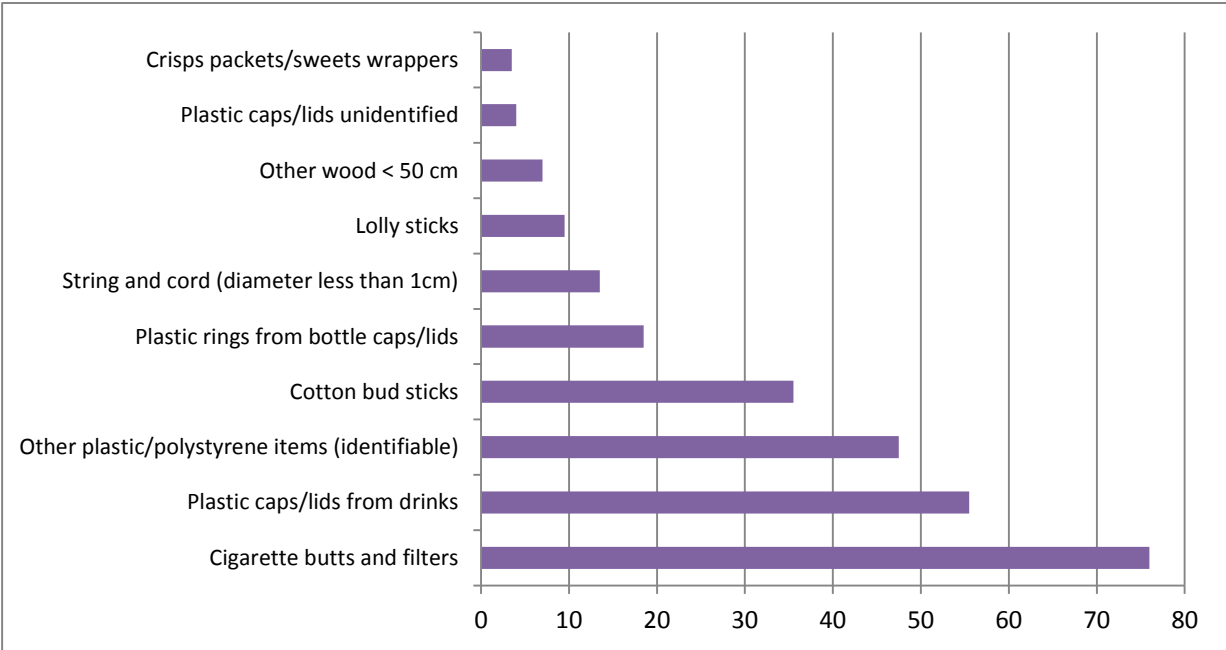


Table 11.19. Top 10 items found in Torre Garcia (Spain).

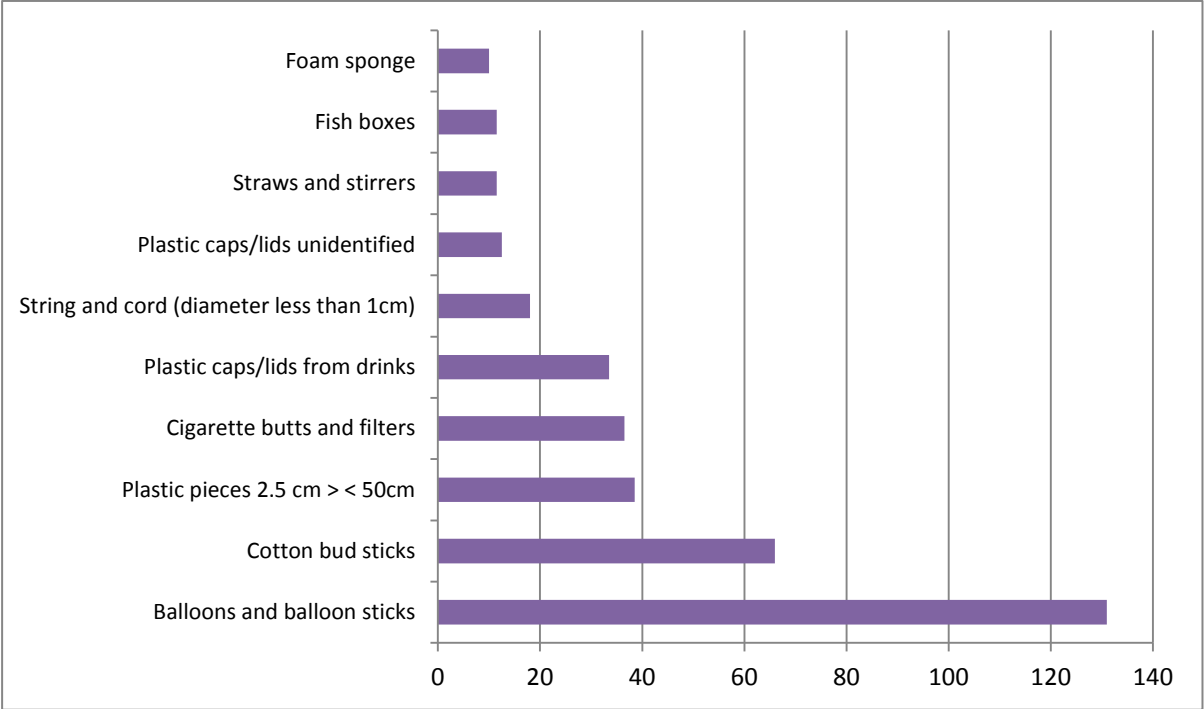


Table 11.20. Top 10 items found in Cala Mesquida (Spain).

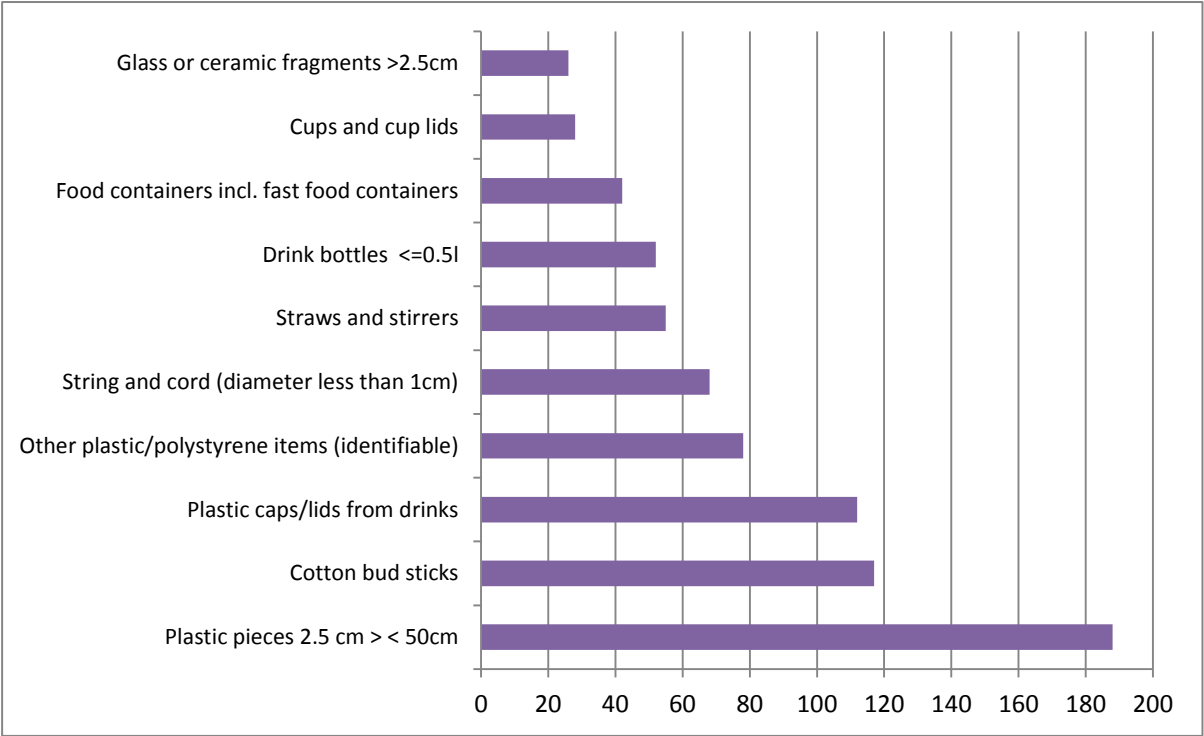
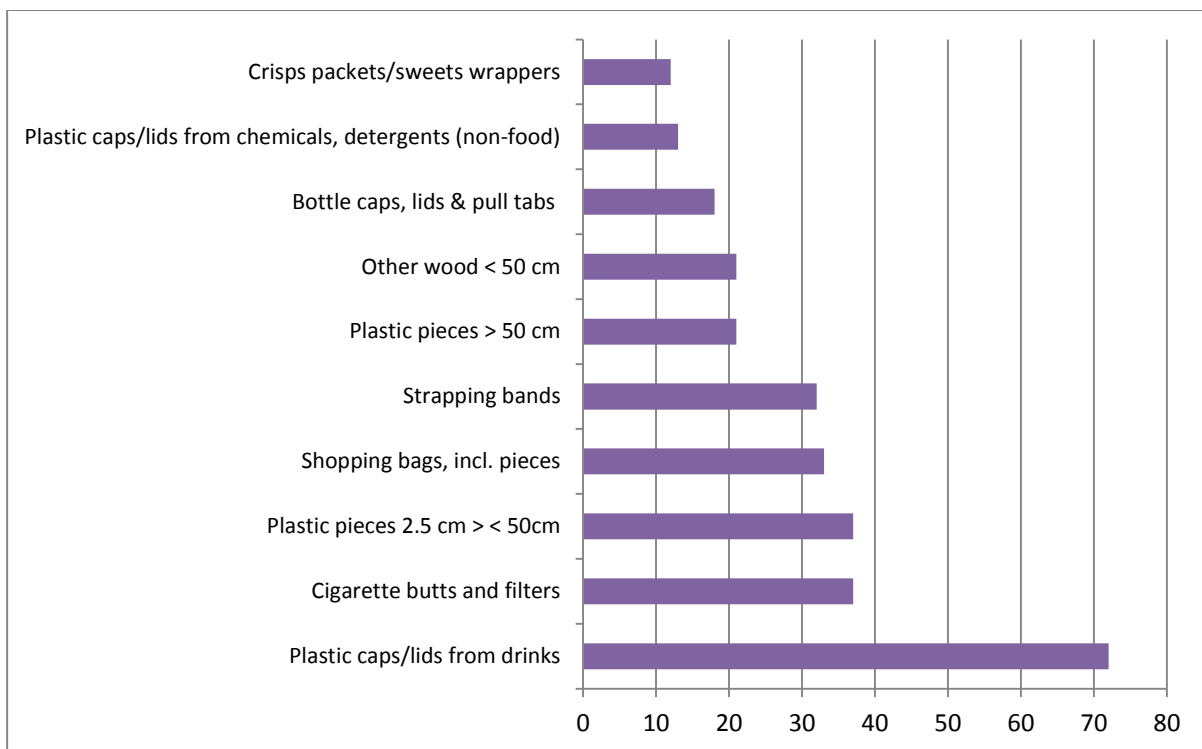


Table 11.21. Top 10 items found in Serallo (Spain).



Table 11.22. Top 10 items found in Akcapinar (Turkey).





Joint measures to preserve natural ecosystems from marine litter in Mediterranean Marine Protected Areas



Catalan Waste Agency - Regional Activity Center for Sustainable Consumption and Production



Sant'Anna School of Advanced Studies



MedPAN – Network of Marine Protected Area Managers in the Mediterranean



Mediterranean Information Office for Environment, Culture and Sustainable Development