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ASSESSING THE AMOUNT OF MARINE LITTER ON BEACHES OF MEDITERRANEAN COASTAL AND MARINE PROTECTED AREAS

Filling in the knowledge gaps via a participatory-science initiative



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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.

Effective and targeted measures to address the growing threat of marine litter in the Mediterranean are hampered by the lack of reliable, coherent and comparable data. This fact is highlighted by the ‘In Depth Assessment of the EU Member States’ Submissions for the Marine Strategy Framework Directive under articles 8, 9 and 10” (Palialexis et al., Joint Research Centre, 2014), that provides insights on the assessment of the environmental status of the Member States with regards to Descriptor 10 (Marine Litter). According to the aforementioned assessment, half of the Member States have limited, very limited or no data at all, with regards to marine litter. Similar findings on the lack of marine litter data are reported in the UN Environment/MAP Quality Status Report (UN Environment/MAP, 2017).

Throughout the years Mediterranean NGOs have significantly contributed to providing data and information on the temporal and spatial distribution of marine litter found stranded on beaches, through dedicated monitoring surveys, adopt-a-beach schemes or beach clean-up campaigns. Furthermore, several Mediterranean countries within their monitoring programmes are considering community-based data collection initiatives as an essential tool to fill in the marine litter knowledge gaps. The involvement of NGOs in data collection is seen to be a cost-effective way to gather required evidence and detect the emerging issues, supporting public authorities to improve efficiency with less administrative burden. The added value of participatory science across the European Union is clearly depicted also in the JRC publication on ‘Citizen Engagement in Science and Policy-Making’ (Figueiredo Nascimento et al., JRC 2016) and the European Commission White Paper on Citizens Science for Europe.



Figure 1-1. Beach litter survey performed by an environmental NGO.

Beach litter surveys can help assess the potential harm to the environment caused by marine litter and can also enhance our knowledge on sources (Galgani et al., JRC, 2013). Even though beach surveys for macro-litter (items > 2.5 cm) assessment are the most common mode of marine litter monitoring in the Mediterranean and are commonly implemented by NGOs, there are still hindrances with regards to the interpretation and comparison of the obtained results due to the different methodological approaches.

Within this context, MIO-ECSDE set up and implemented a participatory-science campaign in order to fill in the knowledge gaps with regards to marine litter found on beaches of coastal and marine protected areas of the Mediterranean and provide fit-for-purpose data for the effective management of marine litter. The campaign was carried out within the framework of the Annual Programme of MIO-ECSDE supported by the EU LIFE Programme (Operating Grant for NGOs).

2. 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. Marine litter can be classified in size classes as follows: macrolitter referring to items above 25mm in the longest dimension; mesolitter from 5mm to 25 mm; and microlitter from 1µm to 5mm. 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 IMAF Decision IG.22/7) (see Box 1.1 and Box 1.2).



Figure 2-1. Typical macro-litter items recorded in beach macro-litter surveys.

Box 2-1. 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 2-1. The Marine Litter Operational Objectives and respective Indicators within the framework of the Barcelona Convention Ecosystem Approach and the Integrated Monitoring and Assessment Programme.

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 microplastics 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.

3. THE BEACH LITTER SURVEYS 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 ($\sim 1.5\text{-}4.5^\circ$); 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 2.5cm 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 macrolitter density was expressed in counts of litter items per 100-metre stretch of coastline and was compared against the beach litter threshold value that was adopted in 2021 by European Members States (Van Loon et al., 2020).

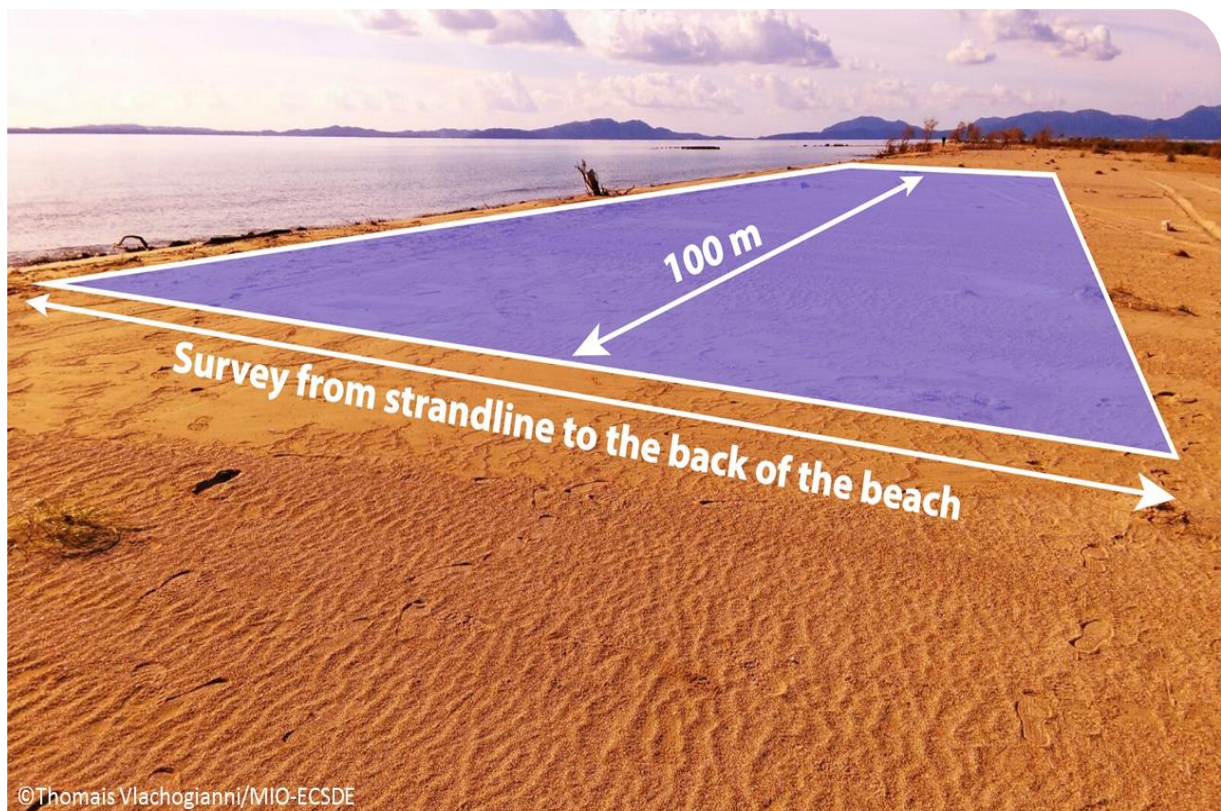


Figure 3-1. The sampling unit.

4. THE STUDY AREAS

The beach litter surveys were carried out on beaches of coastal and marine protected areas located in four Mediterranean countries, namely in Croatia, Cyprus, France and Slovenia. A total of 9 sites were surveyed and seasonal surveys were performed within 2020 and 2021. A total of 46 beach transects were surveyed, which extended over a distance of 4,600 metres (Table 4-1). The organizations involved in the surveys were AKTI PROJECT AND RESEARCH CENTRE (Cyprus), SEAQUARIUM MARINE INSTITUTE (FRANCE), SUNCE (Croatia) and PUBLIC INSTITUTE LANDSCAPE PARK STRUNJAN (Slovenia).

Table 4—1. Surveyed sites per country and organizations involved in the surveys.

Country	Surveyed Site	Site Code	Surveyed Length (m)	Data Producer
Croatia	Sito (Lastovo island)	HR-SIT	300	SUNCE
	Kremena (Lastovo island)	HR-KRE	300	
	Saplun (Lastovo island)	HR-SAP	300	
Cyprus	Lara	CY-LAR	100	AKTI PROJECT AND RESEARCH CENTRE
France	Boucanet	FR-BOU	1400	SEAQUARIUM MARINE INSTITUTE
	Espiguette	FR-ESP	1400	
Slovenia	Bele Skale	SI-BEL	300	PUBLIC INSTITUTE LANDSCAPE PARK STRUNJAN
	Strunjan	SI-STR	300	
	Mesecev zaliv	SI-MES	300	

5. RESULTS

5.1. Abundance of marine litter

On the 9 sites surveyed, a total of 37,040 items were recorded, removed and classified. Items varied widely in abundance and types. The average litter density was calculated to be 912 items/100m ranging from 76 items/100m to 4,630 items/100m. As shown in Table 5-1, the highest litter density of 4,630 items/100m was recorded in beach Sito (Lastovo island, Croatia), followed by a density of 2,829 items/100m recorded in Kremena (Lastovo island, Croatia). The lowest densities in terms of items found on 100-metre stretch of coastline were recorded in Mesecev zaliv (Slovenia) with 84 items/100m and Strunjan (Slovenia) with 76 items/100m. **All surveyed beaches exceeded the European threshold value for beach litter; the 'cleanest' beach was found to have 4 times more litter items than the threshold value of 20 items/100m while the 'dirtiest' beach was found to have 200 times more litter items than the threshold value, signalling an urgent need for action.**

Table 5—1. The average density of litter items recorded in the 9 surveyed beaches, assessed in number of items per 100-metre stretch.

Beach code	Beach name	Average number of items per 100m stretch
HR-SIT	Sito	4630
HR-CRE	Kremena	2829
HR-SAP	Saplun	2713
CY-LAR	Lara	1005
SI-BEL	Bele Skale	254
FR-ESP	Espiguette	193
FR-BOU	Boucanet	140
SI-MES	Mesecev zaliv	84
SI-STR	Strunjan	76

5.2. Composition of marine litter

The marine litter items recorded were classified into 8 major groups of material types on an aggregated basis (Fig. 5-2). **The vast majority of litter items (94%) 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 (2%) and items made of processed wood (less than 2%).

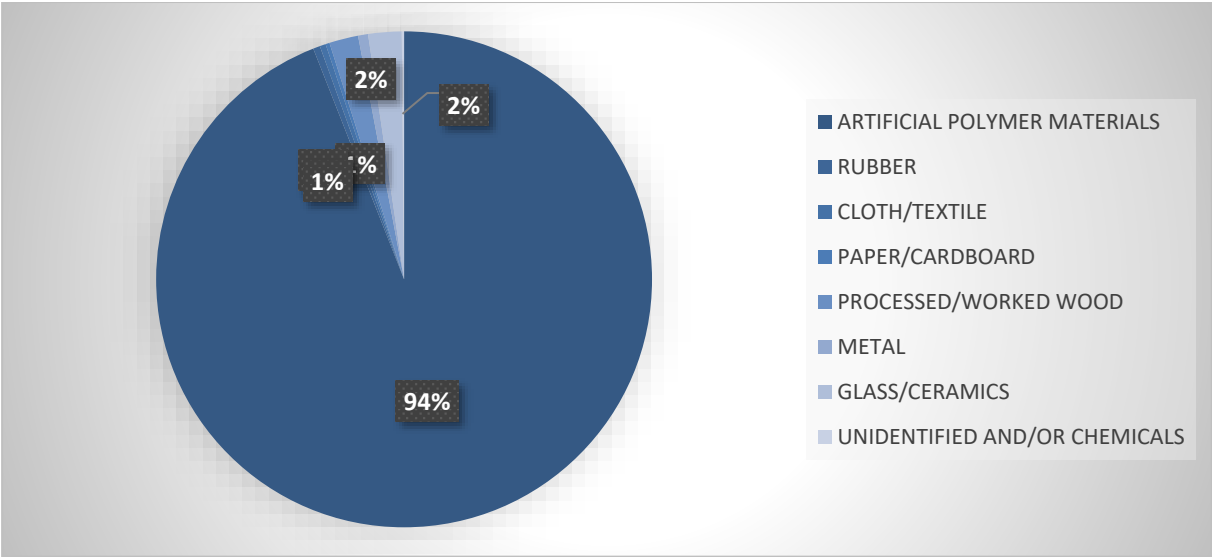


Figure 5-1. Aggregated results of the percentage (%) of total litter items per category type (artificial polymer material; rubber; cloth/textile; paper/cardboard; processed/worked wood; metal, glass/ceramics).

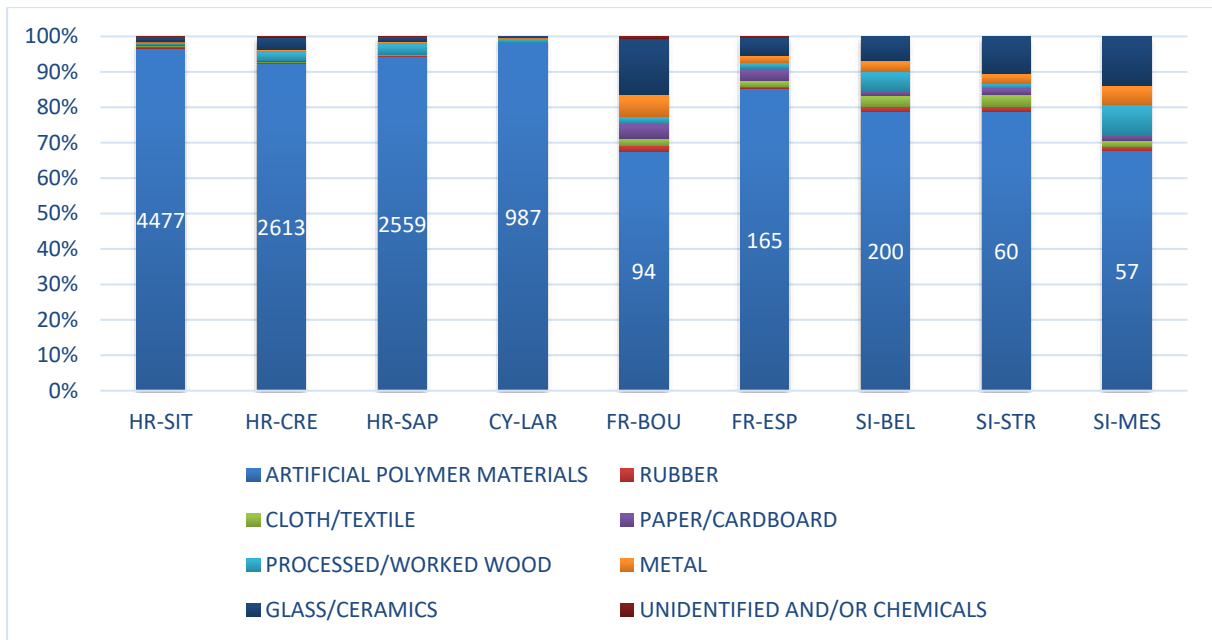


Figure 5-2. Percentage (%) of total litter items per category type (artificial polymer material; rubber; cloth/textile; paper/cardboard; processed/worked wood; metal, glass/ceramics) in the 9 surveyed beaches.

Among the 159 litter categories, plastic pieces 2.5 cm > < 50 cm (G79) accounted for the highest percentage, 17% of the average litter items recorded in all surveys, followed by polystyrene pieces 2.5 cm > < 50cm (G82) with 16% and plastic caps/lids from drinks (G21) with 8%.

Figure 5-3. Top 10 items found on the 9 surveyed beaches of Mediterranean coastal and marine, protected areas calculated on an aggregated basis of average litter counts in all beaches.

TOP 10	Item code	Item name	Average items count
1	G82	Plastic pieces 2.5 cm > < 50cm	230
2	G82	Polystyrene pieces 2.5 cm > < 50cm	212
3	G21	Plastic caps/lids from drinks	105
4	G3	Shopping bags, incl. pieces	80
5	G30	Crisps packets/sweets wrappers	71
6	G73	Foam sponge	64
7	G45	Mussels nets, Oyster nets	50
8	G22	Plastic caps/lids from chemicals, detergents	44
9	G67	Sheets, industrial packaging, plastic sheeting	28
10	G24	Plastic rings from bottle caps/lids	27

6. DISCUSSION & CONCLUDING REMARKS

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; Vlachogianni et al., 2019) and the Pelagos Sanctuary in Italy (Giovacchini et al., 2018). To-date, the most comprehensive efforts to assess marine litter deposited on the beaches of coastal and marine protected areas has been made within the framework of the Interreg Med ACT4LITTER project and the Interreg Med Plastic Busters MPAs.

The average litter density reported within this report of 912 items/100m is similar and comparable to the values reported by other surveys carried out in the Mediterranean (see Table 6-1). It needs to be noted that the discrepancy in reporting marine litter densities in terms of units makes the comparison of results difficult. Within the present study we opted to focus the discussion on marine litter densities expressed in items per 100-m stretch of beach in order to compare them with the threshold value and see how far from reaching good environmental status the studies beaches are.

Table 6—1. Summary of beach litter densities reported in recent scientific literature.

Study areas	Sampling unit	Frequency & timing	Classification list	Litter densities	Reference
Protected areas located in Italy: Po River Delta Park and several locations in Natura 2000 sites	50-m transect	May-June	UNEP/IOC Litter classification list	0.2 items/m ²	Munari et al., 2016
Several coastal sites located at the Pelagos Sanctuary, Italy	100-m transect	Seasonal	OSPAR List	1.06 items/m ²	Giovacchini et al., 2018
Mljet National Park (Croatia), Protected Area of Kalamas-Acherontas-Corfu (Greece); MPA Torre del Cerrano (Italy); the Strunjan Landscape Park (Slovenia)	100-m transect	Every 3 months	MSFD TG10 Masterlist	92 - 10,554 items/100m; 0.09 - 0.41 items/m ²	Vlachogianni et al., 2018
Coastal and marine protected areas located in Albania, Croatia, France, Greece, Italy, Slovenia, Spain and Turkey	100-m transect	Every 3 months	MSFD TG10 Masterlist	1,706 items/100m; 1.2 items/m ²	Vlachogianni et al., 2019 (Results from the Interreg Med ACT4LITTER)
Coastal and marine protected areas located in Croatia, Cyprus, France and Slovenia	100-m transect	Every 3 months, or annual	MSFD TG10 Masterlist	912 items/100m	Vlachogianni, 2022.

The present study provides fit-for-purpose data and baseline information on the amounts and composition of marine litter in several Mediterranean coastal and marine protected areas, as well as a useful input for decision-makers to gear up their efforts in the combat against the marine litter threat. The results of the present study are a direct contribution to the EU Marine Strategy Framework Directive and the Plastics Strategy, as well as to the Regional Plan for Marine Litter Management in the Mediterranean, adopted by the Contracting Parties to the Barcelona Convention. Last but not least, the present study illustrates the essential role that NGOs and MPAs can play in fit-for-purpose data generation initiatives as an essential tool to fill in the marine litter knowledge gaps.

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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

