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Executive Summary

The main objective of this assessment is to understand the current status of the marine litter problem in the Mediterranean, how it is dealt with by the countries of the region and to make practical recommendations in view of the MED POL Regional Strategy for the Sustainable Management of Marine Litter in the Mediterranean Sea. It is the result of a joint effort of relevant authorities, IGOs, NGOs, scientists, and economic sectors in several Mediterranean countries, and has taken full consideration and can be regarded as the follow-up of the collective previous initiatives and activities of UNEP/MAP in its efforts to adequately address the problem of marine litter in the Mediterranean.

The assessment relied on the information collected from scientific literature, monitoring results, data from previous reports, data from the main NGO's and scientific projects (DFISHGEAR, PERSEUS, etc.), analysis of beach clean-up data, initiatives and the direct contacts with local authorities, non-governmental organizations and associations, as well as scientists and individuals, who could provide reliable data on marine litter (recorded or unrecorded). Efforts were made to provide useful statistics that could be further extrapolated to give a quantifiable estimation of the marine litter problem in the Mediterranean.

The main findings of the assessment can be summarized as follows:

- Although useful data on marine litter exists and has been recently improved in the region (types, quantities, etc.) it is inconsistent and geographically restricted mainly to parts of the North Mediterranean. Standardized research data for statistical purposes concerning the problem of litter in the Mediterranean is still a necessity and information sharing between and among NGOs, IGOs, research institutes, relevant authorities, etc. in the Mediterranean regarding litter data needs to be improved through a common platform
- Previous deductions that most of the Mediterranean marine litter is from land-based sources, rather than ships, were confirmed. Marine litter *on beaches* in the Mediterranean originates from shoreline and recreational activities and is composed mainly of plastics (bottles, bags, caps/lids etc.), aluminium (cans, pull tabs) and glass (bottles). This figure is in line with the global average in previous periods (Unep, 2011). Marine litter from smoking related activities accounts for 40% (collected items) which is considerably higher than the global average. In terms of marine litter *floating in the sea,* plastics account for more than 85 %
- Marine litter management must be further strengthened but will need coordination and harmonization. These also imply the implementation of monitoring, through various approaches such as beach surveys, at-sea surveys, estimates of the amounts entering the sea and impacts. There is actually no regular monitoring of micro-debris in the Mediterranean Sea and this must be considered, especially on beaches.
- Most of the countries are undergoing a series of actions and reforms relating to marine litter, but no country has any kind of cross-border collaboration scheme on the issue of marine litter management. The Marine Litter Regional Plan (MLRP) will have a critical role to support common actions.
- The MLRP is based on measures and monitoring efforts should be shouldered by quality control/quality assurance (training, inter-comparisons, use of reference materials for microplastics, etc.) to assist survey teams.
- The implementation of monitoring and its coordination through MLRP is a necessary step to support management measures. This will imply to define or better define baselines and targets and supporting research and capacity building.
- Coordinated management of inputs (rivers, tourism, and maritime transport) will help to reduce marine litter in the Mediterranean Sea. This must also consider fishing activities, focusing on derelict fishing gears

- The economic impact of marine litter has not been fully addressed in the region while the specific to the region impacts on nature and humans need to be further identified and explored.
- Research to support monitoring and management has now become critical and must focus on specific Mediterranean questions such as sources, transport of litter and the presence of sensitive areas where litter may accumulate or affect marine life. Mapping the hot spots at the basin scale, defining the Good Environmental Status (GES), for ingestion of litter in sea turtles, capacity building and technology transfer, using standardized protocols, evaluating the consequences of rafted species and their dispersion, developing strategies, methods and standards, developing a protocol for microplastics in sediments and beaches, searching for new indicator species for impact (entanglement, ingestion, microplastics, rafted species), assessing the quantity and localization of lost fishing gears, and finally defining specific baselines and targets for litter categories that are targeted by reduction measures will largely support and favor the implementation of the MLRP.

Introduction to the Assesment

The general framework: UNEP'S Marine Litter Programme

Marine litter is a complex and multi-dimensional problem with significant implications for the marine and coastal environment and human activities the world over. It originates from many sources and has a wide spectrum of negative environmental, economic, safety, health and cultural impacts. Despite efforts made internationally, regionally and nationally, there are indications that the marine litter problem continues to worsen.

The lack of global and regional strategies, deficiencies in the implementation and enforcement of existing international, regional and national programmes and lack of regulations and standards that could improve the situation are the main reasons that the marine litter problem persists.

The problem of marine litter was recognized by the UN General Assembly, which in its Resolution A/60/L.22 - Oceans and the Law of the Sea - of 29 November 2005 in articles 65-70 calls for national, regional and global actions to address the problem of marine litter. This GA resolution notes the lack of information and data on marine litter, encourages States to develop partnerships with industry and civil society, urges States to integrate the issue of marine litter within national environmental strategies, and encourages States to cooperate regionally and sub-regionally to develop and implement joint prevention and recovery programmes for marine litter. In response to the GA call, UNEP (GPA and the Regional Seas Programme), through its Global Marine Litter Initiative took an active lead in addressing the challenge, among others, by assisting 11 Regional Seas around the world in organizing and implementing regional activities on marine litter (Baltic Sea, Black Sea, Caspian Sea, East Asian Seas, Eastern Africa, Mediterranean Sea, Northwest Pacific, Red Sea and Gulf of Aden, South Asian Seas, South East Pacific and Wider Caribbean).

Taking into account the United Nations General Assembly Resolution, the Global Programme for Action framework, ongoing regional activities organized through the Regional Seas Programme of the United Nations Environment Programme and the outcome of the 2nd Intergovernmental Review of the Global Programme for Action, it has been agreed that the strategy to address the problem of marine litter at the regional level be based on the development and implementation of the Regional Action Plans for Marine Litter or Regional Strategies for the Sustainable Management of Marine Litter. It has also been agreed that the development and implementation of a Regional Strategy should pass through the following three phases:
- Phase I: Assessment of the regional situation;
- Phase II Preparation of the Regional Strategy; including a regional meeting of experts and national authorities; and
- Phase III The integration of the Regional Strategy into the Programme of Work of the respective Regional Seas Programmes and the Implementation of the Regional Strategy at the national and regional level.

The adoption of the Honolulu Strategy and Honolulu Commitment in 2011, and more recently, the particular emphasis on marine litter issues at the Rio+20 Summit 2012, are clear indications of the high attention given to such issues at a more global level.
More recently, leading scientists and policymakers acknowledged in Athens that marine litter remained a "tremendous challenge" in almost all regions of the world, with clear impacts on marine ecosystems and estimates of overall financial damage of plastic to marine ecosystems standing at US$13 billion each year. Marine litter is one of the 8 contaminants of the UNEP/GPA for the protection of marine environment from land based sources and activities.

The Mediterranean context

Marine litter has been an issue of concern in the Mediterranean since the 1970s. The Mediterranean countries adopted the Convention for the Protection of the Mediterranean Sea against Pollution (the Barcelona Convention) in 1976. Within the framework of this Convention the Mediterranean countries adopted in 1980 a Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources. In the Protocol the importance of dealing with the problem of marine litter has been recognized. The Protocol was amended in 1996 and Annex I defined as one of the categories of substances "Litter as any persistent manufactured or processed solid material which is discarded, disposed of, or abandoned in the marine and coastal environment".

The Mediterranean was designated a Special Area for the purposes of Annex V of the MARPOL 73/78 Convention. However, this provision has not entered into force. Only very recently did the Mediterranean coastal States Parties to the MARPOL Annex V present a joint submission to the IMO's MEPC, notifying that adequate reception facilities for garbage were provided in their respective ports.

UNEP/MAP, jointly with IOC and FAO, recognizing the lack of information on marine and coastal litter in the Mediterranean, convened in 1987 an *ad hoc* meeting on persistent materials (UNEP/IOC/FAO, 1991) recommended a pilot survey that was organized in 1988 by UNEP/MAP, in cooperation with IOC and FAO, with five participating countries (Cyprus, Israel, Italy, Spain and Turkey). This pilot survey is considered as a landmark activity for the assessment of coastal and marine litter in the Mediterranean. This was followed by a Comprehensive Bibliography on Marine Litter containing 440 references and an Assessment of the State of Pollution of the Mediterranean Sea by Persistent Synthetic Materials, which can Float, Sink or Remain in Suspension were published by UNEP/MAP in 1991 (MAP/UNEP, 1991).

The Eleventh Meeting of the Contracting Parties asked the Secretariat in 1999 to begin action on coastal and marine litter and to prepare a relevant assessment. A Consultation Meeting on Marine and Coastal Wastes in the Mediterranean was held and several documents were prepared, supporting a project on Marine and Coastal Litter Management. The results of the assessment (MAP/UNEP, 2001) showed that the main sources of coastal litter in the region are river runoff, tourist activities and coastal urban centers. This result indicates that it is the inadequate management of coastal solid waste that is responsible for the presence of litter on the beaches, floating in the water and on the sea bed. In addition to the above mentioned results, almost all the Mediterranean countries have policies for the management of coastal solid waste but the enforcement of the policies is weak because of the poor coordination between different national and local administrations dealing with solid waste issues. Local administration and municipalities are the ultimate responsible for the management of coastal litter in the region when the role of the Ministry of environment is limited to the control aspects.

Based on these facts, MEDPOL built up a strategy to assist coastal local authorities to improve the management of coastal solid waste and prevent the introduction of litter into the marine environment. Along this line, MEDPOL implemented with RAMOGE and UNADEP a pilot project (MAP/UNEP, 2004).

In 2003, UNEP/MAP, in cooperation with World Health Organisation and within the framework of the Strategic Action Programme (SAP), prepared Guidelines for Management of Coastal Litter for the Mediterranean Region (MAP/UNEP/MED POL, 2004).
The UNEP/MAP with the support of the Regional Seas Programme of UNEP in 2006 developed a medium-term public awareness and education campaign. UNEP/MAP opted to work in a project entitled "Keep the Mediterranean Litter-free Campaign"with regional NGOs such as the Mediterranean Information Office for Environment, Culture and Sustainable Development,(MIO-ECSDE), the Hellenic Marine Environment Protection Association (HELMEPA) and Clean Up Greece (Clean Up Greece/HELMPEPA/MIO-ECSDE, 2007). The latter has been developed for the general public as well as for all other stakeholders such as the maritime industry, the tourism sector, agriculture, regional and national authorities, NGOs, the media, etc. Numerous international organizations and NGOs have conducted surveys and beach cleanup campaigns yielding data and information on marine and coastal litter pollution of the Mediterranean Sea. These efforts, which continue to present, are considered as a reliable source of data and information.
The findings and recommendations of the last assessment performed in 2010, led to the preparation of a Marine Litter strategic framework in the Mediterranean in 2012 adopted by COP12, Paris, France, which guided the developement and adoption of the MLRP in 2013 by COP18, Istanbul, Turkey.
Actually, The UNEP/MAP Regional Plan on Marine Litter (Mediterranean countries) adopted in the framework of Land based Sources and Activities Protocol of the Barcelona Convention and the Marine Strategy Framework Directive (MSFD) for European countries are the two main frameworks for marine litter in the Mediterranean Sea.

The adoption of the MLRP in 2013 made the Mediterranean the first regional sea committed to legally binding measures, programmes and related implementation timetables at regional and national level on marine litter management, thus contributing to the Honolulu Commitment and the Rio + 20 marine litter target.

The major objectives of the Regional Plan are to achieve good environmental status through the prevention and reduction of marine litter and its environmental, health and socio economic impacts to a minimum. Most of the measures aim at improving solid waste management, implementing innovative tools related to a sustainable production and consumption and the use of economic incentives, the removal of existing marine litter and the elimination of hot spots, etc. The Regional Plan provides for a sound framework for knowledge enhancement,

monitoring and assessment, research, awareness and cooperation and partnerships among different stakeholders at regional and national levels including the scientific community and the large public. In this respect, the MEDPOL programme of UNEP/MAP is mandated to undertake the assessment of marine litter on a six-year basis at the Mediterranean level as well as to coordinate the formulation and implementation of a marine litter monitoring programme based on an ecosystem approach by all Mediterranean countries. The Regional Plan indicates a list of 30 priority research topics on marine litter and invites the research community to actively contribute to filling these knowledge gaps, facilitating the efficient implementation of measures and assessing their effectiveness.
This assessment is a follow-up and contribution to ongoing efforts in the development and implementation of this Regional Action Plan on Marine Litter in the Mediterranean.

Approach of the Assessment

The main objective of this assessment is to understand the current status of the marine litter problem, how it is dealt with by the Mediterranean countries and to make practical recommendations in view of the Regional Strategy for the Sustainable Management of Marine Litter in the Mediterranean being prepared by MED POL within the Global Marine Litter Initiative of UNEP (GPA and the Regional Seas Programme). It also provides background information on marine Litter to support monitoring and reduction measures to be implemented within the Regional Action Plan.

The project was to collect all readily available information on marine litter in the Mediterranean by researching existing literature and initiatives and contacting relevant authorities, non-governmental organizations and associations, as well as individuals, who could provide reliable data on marine litter. The document also include information from questionnaires, previous and recent, prepared and sent by MED POL to the Mediterranean countries, in which comprehensive information was required about marine litter and derelict fishing gears in the respective countries.

Marine Litter in the Mediterranean Sea

The Mediterranean Sea has been described as one of the most affected areas by marine litter in the world. Human activities generate considerable amounts of waste and quantities are increasing, although they vary between countries. Some of the largest amounts of Municipal Solid Waste (MSW) are generated annually per person in the Mediterranean Sea (208 – 760 kg/Year, http://www.atlas.d-waste.com/). Plastic, which is the main litter component, has now become ubiquitous and may comprises up to 95% of waste accumulated on shorelines, the ocean surface or sea floor.
A majority of these materials do not decompose, or decompose slowly. This phenomenon can also be observed on the sea floor, where 90% of litter caught in benthic trawls is plastic. (Galil *et al.* 1995, Galgani *et al.*, 1995 & 2000, Ioakeimidis *et al.*, 2014) and this figure can reach up to 100% on the sea surface.
Surveys conducted to date show considerable spatial variability. Accumulation rates vary widely and are influenced by many factors, such as the presence of large cities, shore use, hydrodynamics and maritime activities. They are higher in enclosed seas such as the Mediterranean basin with some of the highest densities of marine litter stranded on the sea floor, sometimes reaching over 100,000 items / km² (Galgani *et al.*, 2000). Plastic densities on the deep sea floor did not change between 1994 and 2009 in the Gulf of Lions (Galgani *et al.*, 2011). Conversely, the abundance of debris in deep waters was found to increase over the years (Koutsodendris *et al.*, 2008; Ioakeimidis *et al.*, 2014).
In the Mediterranean, reports from Greece (Koutsodendris *et al.*, 2008; Ioakeimidis et al, 2014) classify land-based sources (up to 69% of litter) and vessel-based sources (up to 26%) as the two predominant litter sources, depending on the area. In addition, litter items have variable floatability and hence variable dispersal potential.
The issue of marine litter and related information on the amounts and their types in the Mediterranean is rather complicated as it is addressed principally by scientific institutions, sub-regional and local authorities in most countries on the one hand and by competent NGOs on the other.
Collection of information is a task that requires considerable human resources directly and indirectly related to the subject along with a sophisticated central coordination mechanism. Unfortunately, this is a recent process for the Mediterranean. However, a relatively systematic and reliable source for amounts and types of litter would be the existing NGO initiatives in the region. NGO efforts are the most significant in terms of surveying and cleaning beaches and the sea and providing information on the volume and types of litter existing in the Mediterranean. The most significant of these at regional level are the following:

- MIO-ECSDE organizes marine litter related events, including clean-ups, in the framework of its annual Mediterranean Action Day (since 1998) with an average participation of member NGOs from 12 Mediterranean countries.
- The Australian organization Clean up the World organizes clean-ups in September with around 115 countries worldwide, many of which in the Mediterranean.
- The International Coastal Cleanup (ICC) campaign is coordinated globally by the Washington-based NGO *Ocean Conservancy* in cooperation with NGOs in over 100 countries and is the largest one-day cleanup event in the world.
- The Italian environmental organization Legambiente coordinates every spring-summer beach clean ups in the Mediterranean.

Furthermore, initiatives of varying importance are taken up by NGOs, local authorities and other partners at national and local level in almost all Mediterranean countries.

All of the above initiatives succeed in gathering thousands of volunteers in the Mediterranean countries with the purpose not only to clean the coasts, rivers and lakes in their local communities but also to raise awareness amongst students, citizens and various stakeholders about the serious implications of marine litter and to inspire people to make a difference and improve their daily environmental conduct.

For the purpose of this assessment the figures resulting from various clean-ups were compared and it was deduced that a common synthesis is not possible due to the fact that each initiative is conducted with different data cards, standards and measures (litter types are classified differently - if at all; in some cases litter is measured in items while in others by weight; etc.), while certain crucial information is completely lacking (length of coast cleaned, type of coast, proximity of coast to sources of litter, etc.).

In view of the inconsistency of the surveys, the outcomes of the various initiatives as well as some deductions that would be useful in the drafting of a regional strategy on managing marine litter in the Mediterranean are presented herewith separately.

Origin, typology and pathways

Sources of marine litter in the Mediterranean

Sources of marine litter are traditionally classified into land-based or ocean-based, depending on where it enters the water. Other factors such as ocean current patterns, climate and tides, and proximity to urban centres, waste disposal sites, industrial and recreational areas, shipping lanes, and commercial fishing grounds influence the type and amount of marine litter found in open ocean areas or collected along beaches and ocean including underwater areas.

Identifying the source of many litter items is a complex task as marine litter enters the ocean from point and diffuse sources both land-based and ocean-based, and can travel long distances before being deposited onto shorelines or settling on the bottom of the ocean, sea or bays. The inadvertent release of litter from coastal landfills and garbage from water transports, recreational beach litter and illegal dumping into coastal and marine waters are practices contributing to the marine litter problem.

Marine litter can be transported indirectly to the sea or coast by rivers, drains, sewage outlets and storm water outflows, road run-off or can be blown there by winds. Land-based sources include tourism and recreational use of the coast, general public litter, fly tipping, local businesses, industry, harbours and unprotected waste disposal sites.

According to the Joint Group of Experts on the Scientific Aspects of Marine Environmental Pollution (GESAMP) (1991), land-based sources account for up to 80 percent of the world's marine pollution. Much of the litter reaches the ocean by beach-going activities, being blown into the water, or is carried by creeks, rivers, and storm drains/sewers to ocean areas. A study recently (Jambeck *et al.*, 2015) analyzed the sources of marine debris and estimates that 4.8 to 12.7 million tons of plastic were dumped into the ocean in 2010, the middle range being about 8.8 million tons. With an estimation of 2% of waste littered on beaches (From US national litter studies), the 208, 519 millions inhabitants of coastal areas were generating 309.160 tons of waste everyday, 10.12% of which is plastic. An estimated 0.731 tons of plastic was littered every day with important differences depending on country (table 2.1.1a).

Researchers predict that, without management measures, the amount of plastic dumped will raise by a factor of ten in the next decade and from a factor 2.17 between 2010 and 2025 in the Mediterranean Sea. Mismanaged plastic could then be increased from 31.865 to 69,143 during that period.

Land based sources can be measured mainly in rivers or storm drains, though there is temporal heterogeneity owing to weather events. In the Mediterranean Sea, there is only one study (Vianello *et al.*, 2015) indicating concentration in the Po river ranging from 1 (Spring) to 12.2 items/m3 (winter), meaning inputs at a level of 50 billons particles every year. In another study (Tweehyusen, 2015) demonstrated that 677 tons of microplastics were entering the Mediterranean Sea every year. Data on microparticles in the Danube river indicated an average plastic load in the range 317 - 4665 items per 1000 m_3 (79.4% industrial, 20.6% others) which equates to 4.8 - 24.2 g per 1000 m3. Information from studies in northern Europe also demonstrated that the majority of litter is plastic and sanitary products may constitute up to 22% of riverine inputs (in number, Moritt *et al.*, 2014). Riverine litter are most often deposited to both sides of the river mouths on coastal beaches, and their abundance generally declined with distance from the river mouth except for large rivers (Rhone, Po, Ebro, Nile) were flow may transport litter very far from estuaries (Galgani *et al.*, 2000; Pham *et al.*, 2014). The situation of the wadi on the south shore of the Mediterranean is of special interest. The persistent presence of pollution and garbage has been demonstrated particularly in a semi-arid climate where annual rainfall is concentrated into just a few months. This may exacerbate the spreading of debris pollution during rainfall only by means of river transport as it works for sediment transport (Achite & Ouillon, 2007, Ludwig *et al.*, 2009). Uncontrolled discharges also act as main sources in the Mediterranean Sea. As an example, only 39 (29%) of the 133 coastal cities from Algeria are controlling their waste discharges in adapted structures without taking illegal deposit in account (Makhoukf, 2012).

Country	Coastal population [1]	Waste generation rate [kg/person/day] [2]	% Plastic in waste stream [2]	% Inadequately managed waste [3]	Waste generation [kg/day]	Plastic waste generation [kg/day]	Inadequately managed plastic waste [kg/day] [7]	Plastic waste littered [kg/day] [7]
Albania	2 530 533	0,77	9	45	1 948 510	174 392	77 897	3 488
Algeria	16 556 580	1,2	12	58	19 867 896	2 374 214	1 378 693	47 484
Bosnia/Herzegovina	585 582	1,2	12	40	702 698	83 972	33 813	1 679
Croatia	1 602 782	2,1	12	9	3 365 842	402 218	37 053	8 044
Cyprus	840 556	2,07	12	0	1 739 951	207 924	831	4 158
Egypt	21 750 943	1,37	13	67	29 798 792	3 858 944	2 572 170	77 179
France	17 287 280	1,92	10	0	33 191 578	3 302 562	0	66 051
Gibraltar	33 483	2,1	12	0	70 314	8 403	9	168
Greece	9 794 702	2	10	0	19 589 404	1 949 146	0	38 983
Israel	6 677 810	2,12	14	1	14 156 957	1 974 896	12 577	39 498
Italy	33 822 532	2,23	6	0	75 424 246	4 487 743	0	89 755
Lebanon	3 890 871	1,18	8	34	4 591 228	365 003	123 700	7 300
Libya	4 050 128	1,2	12	23	4 860 154	580 788	132 985	11 616
Malta	404 707	1,78	12	6	720 378	86 085	5 456	1 722
Monaco	34 050	2,1	12	0	71 505	8 545	0	171
Montenegro	260 336	1,2	12	30	312 403	37 332	11 353	747
Morocco	17 303 431	1,46	5	66	25 263 009	1 250 519	824 650	25 010
Palestine	3 045 258	0,79	8	6	2 405 754	191 257	11 515	3 825
Slovenia	336 594	1,21	12	1	407 279	48 670	550	973
Spain	22 771 488	2,13	13	0	48 503 269	6 281 173	0	125 623
Syria	3 621 997	1,37	13	65	4 962 136	642 597	419 763	12 852
Tunisia	7 274 973	1,2	12	60	8 729 968	1 043 231	621 077	20 865
Turkey	34 042 862	1,77	12	16	60 255 866	7 200 576	1 187 323	144 012
Total/mean	208 519 478	2	11	23	360 939 138	36 560 188	7 451 413	731 204

Table 2.1.1a: Coastal Population and Waste/plastic generation in the Mediterranean countries (After Jambeck et al., 2015 and http://jambeck.engr.uga.edu/landplasticinput). (1) Coastal populations were estimated from global population around a 50 km buffer from the coastline, (2) World bank estimates, (3) modelled, (4) extrapolated/calculated.

Ocean-based sources for marine litter include merchant shipping, ferries and cruise liners, commercial and recreational fishing vessels, military fleets and research vessels, pleasure craft, offshore installations such as oil and gas platforms, drilling rigs and aquaculture sites.

Factors such as ocean current patterns, climate and tides, and proximity to urban centres, industrial and recreational areas, shipping lanes, and fishing grounds also influence the types and amount of litter that are found on the open ocean or collected along beaches and waterways or on the sea floor.

There is no specific evaluation of litter originated from ships in the Mediterranean Sea. However, with an evaluation of inputs from ships at 6 million tons worldwide and 30% of the maritime traffic (http://www.unep.org/regionalseas/marinelitter/about/distribution/) in the Mediterranean sea, one may expect more than a millions ton of garbage coming from ships to the sea.

Because some items can be attributed with a high level of confidence to certain sources, the broad categories can be further detailed into use-categories sources such as recreational litter, shipping litter, fishing litter, sewage-related debris, tourist litter, “sanitary” and “medical”. Such so called provide valuable information for setting targets and reduction measures as they are the most easily linked to measures.

Assessments of the composition of beach litter in different regions of the Mediterranean Sea show that synthetic materials (bottles, bags, caps/lids, fishing nets and small pieces of unidentifiable plastic and polystyrene) make up the largest proportion of overall litter pollution.

Even the remotest parts of the Mediterranean are affected by marine litter. The findings of the “Assessment of the status of marine litter in the Mediterranean” (2009) undertaken by UNEP/MAP MEDPOL in collaboration with the Mediterranean Information Office for Environment, Culture and Sustainable Development (MIO-ECSDE), the Hellenic Marine Environment Protection Association (HELMEPA), and Clean up Greece Environmental Organization, illustrate that although useful data on types and quantity of marine litter exists in the region, it is inconsistent and geographically restricted mainly to parts of the North Mediterranean.

Items found on Mediterranean beaches indicate a predominance of land-based litter, stemming mostly from recreational/tourism activities (40% in ARCADIS, 2014, >50% in Öko-Institut, 2012 and Ocean Conservancy/ICC, 2002-2006). Household-related waste, including sanitary waste, is also of great relevance (40% in ARCADIS, 2014). The amount of litter originating from recreational/tourism activities greatly increases during and after the tourism season. Smoking related wastes in general also seems to be a significant problem in the Mediterranean, as several surveys suggest (UNEP 2009; UNEP/MAP 2008). Finally, the fishing industry is of significance (UNEP/MAP 2013), as well as shipping, especially off the African coast.

Despites the classification has certain drawbacks (litter from food consumption may be both in the *Shoreline and Recreational Activities* category and from crews/passengers on board all types of vessels and boats), this system provides a good overall basis for classifying marine litter items according to the activities that produce them and for monitoring their increasing/decreasing trend.

According to the analysis of data collected, shoreline and recreational activities were the main source every year of the last decade, when it was surpassed by smoking-related waste (Unep, 2011).

A study primarily based on the analysis of data collected within the framework of the ICC campaigns in Mediterranean countries (http://www.oceanconservancy.org/our-work/international-coastal-cleanup/) provided a classification system (table 2.1.1b).

Table 2.1.1b: Classification of marine litter by source (in accordance with Ocean Conservancy’s ICC campaign – with minor adjustments).

Shoreline and Recreational Activities
Litter from land-based activities such as fast food consumption, beachgoers, picnics, sports and recreation, festivals, as well as litter washed from streets, parking lots and storm drains and as a result of poor waste disposal schemes and illegal dumping. Litter items classified in this category include plastic bags, balloons, beverage bottles (plastic & glass) and aluminium cans, caps/lids, clothing, cups/plates/forks/knives/spoons, food wrappers/containers, pull tabs, shotgun shells/wadding, six-pack holders, straws/stirrers and toys
Sea/Waterway Activities
Recreational fishing and boating, commercial fishing, cargo/military/passenger and cruise ship operations and offshore industries such as oil drilling. Litter items included bait containers, bleach/cleaner bottles, buoys/floats, crab/lobster/fish traps, crates, fishing nets and lines, fishing lures/light sticks, light bulbs/tubes, oil/lube tubes, pallets, plastic sheeting, rope and strapping bands.
Smoking-Related Activities
Improper disposal of cigarette filters, cigar tips, lighters and tobacco product packaging is common on both land and sea.
Dumping Activities
Legal and illegal dumping of construction materials, large household items, etc. often results in coastal litter. Other litter items classified in this category include batteries, cars/car parts, tires and 55-gal drums.
Medical/Personal Hygiene
This litter can result from people improperly disposing of waste in toilets and city streets. Since medical and personal hygiene litter often enters the waste stream through sewer systems, its presence on the beach can indicate the presence of other, unseen pollutants. Litter items classified in this category includes condoms, diapers, syringes and tampons.

Marine litter from smoking related activities accounts for 40% of total marine litter in the same period and 53.5% of the top ten items counted in 2013. Although the number of litter items from smokers dropped significantly between 2004 and 2005, since 2005 it is on the rise again. The figure in the Mediterranean is considerably higher than the global average, especially in some countries (Greece), and constitutes a serious problem that has to be given priority in a Regional Strategy to address the issue.
Moreover, hotel beaches are usually cleaned by hotel personnel on a daily basis during summer and ashtrays are available on site. Most public sand beaches in tourism areas are jammed with cigarettes butts, as stated in the research of the Balearic Islands and confirmed by the beach clean-ups of Mediterranean NGOs. Consequently, public users seem to be more careless in non-surveyed areas.
Sea and waterway activities account for 5% of marine litter in the Mediterranean and have remained steadily low throughout the period under study. This could be largely due to the fact that all vessels above 400 tons or carrying more than 15 persons are obliged to implement garbage management plans in accordance with international maritime law. It is also true that the situation concerning the availability of reception facilities in the major Mediterranean ports has improved in recent years.
Prohibitions regarding the disposal of solid wastes are particularly strict in sea areas with special characteristics, such as the Mediterranean, which is termed a Special Area under the MARPOL International Convention. The Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) at its 57th Session (31st March – 4th April 2008), has adopted an MEPC resolution establishing the date on which the MARPOL Annex V (Regulations for the Prevention of Pollution by Garbage from Ships) special area regulations shall take effect in the Mediterranean Sea. MEPC decided that the discharge requirements for special areas of MARPOL Annex V shall take effect, for the Mediterranean Sea, on 1st May 2009. Consequently, for all ships, as from 1st May 2009, disposal into the Mediterranean Sea of the following was prohibited: all plastics, including but not limited to synthetic ropes, synthetic fishing nets and plastic garbage bags; and all other garbage, including paper products, rags, glass metal, bottles, crockery, dunnage, lining and packing materials.

In July 2011, MEPC 62 adopted, by resolution MEPC.201 (62), the revised MARPOL Annex V which entered into force on 1 January 2013. In March 2012, MEPC 63 adopted the 2012 Guidelines for the implementation of MARPOL Annex V (resolution MEPC.219(63)) and the 2012 Guidelines for the development of garbage management plans (resolution MEPC.220(63)).
Under the revised MARPOL Annex V, garbage includes all kinds of food, domestic and operational waste, all plastics, cargo residues, incinerator ashes, cooking oil, fishing gear, and animal carcasses generated during the normal operation of the ship and liable to be disposed of continuously or periodically. Garbage does not include fresh fish generated as a result of fishing activities undertaken during the voyage, or as a result of aquaculture activities.
The Annex also obliges Governments to ensure the provision of adequate reception facilities at ports and terminals for the reception of garbage. Under Annex V, the Mediterranean Sea area was defined as a special area due to its oceanographic and ecological condition and the particular heavy maritime traffic, low water exchange, endangered marine species, etc. This mean special considerations to port state control, placards for passengers ships, garbage management plans (Resolution MEPC.220-63), garbage record books, cargo residues and shipboard incinerator.

Problems still exist in relation to the operation and use of port reception facilities. Seafarers and shipping companies still complain that although crews on board merchant vessels may implement waste management plans including the separation of solid wastes in accordance with international legislative requirements, the efficiency of the shore side management of these separated waste streams often remains in question. Ships should not be deterred from discharging waste to port reception facilities due to high costs, complicated procedures, unnecessary paperwork, excessive sanitary regulations, customs regulations, etc. Furthermore, coastal municipalities must make sure that the waste left in reception facilities is properly taken care of on land, in a manner that is optimal in terms of caring for the environment and human health. It is essential that governments, local/port authorities, the maritime industry and other stakeholders enhance their cooperation in order to address all remaining problems regarding the availability of port reception facilities, and the collection, treatment and disposal of waste. This need is more urgent in the case of smaller fishing harbours and marinas where even greater problems exist.
Equally low are the figures for marine litter relating to "*dumping activities and medical/personal hygiene*", which are 2% and 1% respectively. From the above evidence, it is clear that marine litter from shoreline and recreational activities and from smoking related activities are two areas for priority action by regional policies or awareness raising campaigns in the Mediterranean.
Marine litter from shoreline and recreational activities has its root cause in the fact that the situation of solid waste management in most Mediterranean countries is still very poor. Funding, awareness, participation of individuals and good practices are insufficient in this area. Current legal and illegal waste handling practices contribute to the presence of marine litter. The inadvertent release of litter from coastal landfills and garbage from water transports; recreational beach and roadside litter and the illegal dumping of domestic and industrial garbage into coastal and marine waters are practices contributing to the marine litter problem. A regional common framework, in tune with on-going global efforts, is necessary to create the conditions for curbing the problem of marine litter in terms of proper solid waste management practices and education and public awareness.
The overall goal in the Mediterranean should be to meet the main objectives of the Global Programme of Action for the Protection of Marine Environment from Land-based Activities (GPA) on marine litter, i.e. to establish controlled and environmentally sound facilities for receiving, collecting, handling and disposing of litter from coastal area communities; and to reduce significantly the amount of litter reaching the marine and coastal environment by the prevention or reduction of the generation of solid waste and improvements in its management, including collection and recycling of litter. Reduction of waste at source, reuse, recycling (including composting), energy recovery, and proper landfilling should be the ways to achieve the goal of reducing the total quantity of waste that each Mediterranean country generates, the quantity reaching landfills, in particular, and to increase waste recovery and recycling. Indeed all the Mediterranean countries that replied to the questionnaires that were sent to them in the framework of the 2011 assessment (UNEP, 2011) have responded that most of the above are priorities in the waste management schemes under development (see chapter 5).
Tourism needs a clean environment. Therefore the efficient handling of solid waste is a key issue in the planning of tourism zones and in the requirements/regulations by governments to the tourism developers.

With globalisation shifting power away from governments and into the hands of the private sector, despite the benefits from this trend, there are bound to be negative effects on the environment.
Marine litter from shoreline and recreational activities is highly connected to Tourism. Due to the region's natural and cultural resources, a desirable climate, and a location close to key markets, the Mediterranean Sea is one of the biggest tourist regions in the world. Many of the tourist destinations are concentrated along the coast with a most popular season in summer, with a heavy dependence on the marine environment. Tourist revenue is of significant socio-economic importance for the coastal regions and is an important growth sector for the Mediterranean partner countries. In 2010, 50 million tourists visited the region, up from 38.5 million in 2006. For the last two decades, the countries of the Southern and Eastern Mediterranean have recorded the highest growth rates in inbound world tourism (9% annual growth). At the same time, domestic tourism in these countries also grew progressively. The economic performance of tourism in the region has been surprising, given the security risks, natural disasters, oil price rises and politic or economic uncertainties in the region.

Table 2.1.1c shows the tourism development over the last five years, between 2006 and 2010, for the Southern and Eastern Mediterranean countries belonging to the Facility for Euro-Mediterranean Investment and Partnership (FEMIP). Despite political unrest in some of the Partner Countries, the total annual average growth rate in 2006 was 12%, doubling the world average as measured in terms of tourist arrivals and tourist expenditure

Table 2.1.1c: Tourist arrivals and tourist expenditures in Mediterranean partner countries from 2006 to 2010

	2006		2010		2006-2010
Country	Tourists arrival	Tourist expenditure	Tourists arrival	Tourist expenditure	Annual growth
Algeria	1,4	0,1	1,9	0,2	8,9
Egypt	9,1	5,3	14	11,4	13,5
Gaza(1)	ND	ND	0,52	0,3	ND
Israel	1,8	1,4	2,8	3,8	13,8
Lebanon	1,1	ND	2,1	2,3	22,7
Morocco	6,6	4,8	9,3	5,9	10,2
Syria	8	1,7	8,5	2,2	1,6
Tunisia	6,6	1,6	6,9	2,7	1,4

Source: (*http://www.eib.org/infocentre/publications/all/femip-for-the-mediterranean-promoting-tourism-development.htm?lang=fr*). *(1) Data from west bank*

At the basin level, tourist arrivals have been increased from 175 million to 306 million between 1995 and 2011(table 2.1.1d).

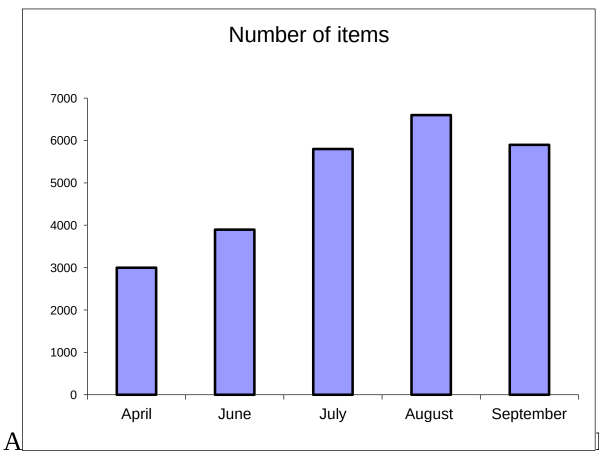
Table 2.1.1d: Tourism related activity in the Mediterranean Sea (source http://www2.unwto.org/)

Activity	1995	1998	2001	2004	2007	2011
Tourists arrivals	175	205	235	251	292	306
Tourist expenditure	87	116	155	162	186	190

Many studies dedicated to the local beaches surveys and litter collection provide information on Litter and tourism. During summer season the inhabitants of seaside towns sometimes are twice as much as in wintertime. In some tourist areas more than 75% of the annual waste production is generated in summer season. According to statistics from holiday destinations in the Mediterranean (Bibione/Italy and Kos/Greece) tourists generate an average of 10% to 15% more waste than inhabitants. In the example of Kos Island, the tourism period is from April to October with 70% of the total waste produced during this period (UNEP 2011).

Malta, where over 20% of its Global Net Production is generated from tourism, realized an increase of packaging (37% of municipal solid waste) in 2004 and introduced “bring-in sites” with 400 stations installed by 2006 (State of the Environment Report Malta, 2005, in UNEP 2011). Unfortunately no new data regarding the results of the introduction is yet available and the latest report from 2005 still shows an increasing waste production per capita and tourism.

Research funded by the Balearic Government in 2005 (Martinez-Ribes *et al.*, 2007) focused on the origin and abundance of beach debris in the Balearic Islands, including Mallorca, Menorca and Ibiza, main areas of tourism destination. This fundamental study shows similarities to other tourism areas and is therefore very helpful regarding the sources of littering, which is highly connected to tourism. Litter found in summertime is twice as much as in winter (Figure 2.1.1e).



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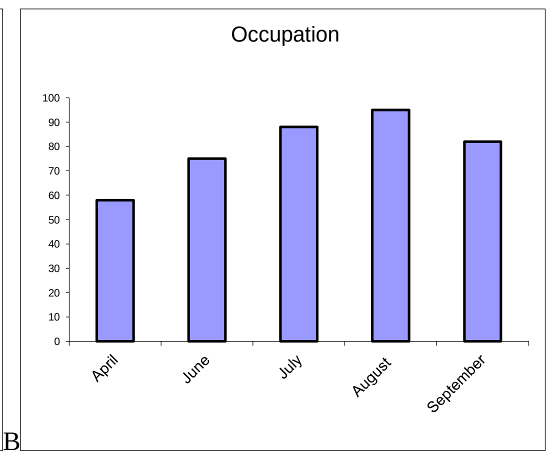
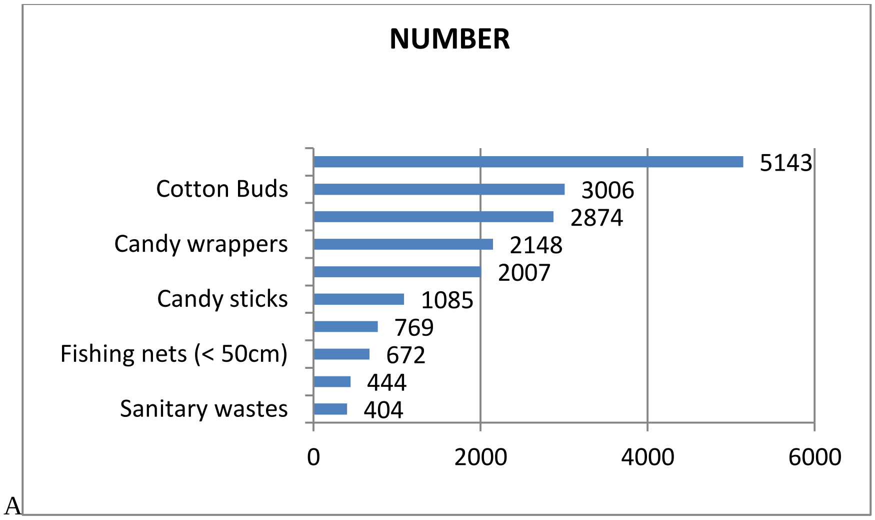


B

Figure 2.1.1e: Monthly variation of debris items (A) and percentage of hotel occupation for the corresponding date (B) in the Balearic Islands (Source Martinez-Ribes et al., 2007).

In another example, Israel achieved good results with their pollution abatement Clean Coast Index, involving Municipalities and NGOs in beach clean-ups (Ministry of Environmental Protection, 2008). Although there is no data about the types and quantities of litter pollution in the coastal areas, the published index shows a 30% reduction of littered beaches. Raising public awareness with leaflets and competitions in tourism and public areas supported the strategy and the ongoing efforts will be continued on a yearly basis to tackle the litter problem on the shorelines of Israel.

Finally, data from a monitoring experiment on 52 beaches samples in France (Mer-terre.org, figure 2.1.1f) confirmed the importance of tourism and fishing related activities as the main sources of litter



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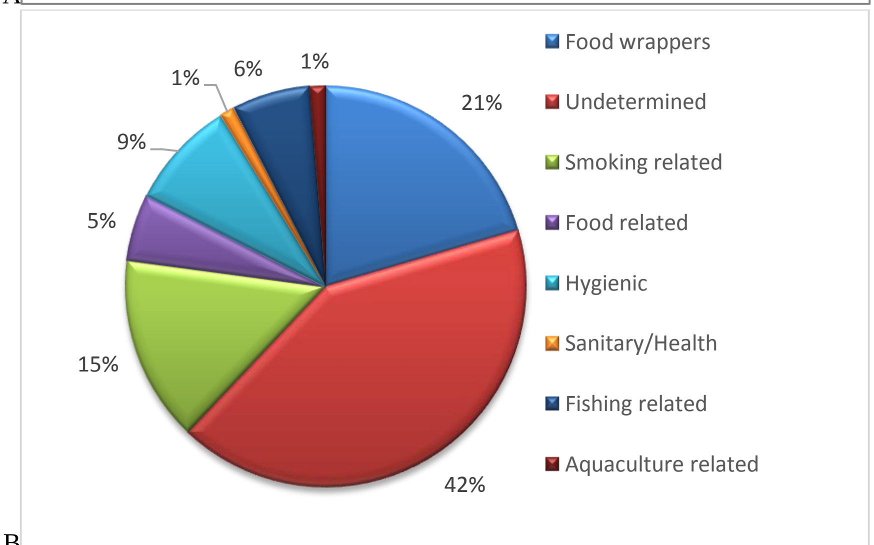

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Figure 2.1.1f: Tops ten items (A) and main sources of litter (B) collected on 52 beaches samples around Marseille between 2008 and 2014 (Source Mer-terre.org)

Circulation

Circulation is the primary driver of marine litter transport. Currents are responsible for the advection of items of every size at all depths, as a function of their composition and specific weight (zambianchi *et al.*, in CIESM, 2014). This is also true for litter that is less dense than seawater and floats at the surface and thus easily accumulates in convergent regions. The role of currents, however, may be quite complex. The possible chaotic characteristics of even two dimensional time-dependent flows makes transport difficult to predict, and causes a number of non-trivial Lagrangian behaviour expressions resulting in the formation of attractive and repulsive features of coastal and offshore flow fields. Models are however crucial for assessing budgets of marine litter at large scale.

The main large oceanic aggregation patterns (‘‘garbage patches’’) is characterised by high densities of marine debris that are now quite well described and identified (Lebreton *et al.*, 2012; Maximenko *et al.*, 2012) with accumulation structures in most of the main oceanic basins directly correlated to the anticyclonic wind forcing and its associated Ekman transport. At a finer scale, regional seas have also been under investigation. Semi-enclosed seas that are surrounded by developed areas, such as the Mediterranean Sea, are likely to have particularly high concentration of marine debris (Barnes and Milner, 2005; Galgani *et al.*, 2014). There, studies have already documented the beaching of litter, their transport at the surface (Aliani and Molcard, 2003; Aliani *et al.*, 2003, Mansui *et al.*, 2014) and accumulation on the sea floor (Galgani *et al.*, 1995 a and 1996; Galil *et al.*, 1995; Pham *et al.*, 2014; Ramirez-Llodra *et al.*, 2013).

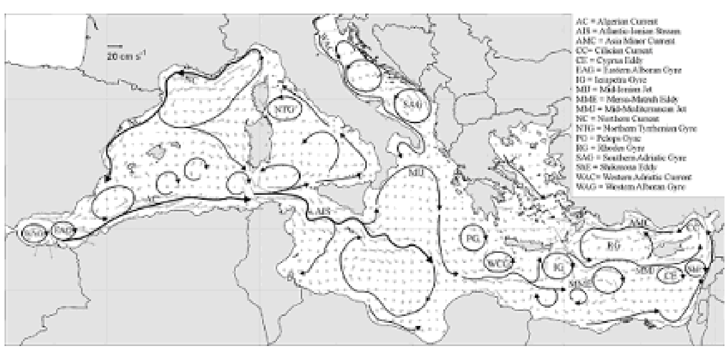
Models simulating the three dimensional circulation in the Mediterranean Sea are presently available to the scientific community even in an operational (predictive) mode. They are getting more and more accurate thanks to the ever increasing abundance of in situ data and the development of sophisticated assimilation techniques for such data. An effort to better understand local wind-induced effects on floating material, windage and Stokes' drift is however still needed and dedicate investigations on the possible functioning, role, and parametrization of sub mesoscale structures, both in a two-dimensional and a three-dimensional perspective. Coastal related input and stranding processes also need to be investigated. For this, coastal studies may require the development or the refinement and focusing of regional models, characterized by higher spatial and temporal resolutions.

The Mediterranean situation appears particularly delicate for the possible accumulation of floating plastics, since the basin is characterized by a net inflow of surface waters of Atlantic origin through the Strait of Gibraltar, with no outflow possibility for items less dense than seawater anywhere. In addition to this, floating item inflow from the Suez Canal may not be overlooked, in particular for the possibility of litter representing a vector for invasive species.

The existing numerical simulations enable to picture possible scenarios of accumulation and to quantify likely coastal impacts of floating marine debris. The time scale considered

Here is so that the variability of the surface circulation is very high as the instabilities that occur in the basin. No global data set does exist on surface marine debris and real world simulation must consider anthropogenic sources, such as harbours, highly populated coastal cities, river outflows for the inland sources and large cargo and passenger ships routes as well as tourism seasonal variability at sea. Nevertheless, some scenarios could be hypothesised to evaluate a realistic distribution through simulations based on homogeneous and continuous deployment of litter. Only few large sub-basins appear as possible retention areas, namely the north-western Mediterranean and the Tyrrhenian sub-basins, the southern Adriatic and the Gulf of Syrt (Poullain *et al.*, 2012; Mansui et al., 2014). These regions loose however their retention character for longer duration journeys because no permanent gyres, at more than the scale of months, are occurring in the Mediterranean and because seasonal and inter-annual variability alter the water movements and the distribution of litter.

Some of the specific gyres in the western basin could retain and export floating objects and redistribute them after a shift in the large scale circulation. If, the western Mediterranean coasts present very low coastal impact,, the southern coastal strip of the eastern Mediterranean basin seems to be however a preferential beaching destination where debris stagnating along the Tunisian and Libyan coasts could result from the open sea accumulation region in the Gulf of Syrt (Erikssen *et al.*, 2014; Mansui *et al.*, 2014). As a counterpart, the Levantine sub-basin appears more as a local and potential source for its coast (Mansui *et al.*, 2014).



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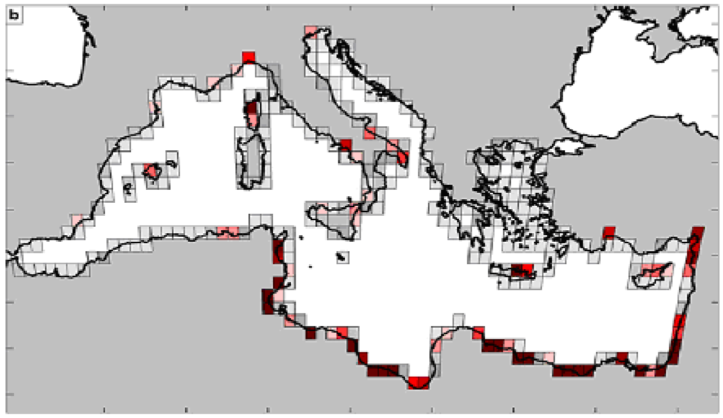

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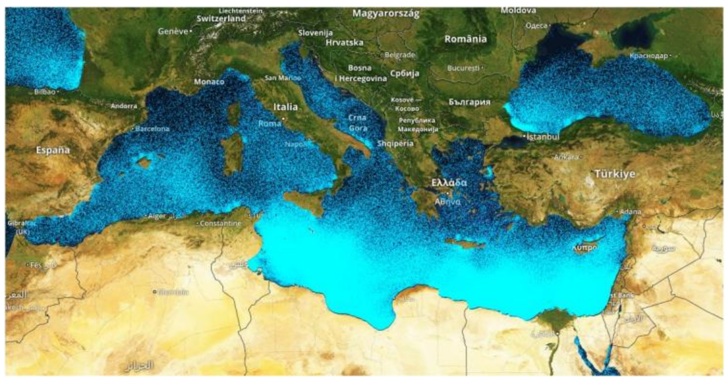


Figure 2.1.2a: General predictive scheme of (A) the surface water circulation the Mediterranean Sea (data from drifters, Lebreton et al., 2012), (B) litter stranding on Mediterranean Beaches (Mansui et al., 2014) and floating plastic particles (iEriksen et al., 2014)

Typology of marine litter in the Mediterranean

Marine litter in the Mediterranean includes a wide variety of substances also encountered in other marine and coastal areas of the world. Based on data provided by the Ocean Conservancy and processed and analyzed by HELMEPA from beach clean-ups in Mediterranean countries within the framework of the ICC campaign, the main types of litter found on Mediterranean beaches, floating on the sea surface or lying on the seabed are listed in Table 2.1.3 a and table 2.1.3b hereunder.

Table 2.1.3a: 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 2.1.3b: 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 collectedn umber	98117	6796	11295	16490	24724	6350	3443	4706	2436	6405
number /100m	175	12	20	29	44	11	6	8	4	11

By far the No. 1 marine litter item in the Mediterranean are cigarette filters (closely followed by cigar tips), which constitute a real scourge for the region and can be found even in the most remote coastal areas. Thus, 4858 volunteers collected 95641 cigarette filters in 2013, which corresponds to almost 19.6 cigarette filters per volunteer, while the global average in 2006 was only 3.66 cigarette filters per volunteer. The degradation time for each type of Litter since an important point as some that may degrade fast, in the range of months or years, indicating more inputs and concern.

Four categories of items seem to be most prominent on the beaches in the northern part of the Mediterranean (Table 2.1.3c): Items found indicate a predominance of land-based litter, stemming mostly from recreational/tourism activities (40% in ARCADIS, 2014, >50% in Öko-Institut, 2012 and Ocean Conservancy/ICC 2002-2006). Household-related waste, including sanitary waste, is also of great relevance (40% in ARCADIS 2014); the amount of litter originating from recreational/tourism activities greatly increases during and after the tourism season. Smoking related wastes in general seems to be a significant problem in the Mediterranean, as several surveys suggest (UNEP 2009; UNEP/MAP 2008). Also, the fishing industry is of significance (UNEP/MAP 2013), as well as shipping (the latter especially off the African coast).

Table 2.1.3c: 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)	- Cotton bud sticks - Plastic/polystyrene pieces - Crisp/sweets/chips - Other sanitary items - Charcoal (201 items) Ports: 1: Crisp/sweets packets and lolly sticks 2: cigarette butts 3: cotton bud sticks	Beaches: Plastics: 50% by volume: 80% (Barcelona Provincial Government, cited in ARCADIS) Ports: 29% plastics, 22% wood, 21% organic matter	Recreational & tourism:40% Households(combined):40% Coastal tourism: 32,3% Toilet/sanitary: 26,2% household: 11,2% Waste collection: 6% Recreational: 5,6%
Öko-Institut (2012; figures mainly from UNEP 2009)	-Cigarette butts: 29,1% - Caps/lids: 6,7% - Beverage cans: 6,3% - Beverage bottles (glass): 5,5% - Cigarette lighters: 5,2%	Beaches: 37-80% plastics Floating: 60-83% plastics Sea-floor: 36-90% plastics	Recreational/shoreline activities: >50%, Increase in tourism season
UNEP/MAP (cited in ARCADIS 2014)	-Cigarette butts/filters: 27% -Cigar Tips: 10% -Plastic bottles: 9,8% Plastic -bags: 8,5% - Aluminum cans: 7,6%	Floating: 83% plastics	
Ocean Conservancy/ICC 2002-2006 (cited in UNEP/MAP 2008)			Beach litter: recreational activities: 52% Smoking-related activities: 40% waterways activities: 5%
JRC IES (2011)		Beach:83% plastics/polystyrene	

In a project along the Coasts of El-Mina and Tripoli/Lebanon, ***t***en fishermen were selected to collect all marine litter caught in their nets on a daily basis, store them in plastic bags and record date, name of the fishing vessel and the location of fishing activities. Marine litter was divided in six categories: 1) Cloth; 2) Fishing material; 3) Glass; 4) Metal; 5) Paper; and 6) Plastic, volume estimated, data entered and processed in a specially designed Geographical Information System, percentages calculated and maps identifying the location of marine litter generated. All six categories were present in the waters of El-Mina/Tripoli in the following percentages: 1) Cloth: 1.74%; 2) Fishing material: 1.74%; 3) Glass: 1.16%; 4) Metal: 16.81%; 5) Paper: 0.87%; and 6) Plastic: 77.68%. Litter was mostly found in areas of high anthropological stress, mainly at the mouth of the Abou Ali River, the fishing and commercial ports, the conglomeration of rocks off the El-Mina headland and around the Palm Island Reserve. The results revealed the influence of human activities and river inputs. Temporal trends indicated the presence of plastic and metal over the whole period of collection, while all other categories were collected sporadically. This passive method for monitoring marine litter at minimal costs has been validated and can be applied to other areas around the Mediterranean. Analysis of the data also revealed that the occurrence of the different litter categories occurred at different frequencies according to the month of sampling. Plastic and metal were present over the five month period while the other litter categories occurred in some months and not others. The lowest percentages were recorded in the month of October, coinciding with the end of the tourism season and dry weather. August and September experience high tourism activities, while the first rains start at the end of October and intensify in November and December. This might explain the difference in percent waste collected during the five month period. *(Source: Marine Resources & Coastal Zone Management Program, 2005)*

On the sea floor, compilation of data from 16 studies covering the entire basin of the Mediterranean Sea (see chapter 2.2.4) confirmed the importance of plastic, at 62.7 % +/- 5.47 of total debris. This was also confirmed by an analysis of data from regular monitoring of litter on the sea floor in the gulf of Lion (figure 2.1.3a)

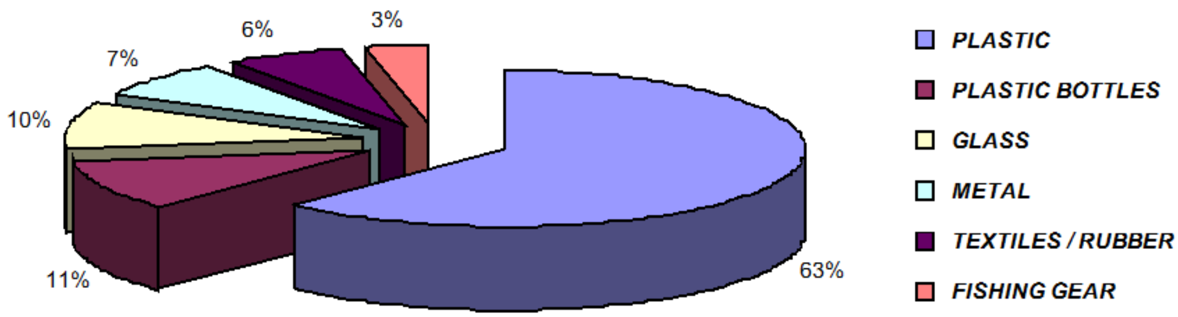
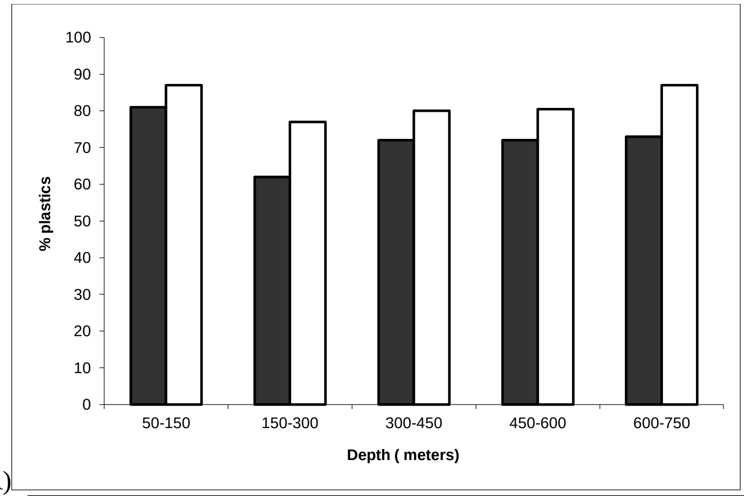


Figure 2.1.3a: Typology of debris collected between 30 and 800m in the Gulf of Lion, France (MEDITS cruises, average from 70 stations/year and 15 years monitoring, 1994-2009, Galgani et al., 2011)

Analysis of litter density from trawl surveys revealed plastic to be the most common litter recovered (found in 98% of the trawls, Ramirez lodrat *et al.*, 2013). This high percentage of plastic is not related to the depth when considering sandy bottoms. Analysis of data from 2011 (Gulf of Lion, Galgani *et al.* unpublished) and 2013 (Guven *et al.*, 2013) demonstrated the constant percentage of plastics between 50 and 750 m (figure 2.1.3b). This pattern is somewhat different when considering rocky slopes where the important losses of fishing gears account for an important part of debris in upper part of canyons, artificially decreasing the percentage of plastics. An analysis of data from surveys led by various European laboratories between 1999 and 2011 (Pham *et al.*, 2014) showed that in canyons, plastic was the dominant litter items (50%) followed by fishing gear (25%), On slopes, the dominant litter items recovered was fishing gear (59%), followed by plastic (31%).



(A) (B)

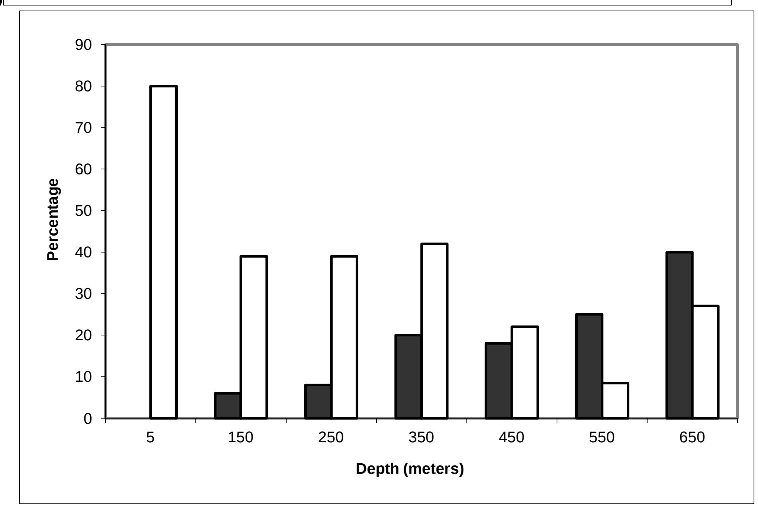


Figure 2.1.3b: (A) Percentage of plastics in litter collected by trawling at different depths in the gulf of Lion (black bars, 2011, 69 tows, Galgani et al, original data) and south east Turkey (white bars, 2013, 38 tows, Guven et al., 2013) and (B) percentages of plastics (black bars) and fishing gears (white bars) of debris observed on rocky slopes of 18 canyons off the French Mediterranean coasts (101 ROV dives in 2009, 700-800m, Fabri et al.,2014).

In deep analysis finally detected that the "Distance to the coast" variable accounted for less than 20% of the variance in the distribution of litter between canyons (Fabri *et al.*, 2014). In the Maltese Islands (Misfud *et al.*, 2012), litter was found to be significantly positively correlated to mean wave height, mean wave energy density and distance to the nearest shore. Plastic, the main litter constituent, showed the same correlation patterns, also including depth and distance to the nearest bunkering area. Glass was positively correlated to all of the different fishing activities considered.

In some areas, fishing gears may account for the largest part of debris, depending on fishing activity. As an example (Figure 2.1.3c), a quantitative assessment of debris present in the deep seafloor (30–300 m depth) was carried out in 26 areas off the coast of three Italian regions in the Tyrrhenian Sea, using a Remotely Operated Vehicle (ROV). The dominant type of debris (89%) was represented by fishing gears, mainly lines, while plastic objects were recorded only occasionally. Abundant quantities of gears were found on rocky banks in Sicily and Campania (0.09–0.12 debris m_2), proving intense fishing activity. Fifty

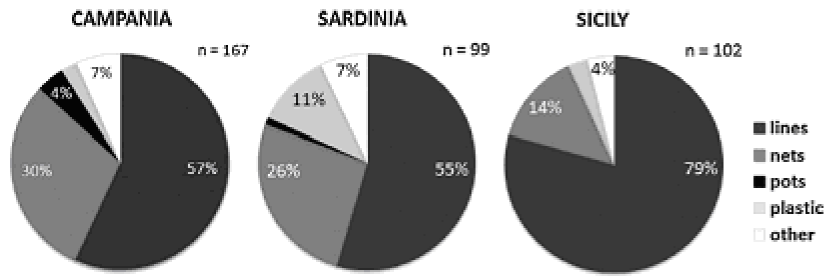


Figure 2.1.3c: Frequency of occurrence of marine debris items found in each region by debris category. ''n'' refers to the total number of debris items recorded in each region (Angiolillo et al., 2015, in press)

Finally, analyse of the composition of floating litter, including, considering large debris, Small fragments measuring less than 2.5 cm that are referred as meso particles and microparticles demonstrate again the prevalence of plastic, accounting for more than 95 %, sometimes up to 100%) mainly because of the density of many synthetic polymers such as polyethylene and polypropylene that are floating at the surface when most heavier materials, metals and glass, are sinking unless they are closed (drums, bottles, etc.).

Degradation of marine litter at sea

Studies have shown that debris found in oceans is dominated by plastics. They are made by bonding low molecular weight molecules called monomers (ethylene, propylene, etc.) in different chemical reactions to make high molecular weight compounds known as synthetic polymers (polyethylene, polypropylene, etc.) or by modifying high molecular natural materials. These materials are usually mixed with some other chemicals or additives in order to obtain the desired properties for a product. These include plasticisers, adhesives, flame retardants and pigments.
It may take centuries for physical, chemical and biological processes to degrade plastics to secondary microplastics (OSPAR, 2015) in the oceans.
Table 2.1.4a below provides an indication of the necessary time for the decomposition of various litter items in the marine environment. It is worth noticing the fact, still unknown to the majority of the public that it may take between 1-5 years for a cigarette filter to decompose in the marine environment. The slow decomposition of cigarette filters is mainly due to contained substances such as foamed plastic and chemicals, which may also cause serious health problems to marine fauna and flora (source UNEP, 2011). Moreover, litter on the sea floor may persist for longer periods due to lower bacterial degradation rates in the dark and when oxygen is at lower concentrations

Table 2.1.4a: How long it take for marine litter to decompose?

Item	Degradation time
Glass bottle	1 million years
fishing line	600 years
plastic bottle	450 years
aluminium can	80-200 years
rubber boot sole	50-80 years
plastic cup	50 years
tin can	50 years
nylon fabric	30-40 years
plastic bag	10-20 years
cigarette filter	1-5 years
woollen clothes	1-5 years
plywood	1-3 years

waxed milk, Carton	3 months
apple core	2 months
newspaper	6 weeks
orange peel	2-5 weeks
paper towel	2-4 weeks

Source: The Ocean Conservancy

As persistence is a key characteristic of plastics at sea, improving our knowledge on degradation processes will need to consider many aspects such as abrasion (mechanical), photo degradation thermal, chemical and biological degradation. With respect to the last point, it is important to not only consider the species and metabolic pathways involved but the entire process (attachment and biofilm formation, bio-deterioration, bio-fragmentation, bio-assimilation and bio-mineralisation). To date, the little data available on the evaluation of degradation are related to laboratory studies. Surface properties such as surface functional groups, surface topography, point of zero charge, and color change are important factors that may vary during degradation with changes in surface properties that may explain interaction between plastics, microbes, and pollutants. However, Standardized tests are still needed and most of the knowledge on plastic degradation processes uses culture-based approaches, for biodegradation studies.
One of the serious hypotheses regarding the degradation of plastic at sea "missing" plastic at sea is that the fragmentation processes may finally lead to sub micrometric fragments, defined as nanoplastics, which could not be detected and monitored so far. Little has been known about the true extent of the damage caused by these nano-plastics but they may have much greater impacts than microplastics on the marine ecosystem because of their very special physico-chemical properties (high surface to volume ratio, slow rate of sedimentation or flotation, size close to membrane permeability) and their potential to be directly ingested by the smallest marine species and pass more easily through biological membranes. There is however a lack of validated research methodologies and data on environmental concentrations and impacts.

Distribution of marine litter in the Mediterranean (Regional, National, local)

Beaches Regional surveys

Strandline surveys, cleaning and regular surveys at sea are gradually being organized in many Mediterranean countries in the aim of providing information on temporal and spatial distribution. The various strategies based on the measurement of quantities or fluxes have been adopted for data collection purposes. However, most surveys are conducted by NGOs with a focus on cleaning. Moreover, Small fragments measuring less than 2.5 cm, also referred to as mesodebris (versus macro debris), are often buried and may not be targeted by clean-up campaigns or monitoring surveys. Stranding fluxes are therefore difficult to assess and a decrease in litter amounts at sea will only serve to slow stranding rates. They can comprise a large proportion of the debris found on beaches and very high densities have been found in some areas.
Standing stock evaluations of beach litter reflect the long-term balance between inputs, land-based sources or stranding, and outputs from export, burial, degradation and clean-ups. Recording the rate at which litter accumulates on beaches through regular surveys is currently the most commonly-used approach for assessing long-term accumulation patterns and cycles. The majority of studies performed to date have demonstrated densities in the 1 item/m2 range (Table 2.2.6) but showing a high variability in the density of litter depending the use or characteristics of each beach. Plastic accounts for a large proportion of the litter found on beaches in many areas, although other specific types of plastic are widely-found in certain areas, according to type (Styrofoam, etc.) or use (fishing gear). For ICC (Table 2.2.2a), cigarette butts, plastic bags, fishing equipment and food & beverage packaging are the most commonly-found items, accounting for over 80% of litter stranded on beaches.

Table 2.2.1a: 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)	StrawsS tirrers	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

National Case Studies may provide more detailed information on local constraints and effective factors on the distribution of litter. It must be important to note however that volunteer groups should be informed about the necessity to submit standardized research data for statistical purposes. Clean up actions by NGOs are usually organized to raise awareness and not so much for data collection and cleanup programmes should increase scientific relevance of information and information sharing.

Public participation in the cleaning campaigns is strong in the Mediterranean Sea. It is however not constant, with for example a decrease by 50% of volunteers between 2002 and 2007 (15,648 volunteers participating in 2002, 7,305 in 2006) and 70% between 2002 and 2013 (4830 volunteers in 2013). This may be interpreted as (i) a decrease in the environmental awareness and/or volunteer spirit of coastal inhabitants in the Mediterranean, (ii) a shift of focus of the general public's attention to other current environmental concerns such as global warming, and (iii) a reduced impact of environmental NGOs' action in the region. Due to this number of changing variables every year, it is difficult to draw conclusions regarding the overall increase or decrease of marine litter in the Mediterranean during the period under study. However, interesting observations the proliferation of lighter marine litter items in the Mediterranean (plastics, aluminum and smoking-related litter), as opposed to heavier items from basic use (bottles, cans, see figure 2.2.1a) or from dumping activities (household appliances, construction materials, tires, etc.) This could be related to the efficiency of preventive action (easier collection, recycling, adoption and/or implementation of stricter legislation with regards to dumping activities, etc. ;) for larger items and the difficulty to manage inputs from very diffuse sources such as from general public.

Environmental awareness is also of importance when this general public who, conscious of the impact, do not use beaches as disposal sites for heavy garbage items as lightheartedly as they did in the past. Therefore, the removal of these heavier items combined with the persistent nature of plastics and other lighter marine litter items which can still be found in considerable numbers in the Mediterranean, has led to the changing nature of marine litter in the region.

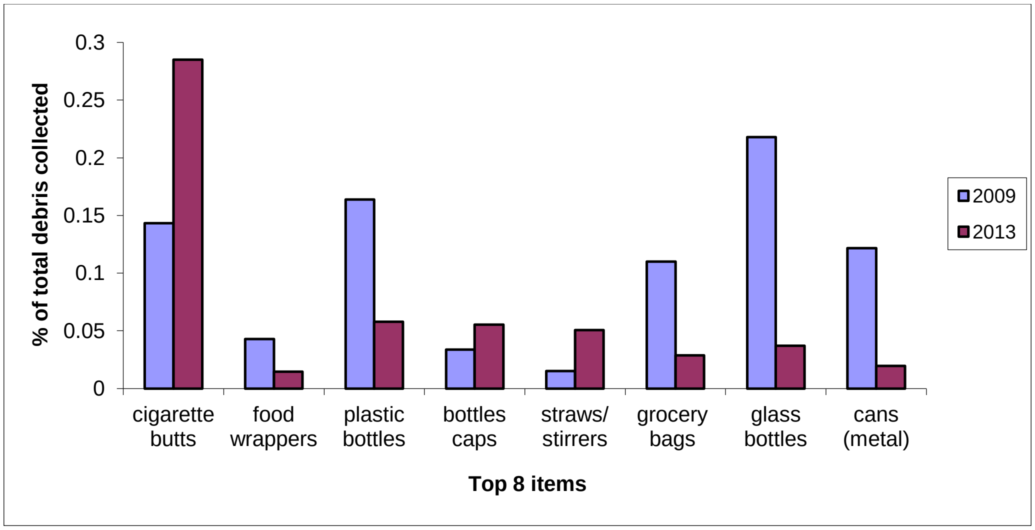
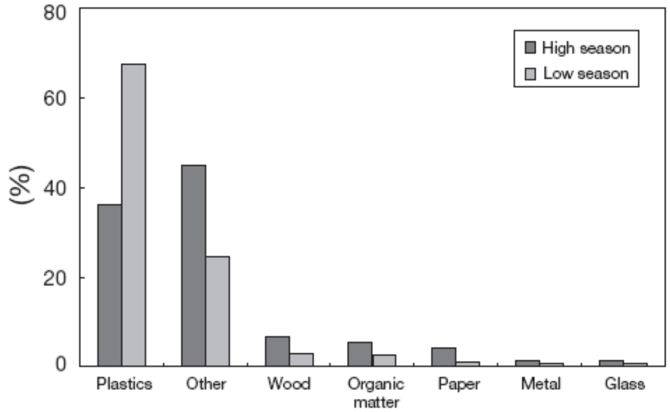


Figure 2.2.1a: Changes in percentages of the top 8 items in the Mediterranean Sea between 2009 and 2013. Data from Ocean Coastal Cleanup on total of debris of 303522 items and 110698 items collected in 2009 and 2013 respectively on beaches from Greece, Turkey, Egypt and Spain (data from http://www.oceanconservancy.org/)

Data from *Clean up Greece* between 2004 and 2008 indicated however the importance plastic and paper abandoned and wind born when considering on island beaches. On isolated beaches, other visible and larger sized litter items (metal, rubber, glass and textile) are increased due to illegal dumping.

The abundance, nature and possible sources of litter on 32 beaches on the Balearic Islands (Mediterranean Sea) were investigated in 2005 (Figure 2.2.1b). Mean summer abundance in the Balearics reached approximately 36 items per m^{-1}, with a corresponding weight of 32±25 g per m^{-1}, which is comparable to the results of other studies in the Mediterranean. Strong similarities between islands and a statistically significant seasonal evolution of litter composition and abundance were demonstrated. In summer (the high tourist season), debris contamination was double that in the low season and showed a heterogeneous nature associated with beach use. Again, cigarette butts were the most abundant item, accounting for up to 46% of the objects observed in the high tourist season. In contrast, plastics related to personal hygiene/medical items were predominant in wintertime (67%) and natural wood was the most important debris by weight (75%). In both seasons, litter characteristics suggested a strong relationship with local land-based origins. While beach users were the main source of summer debris, low tourist season litter was primarily attributed to drainage and outfall systems.



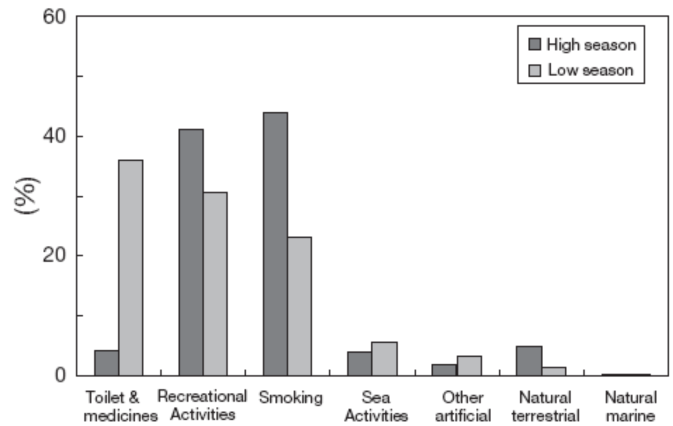


Figure 2.2.1b: Litter composition (A) and estimated origin (B) of the litter collected in low and high tourist season in Balearic Islands (source Martinez-ribes et al., 2007)

Finally, More recent data obtained within the Defishgear project (under press, See Table 2.2.6) indicated densities ranging from 0.715 items / m2 (range: 0.03 – 6.38) In Ionian Sea)/South Adriatic Sea to 1.139 items/m2 (0.771 – 1.507) in North Western Adriatic.

Floating Litter on the surface of the Mediterranean Sea

Floating debris comprises the mobile fraction of debris in the marine environment as it is less dense than seawater. However, the buoyancy and density of plastics may change during their stay in the sea due to weathering and biofouling (Barnes *et al.*, 2009). Polymers comprise the majority of floating marine debris, with figures reaching up to 100%. Although synthetic polymers are resistant to biological or chemical degradation processes, they can be physically degraded into smaller fragments and hence turn into micro litter, defined as measuring less than 5 mm.

They can also be transported by currents until they sink to the sea floor, be deposited on the shore or degraded over time. A 30-year circulation model using various input scenarios showed the accumulation of floating debris in ocean gyres and closed seas such as the Mediterranean Sea were 7-8% of the total debris is expected to accumulate (Lebreton *et al.*, 2012).

Visual assessment approaches include the use of research vessels, marine mammal surveys, commercial shipping carriers and dedicated litter observations. Aerial surveys are now being employed for larger items. Although the basic principle of floating debris monitoring through visual observation is very simple, as for beaches, few datasets are available for the comparable assessment of debris abundance and monitoring is only performed occasionally (Table 2.2.6). Only a few studies have been published on the abundance of floating macro and mega debris in Mediterranean waters (Morris, 1980; Saydam *et al.*, 1985; McCoy, 1988; Aliani *et al.*, 2003; UNEP/MAP/MEDPOL, 2009; Topcu *et al.*, 2010, Gerigny *et al.*, 2011, Suaria and Aliani, 2015) and the reported quantities measuring over 2 cm range from 0 to over 600 per square kilometer. The Mediterranean Sea is often referred to as one of the places with the highest concentration of litter in the world. For floating litter very high levels of plastic pollution are found but densities are generally comparable to what is being reported from many coastal areas worldwide. In the Ligurian Sea, data was collected through ship-based visual observations in 1997 and 2000. 15-25 items/km² were found in 1997, with a decrease to 1.5 – 3 items in 2000 (Aliani and Molcard, 2003).

Data may also be obtained from NGOs. HELMEPA a Greek organisation of maritime stakeholders invited its member managing companies with ships traveling in or transiting the Mediterranean to implement a programme for the monitoring and recording of litter floating on the sea surface.

Between the period February – April 2008 14 reports were received by HELMEPA member-vessels containing information on litter observations from various sea areas in the Mediterranean. In total, observations of 1,051.8 nautical miles (n.m.) of Mediterranean Sea resulted in the recording of 500.8 Kg of marine litter (Table 2.2.2a).

The total length of observation for floating marine litter carried out by HELMEPA member vessels was 1,051.8 nautical miles (1,947 kilometers) corresponding to an area of observation of around 172.8 km^2. The width of observation depended on the weather conditions, the sea state, the position of the Observer, the use of binoculars, the freeboard and volume of marine litter, etc., and generally fluctuated between 22 and 150 meters. Observations were carried out mainly in the eastern Mediterranean (Aegean Sea, Libyan Sea and Eastern Mediterranean Levantine Sea), in the Alboran Sea between Spain and Morocco, and in the Adriatic Sea. The total number of items of marine litter that was recorded was 366 items corresponding to a concentration of one item per 3 n.m. or 2.1 items per km^2. The concentration of marine litter ranged from 0.08 to 71 items/nm. Relatively higher concentrations of marine litter were observed along routes close to coastal areas while there were cases where lengthy observations (more than 120 nm) revealed no existence of marine litter. Plastics accounted for about 83.0% of marine litter items, while all other major categories accounted for about 17%, as the following graph shows. Base on weight extrapolations, the average quantity of marine litter was estimated to be 230.8 kg/km2 ranging from 0.002 to 2,627.0 kg/km2. Relatively heavy items such as steel drums, wooden pallets and crates observed on the sea surface were responsible for the greater quantity of marine litter in certain routes. In terms of the length of observation, the average quantity was 0.47 kg/n.m.

Table 2.2.2a: Marine Litter Survey by HELMEPA Member Vessels: Number of floating litter collected in 2008 along a sampling area of 172.8 km^2

Sea area surveyed	Fishing Nets	Wooden Pallets	Plastic Packaging	Ropes	Plastic Bags	Clothing	Steel Drums	Wooden trace	Buoys	Paperboard boxes	Plastic bottles	Plastic containers
Mytilene sea (Northeastern Mediterranean)			**50**			**6**			**5**		**10**	
Saronikos Gulf (off Athens)			**25**		**30**						**8**	**4**
Mirtoon Sea (South Aegean)								**1**				
Off South Cyprus	**6**								**8**			**2**
East coast of Crete												**1**
Myrtoon Sea (South Aegean)	**3**											**2**
West Mediterranean		**2**	**3**	**1**	**10**		**1**		**8**			
Off Algeria				**5**					**6**			
Gibraltar					**30**							
Off Egypt	**3**	**2**			**1**		**1**		**3**			
Adriatic Sea					**9**	**6**			**5**	**12**	**9**	**6**
South Crete		**2**					**3**	**12**			**4**	

HELMEPA also provided data on the volume of marine litter recovered from the sea surface of the port of Piraeus for a two-year period (2006-2007), which was processed and analyzed by HELMEPA. The daily collection of floating debris from the port sea area (including the passenger and container port) was carried out by specialized skimmer vessels and/or manually from auxiliary boats. The volume of marine litter fluctuated from 1.47 m^3 per day to 3.46 m^3 per day, while the average volume was estimated to be 1.89 m^3 per day. During the summer season when the operation of the passenger port is extremely high (*it should be noted that Piraeus is the largest port in Europe and the third largest in the world in terms of passenger transportation, servicing 19,000,000 passengers annually*) the volume of marine litter is significantly higher reaching an average of 2.96 m^3 per day. Although quantitative information in respect of the origin of the debris does not exist, it appears that domestic garbage from passengers and litter ending up to sea via urban sewers are the prevailing categories.

Debris was also quantified during marine mammal observation cruises in the northern western basin Mediterranean Sea, in a 100 x 200 km offshore area between Marseille and Nice and in the Corsican channel. A maximum density of 55 items/km² was found, with a clearly-discernible spatial variability relating to residual circulation and a Liguro-Provencal current vein routing debris to the West (Gerigny *et al.*, 2012 and Figure 2.2.2a).

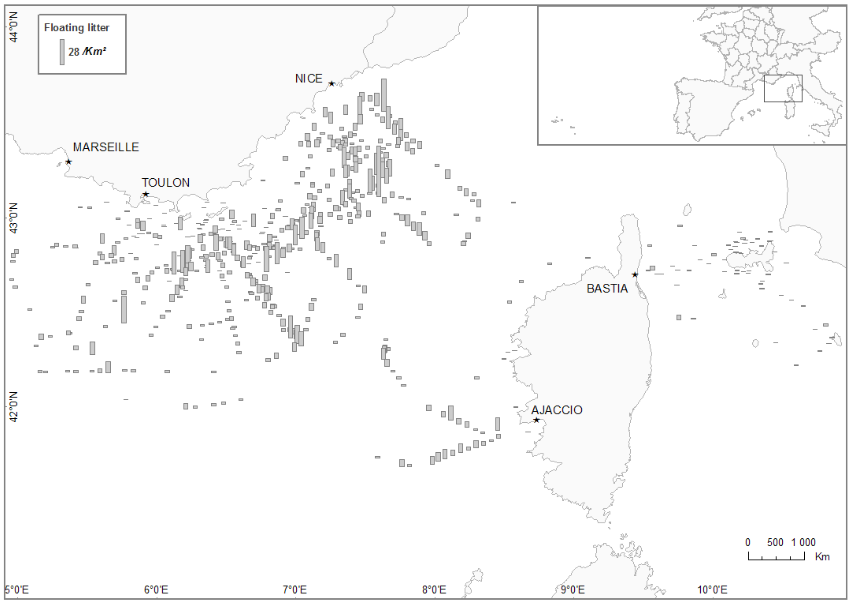


Figure 2.2.2a: *Distribution of floating litter in the northwestern Mediterranean Sea (2006-2008) (visual observations). IFREMER/SHOM map using data from the Ecocean/ParticipeFutur project for initial MSFD assessment (Gerigny et al., 2011).*

Subsequent survey made in the Eastern Mediterranean (Topcu *et al.*, 2010) reported densities of less than 2.5 items/ km2). It is important however mentioning that surveys from ferries and commercial vessels imply lower detection rates especially for smaller objects. Therefore, comparisons among different regions or years are often altered by the great diversity in counting protocols and viewing conditions encountered in the different surveys. Automated methods has been developed recently and tested in the Mediterranean Sea (Hanke and Piha, 2011) where data from ferry boxes using camera on-board regular shipping lines enabled to recognise floating or slightly submerged material of different colors and shapes, down to centimeter size, also indicating larger quantities in coastal areas.

More recently, results from Suaria and Aliani (2014) dedicated to the first large-scale survey of anthropogenic debris (>2 cm) in the central and western part of the Mediterranean Sea (Figure 2.2.2b) demonstrated that, 78% of all sighted objects were of anthropogenic origin, 95.6% of which were petrochemical derivatives (i.e. plastic and Styrofoam). Throughout the entire study area, densities ranged from 0 to 194.6 items/km2 and mean abundances of 24.9 items/km2. Maximum debris densities (>52 items/km2) were found in the Adriatic Sea and in the Algerian basin, while the lowest densities (<6.3 items/km2) were observed in the Central Tyrrhenian and in the Sicilian Sea. All the other areas had mean densities ranging from 10.9 to 30.7 items/ km2. The authors then evaluated at more than 62 million the number of macro-litter items currently floating on the surface of the whole Mediterranean basin.

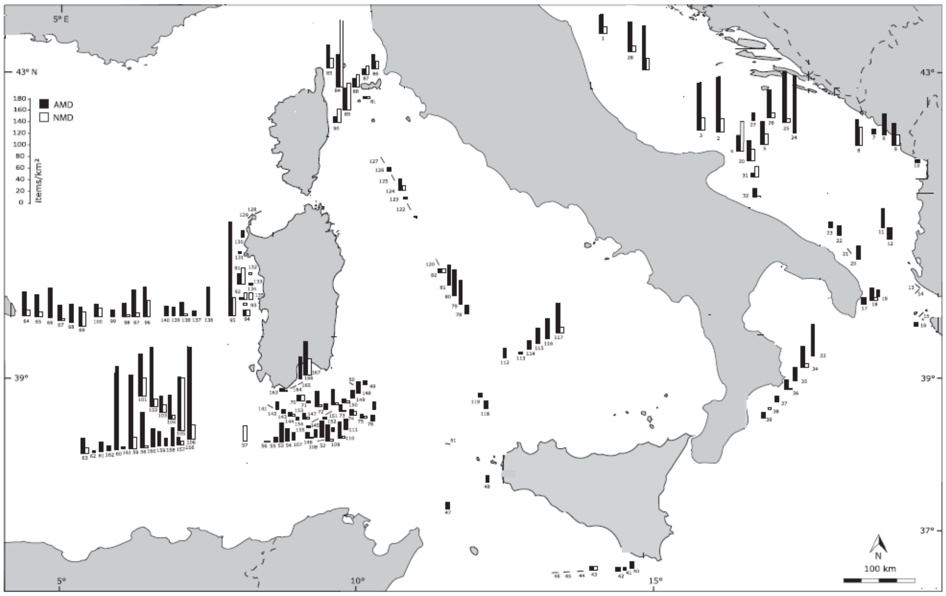


Figure 2.2.2b: Anthropogenic (black bars) and Natural (white bars) Marine Debris densities (items/km2) in the Western, Adriatic and Northern Ionian basins of the Mediterranean Sea (From Suaria and Aliani, 2014)

The highest densities found in the Adriatic Sea and along the North-western African coast are related to some of the heaviest densities in coastal population of the entire Mediterranean basin (UNEP/MAP (2012). North African countries in particular, also have the highest rates of growth in coastal population densities, including touristic densities. Algeria for instance, has a coastal population that was increased by 112% in the last 30 years and it currently represents one of the most densely populated coastlines in the whole basin (UNEP/MAP/PlanBleu, 2009). In addition, it should be noted that in some countries, appropriate recycling facilities have not been fully implemented yet, and the cost of proper solid waste disposal is still often beyond their financial capacity (UNEP, 2009).

Once into the marine environment, the hydrographic characteristics of the basin may play an important role in the transport, accumulation and distribution of floating debris. Atlantic surface waters enter the Mediterranean Sea through the strait of Gibraltar and circulate anticlockwise in the whole Algero-Provencal Basin, forming the so-called Algerian Current, which flows until the Channel of Sardinia and most often leads to the generation of a series of anticyclonic eddies 50–100 km in diameter wandering in the middle basin. Despite non being permanent, these mesoscale features could act as retention zones for floating debris and would help explain the high litter densities found in the central Algerian basin at around 80 nautical miles from the nearest shore. For the southern Adriatic Sea. First, it should be noticed that about one-third of the total mean annual river discharge into the whole Mediterranean basin flows into this basin, particularly relevant being the Po River in the northern basin and the Albanian rivers (UNEP/MAP, 2012).

In addition, the shores of the Adriatic Sea are populated by more than 3.5 million people, with fisheries and tourism acting as significant sources with 19 seaports handling more than a million tonnes of cargo per year and a considerable volume of passengers during the touristic season. Finally, significant cyclonic gyres are found also in the central and southern Adriatic Sea (Suaria and Aliani, 2014) favouring the retention of floating debris in the middle of the basin). This is also the Case in the Northern eastern part of the Aegean Sea where densities of floating litter is higher due to circulating waters and black sea/Mediterranean sea water exchanges (Ryan *et al.*, 2014). As for anthropogenic debris accumulating in oceans gyres and convergence zones, the existence of Floating Marine Debris accumulation zones in is a stimulating hypothesis as their presence was supported recently (Mansui *et al.*, 2015). the existence of one or more ‘‘Mediterranean Garbage Patches’’ should be investigated in more detail as there are no permanent hydrodynamic structures the Mediterranean Sea where local drivers may more largely affect litter distribution (CIESM, 2014).

Sea floor

Most litter comprises high-density materials and hence sinks. Even low-density synthetic polymers, such as polyethylene and polypropylene, may sink under the weight of fouling or additives. General strategies for the investigation of seabed debris are similar to those used to assess the abundance and type of benthic species. More than 50 studies were conducted worldwide between 2000 and 2015, but, until recently, very few covered extensive geographic areas or considerable depths. The Mediterranean Sea is a special case, as its shelves are not extensive and its deep sea environments can be influenced by the presence of coastal canyons. The geographical distribution of plastic debris is highly impacted by hydrodynamics, geomorphology and human factors. Continental shelves are proven accumulation zones, but they often gather smaller concentrations of debris than canyons: debris is washed offshore by currents associated with offshore winds and river plumes.

Only few studies have focused on debris located at depths of over 500 m in the Mediterranean (Galil, 1995; Galgani *et al.*, 1996, 2000, 2004; Pham *et al.*, 2014; Ramirez-Llodra *et al.*, 2013) (table 2.2.6). Galgani *et al.* (2000) observed decreasing trends in deep sea pollution over time off the European coast, with extremely variable distribution and debris aggregation in submarine canyons. Using a deep sea remote operated vehicle (ROV), video surveys concluded that submarine canyons may act as a conduit for the transport of marine debris into the deep sea. Higher bottom densities are also found in particular areas, such as around rocks and wrecks, and in depressions and channels. In some areas, local water movements carry debris away from the coast to accumulate in high sedimentation zones. The distal deltas of rivers may also fan out into deeper waters, creating high accumulation areas.

A wide variety of human activities, such as fishing, urban development and tourism, contribute to these patterns of seabed debris distribution. Fishing debris, including ghost nets, prevails in commercial fishing zones and can constitute high percentages of total litter. More generally, accumulation trends in the deep sea are of particular concern, as plastic longevity increases in deep waters and most polymers degrade slowly in areas devoid of light and with lower oxygen content.

The abundance of plastic debris is very location-dependent, with mean values ranging from 0 to over 7,700 items per km² (table 2.2.6). Mediterranean sites tend to show the highest densities, due to the combination of a populated coastline, coastal shipping, limited tidal flows and a closed basin, with exchanges limited to Gibraltar. In general, bottom debris tends to become trapped in areas with low circulation, where sediments accumulate.

Counts from 7 surveys and 295 samples in the Mediterranean Sea and Black Sea (2,500,000 km², worldatlas.com) indicate an average density of 179 plastic items/ km2 for all compartments, including shelves, slopes, canyons and deep sea plains, in line with trawl data on 3 sites described by Pham *et al.*, 2014. On the basis of this data, we can assume that # 0.5 billion litter items are currently lying on the Mediterranean Sea floor. Mapping the litter in the sea floor enable to precise the accumulation areas (Figures 2.2.3 a-c).

In a study on 67 sites conducted in the Adriatic Sea using commercial trawl, analysis of Marine litter, sorted and classified in major categories confirmed that plastic is dominant in terms of weight followed by metal. The highest concentration of litter was found close to the coast likely as a consequence of high coastal urbanization, river inflow and extensive navigation.

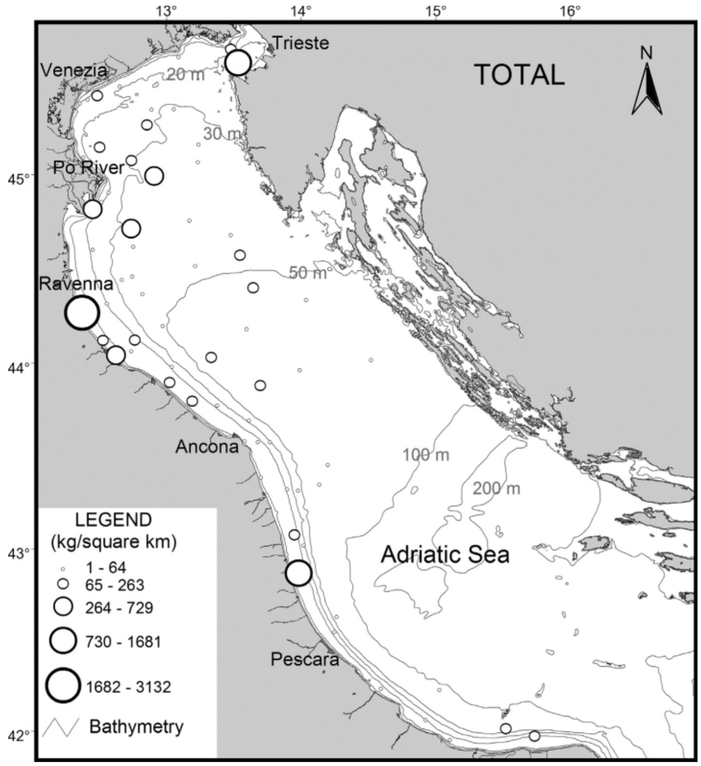
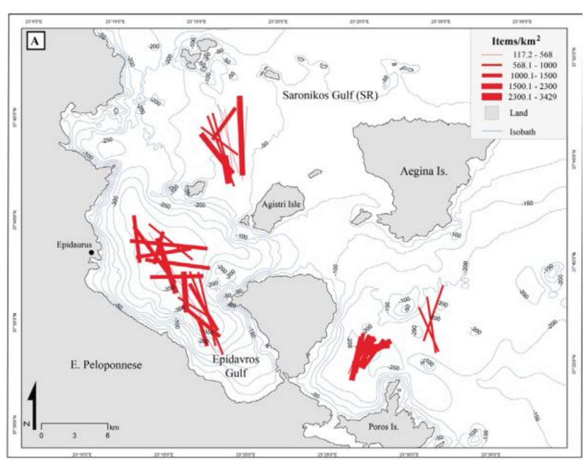


Figure 2.2.3a: Marine litter collected on seabed from the northern Adriatic (Solemon cruises, 2011-2012, Strafella et al., 2015).

Recently, benthic marine litter, was investigated in 4 study areas from the Eastern Mediterranean (Saronikos, Patras and Echinades Gulfs; Limassol Gulf). Densities ranged from 24 to 1211 items/km2, with the Saronikos Gulf being the most affected area. Plastics were predominant in all study areas ranging from 45.2% to 95%. Metals and Glass/Ceramics reached maximum values of 21.9% and of 22.4%.



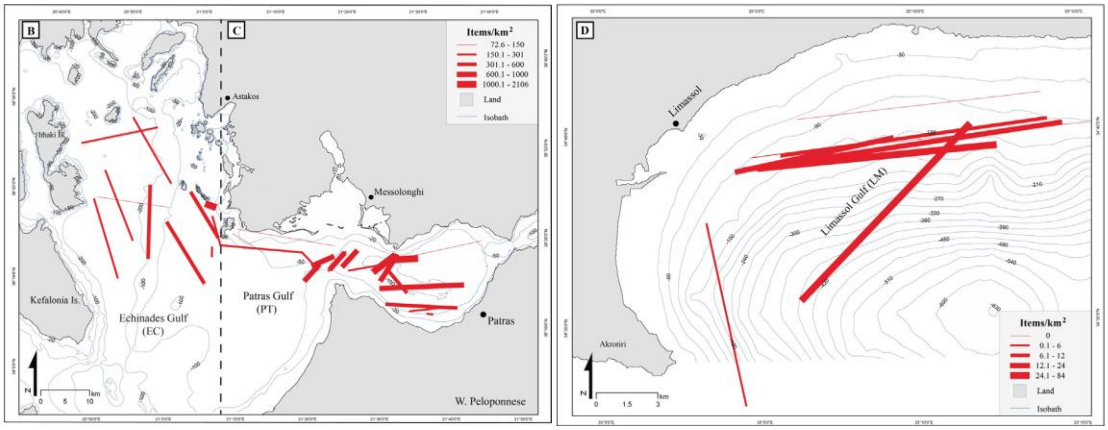


Figure 2.2.3b: Marine Litter density (items/km2) in Saronikos Gulf (Greece, Aegean Sea, A), Echinades Gulf (B) and Gulf of Patras (Greece, Ionian Sea, C), Limassol Gulf (Cyprus/ levantin basin, D) Line positioning correspond to the trawling transect; line thickness to marine litter density. (After Ioakeimidis et al., 2014)

In another example, The distribution and abundance of large marine debris were investigated on the continental slope and bathyal plain of the northwestern Mediterranean Sea during annual cruises undertaken between 1994 and 2009 (Galgani *et al.*, 2011). Different types of debris were enumerated, particularly pieces of plastic, plastic and glass bottles, metallic objects, glass and diverse materials including fishing gear. The results showed considerable geographical variation, with concentrations ranging from 0 to 176 pieces of debris/ha. In most stations sampled, plastic bags accounted for a very high percentage (more than 70%) of total debris. In the Gulf of Lions, only small amounts of debris were collected on the continental shelf. Most of the debris was found in canyons descending from the continental slope and in the bathyal plain, with high amounts occurring to a depth of more than 500 m (figure 2.2.3c).

Table 2.2.3a: Distribution of debris in relation to the depth (Galgani *et al.*, 1996)

Depth (m)	Tows	Total area (km^2)	Total debris	Plastics	Debris (km^{-2})
<200	57	3.03	337	229 (68%)	111.2
200-1000	21	0.816	568	483 (85%)	696
>1000	10	0.17	631	537 (85%)	3712

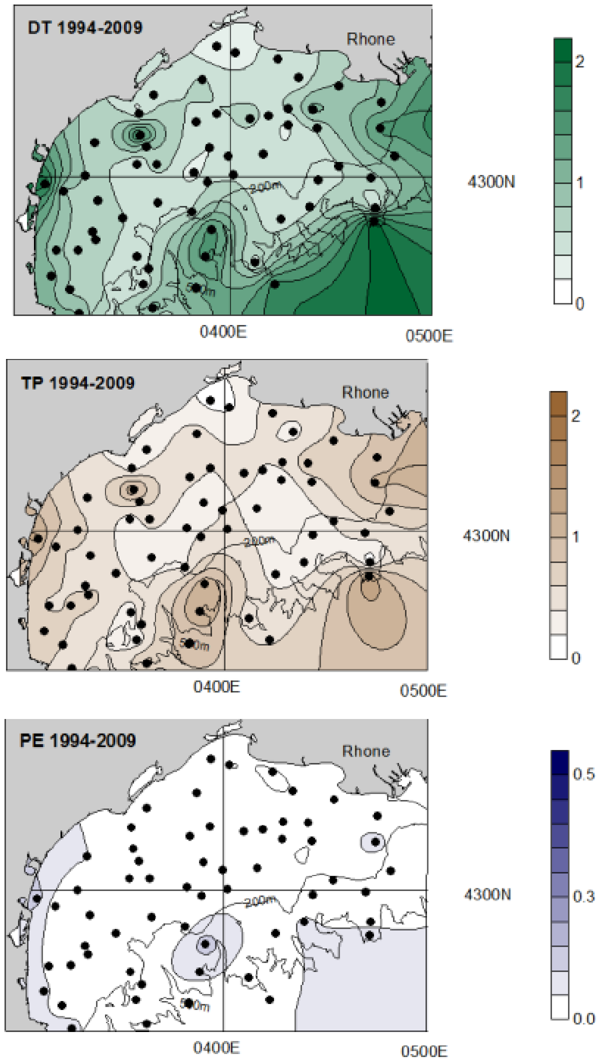


Figure 2.2.3c: Mean annual litter densities on the sea floor from the gulf of Lion for a period of 15 years of sampling (1994 –2009). Results are extrapolated densities expressed in items per hectare of the following categories total Debris (DT), Total plastics (TP) and fishing gears (PE). Data were from MEDITS cruises (Source: Galgani et al., 1996)

Derelict fishing gear

Fishing gears (gillnets, trammel nets, wreck nets, pots and traps), damaged or worn out, may be discarded or abandoned by fishermen at sea. Gillnets, driftnets or other fishing gear may also be broken or dispersed by storms. Some of these can then continue to catch and kill marine organisms (fish and crustaceans, birds, marine mammals and turtles), commercial or not, for decades, until they are degraded (Bearzi, 2002; Brown and Macfadyen, 2007). Work has been however dominated by biological and technical analysis with very little attention to the socio-economic elements of either the impacts of ghost fishing or the management responses. The issue of 'ghost fishing' first gained global recognition at the 16th Session of the FAO Committee on Fisheries in April 1985. This is an important issue when very high proportions of litter consist of Net fragments. Some of the fragments may have food organisms growing on them, and may occasionally be regarded as food by organisms that are attracted.

Despite The International Maritime Organisation (IMO) Convention for the Prevention of the Pollution from Ships (commonly referred to as MARPOL 73/78) that specifically prohibits the abandonment/dumping of fishing gear (Annex V, Regulation 3), It has been estimated that 640,000 tons of such ghost nets are scattered overall in the world oceans, representing an incredible 10 percent of all marine debris (UNEP/FAO, 2009). The causes of the losses vary between and within fisheries and fishing "metiers" with some common features particularly the conditions in which they occur. Factors, investigated under the FANTARED 2 project (2003) include, in decreasing order of relative importance, (i) conflict with other sectors, (ii) working in deep water, (iii) poor weather conditions and/or on very hard ground, (iv) working very long fleets, and (v) working more gear than can be hauled regularly. Due to improved communications between fishermen, losses were decreased in recent years. Moreover, there is generally a high economic motivation to retrieve lost fishing gears, in a short or long time, depending on the circumstances of the loss (depth and rougher ground conditions making the retrieval more difficult).

The open ground fisheries usually account for the biggest amount of fishing gears lost. Rates of permanent net loss in European waters appear to be low, and typically below 1% of nets deployed. Because their presence is not controlled, the available data for the Mediterranean do not allow evaluating precisely the relative importance of this threat, as compared to by catch in operating fishing gear. Bottom gillnet fisheries are very common throughout the Mediterranean basin, with more than 20,000 boats involved (http://firms.fao.org/firms/fishery/761/en). Target species are largely represented by demersal and bentho-pelagic fish and crustaceans. Although few entrapments in bottom gillnets have been documented (see table), this may be in part due to under-reporting as a result from the reluctance of fishers to report such incidents (Pawson, 003).

In the Mediterranean static gears is an important part of ghost fishing. Losses is then often a combination of rough bottom (rocks, wrecks) and strong currents complicating the retrieval of the gears and giving very variable results (pieces of netting and/or ropes, bundles of nets, etc.). Because of self-recovery favoured by GPS positioning and considerable efforts to avoid losses because of costs, the rate remains low when considering the total number of nets that are set. Finally, Losses due to storms are less frequent as usually fishermen are aware of bad weather conditions, giving however the lowest net retrieval rates as the nets are usually moved away from the place they were set.

The declining ghost catch rate over time is following a negative exponential function with rapidly declining ghost catch rates. On a daily basis ghost catches are assumed to decline quickly with ghost catches at 5% of the active catches after 90 days (Browne *et al.*, 2007). After 90 days, the decline in catch rates slows down considerably, with catches continuing at only low levels. FANTARED (Fantared, 2003) showed however that gears in shallower dynamic conditions tend to stop fishing earlier, sometimes after just a few months, while gear lost/discarded in deep water with little tidal/current activity can continue to fish for years rather than months. Ayaz *et al.* (2006) investigated and compared ghost fishing by monofilament and multifilament gillnets in Izmir Bay (eastern Aegean Sea). Gillnets were monitored every day by divers. After 106 days for the monofilament gillnets and 112 days for multifilament gillnets, a total of 29 species (22 fish, 5 crustaceans, 1 cephalopod, and 1 gastropod) were captured by the ghost gillnets and 17 specimens of the endangered species Pinna nobilis were killed during the study. Weekly fish catch rates of both gillnet types declined exponentially, reaching 55 (monofilament) and 63% (multifilaments) decrease respectively. One year after deployment, all had completely collapsed and excessively colonized by biota. On rocky bottoms, dependent on the level of exposure to the elements, gillnet catch rates can be near zero over an 8–11-month period. Fishing rates may nonetheless continue at rates of less than to 15% of normal gillnet rates in some cases. While studies showed that nets set in very deep water may fish for many years, the effective fishing lifetime of nets studied in Europe was in most cases not more than 6–12 months (Brown and Macfayden, 2007) and in almost all bottom conditions, ghost catches initially showing a high percentage of fish before switch progressively to catches dominated by crustaceans.

Estimated ghost catches are generally believed to be well under 1% of landed catches. In the French Mediterranean Sea, an annual loss of hake was estimated at 0.27% and 0.54% of the total commercial landings (2072–4144 individuals) but without analysis beyond a biological quantification of ghost catch to valuing it (Browne *et al.*, 2012).

In the studies that have been done in European fisheries, mortality rates from lost pots and traps are believed to be low, due to escapement of trapped organisms, low loss and high retrieval rates and damage. Mortality rates from lost demersal longlines, seine nets and jigging gear is also usually low as they stop fishing immediately or shortly after loss. Mortality levels from lost trawls are also believed to be low because these gears rely on their movement through water for their catching efficiency. Bingel (1989, in Golik, 1997) attempted to estimate the quantity of fishing gear lost between 2637 and 3342 tons in the Mediterranean Sea, based on an extrapolation of data from the Turkish industry losses. According to the targets species, FANTARED 2 (2003) estimated net losses in the French Mediterranean Sea at 6.25 km per boat and per year. With boats fishing different species, losses were estimated between 0.7 (red mullet) and 1.2 km (Sea Bream, Hake) per boat and per year, with percentages of total nets lost per boat between 0.20 (hake) and 3.2 (Sea bream) % of nets lost per boat.

Modern gears are mostly made of non-biodegradable synthetic fibres and can persist for long periods. They can therefore theoretically continue to catch fish for long periods of time. Fish, dolphins, sea turtles, seabirds, crabs and other animals swimming free in the water column or moving on the seabed, once captured by nets may die. Alterations of the marine environment and its habitat functions, obstacles to navigation and possible damages to the vessels, hazards for recreational and / or professional divers are other risks caused by ghost nets.

While the environmental impacts of lost static gear may be considerable, these impacts must also be considered in the broader context as compared to the environmental impacts of other fishing methods. Mobile gears such as trawls generally have much greater impacts than static gears in terms of target catch, non-target catch, and discards, as well as habitat and biodiversity damage. The mortality attributed to lost fishing gear is dependent on the species present, species abundance, species vulnerability and ghost gear status (Browne and Macfayden, 2007). However, since mortality rates associated with ghost fishing decline rapidly in most fisheries once nets/pots have been lost and while there are gaps in our knowledge, the extent of ghost fishing in fisheries may be less interesting than expected. Lost gear has a negative aesthetic impact as a source of litter at sea and on beaches, and can potentially entangle with active fishing gear and vessel propulsion systems. The significance of the aesthetic impact of fishing gear as a source of litter will vary by region. It may be particularly important mainly in areas where tourism is significant.

The causes of gear loss are important not only in terms of impacts but for developing appropriate management measures. conflict with other activities, working in deep water or bad weather conditions or very hard grounds, working very long nets or more gears than permitted but also ‘discarded/ abandoned’ gears are the most important reasons of losses. The European Community banned netting below 200m from 1 February 2006 as a measure before long term management conditions could be developed. Curative measures in Europe often take the form of gear retrieval programmes. They are however limited in the Mediterranean Sea.

GHOST and DEFISHING

The Adriatic region is facing a big gap when it comes to marine litter analysis resulting in a lack of appropriate mitigation measures aimed at reducing pollution by ghost net, evident in every country of the region. Through the implementation of various projects, marine litter in the Adriatic coastal waters will be reduced by involving fishermen as one of the key factors for marine litter cause and solution. Pilot activities are underway, setting out a system for collection and recycling of derelict fishing gear, including the so called "ghost nets». The EU project GHOST (http://www.life-ghost.eu/index.php/en/) was started To assess the impact of ghost nets on fish and benthic communities characterizing the rocky outcrops located off the coast of Veneto, commonly known as *Tegnùe.*The mapping of the 20 rocky outcrops located off the Veneto coasts, which had been previously supposed to be potentially affected by ghost nets, has been completed. A 20 square kilometers area has been mapped through the acoustic instrument (High Resolution Scanning Sonar), providing images of each outcrop conformation with possible entangled ghost nets. Photo-surveys have showed that most of the outcrops are spoilt by Abandoned or Lost Derelict Fishing Gears (ALDFG). The project started to recover ALDFGs, which will be subsequently analyzed by type in order to identify the potential recyclable components. The project will then help to test the efficacy of the methods to map and remove ALDFG, thus to demonstrate its applicability in similar coastal habitats and to develop operative protocols for ALDFG management in coastal areas. DeFishGear (http://www.defishgear.net/project/main-lines-of-activities) is addressing the wider context of the marine litter issue in the Adriatic. Part of the project deals with the implementation and management of preventive and mitigation actions such as (i) Fishing for litter, undertaken by fishermen while performing their daily fishing activities, leading to the removal of marine litter and awareness within the fishing sector, (ii) Targeted recovery of 'ghost nets' through a direct involvement of fishermen and divers, and (iii) Establishment of fishing gear management schemes to collect and recycle lost or abandoned fishing and other gear in the Adriatic region.

More generally, the European projects FANTARED (1 & 2) classified the management options for addressing lost gear into two groups dedicated to methods used for reducing respectively lost fishing gear and discarded fishing gear, that have to be different. For lost gears, the amount of time and effort spent retrieving gear is related to its value, the probability of recovery and the opportunity cost of carrying on fishing. For Abandoned fishing gear, on the other hand, the gear has no financial value and leaving it in the sea is a convenient means of disposal for the careless and irresponsible fisher.

Logistically, the management options for addressing lost gear can be however different with considerations to prevention, information and good practices (Macfayden *et al.*, 2009). Many of the current management responses to deal with ghost fishing feature gear retrieval programmes. However, a number of problems were identified, including (i) The precise information needed on location of gears, (ii) The reduced surface that can be covered in campaigns, (iii) The poor efficiency of recovery, (iv) The time when gears remain at sea, and (v) The cost. In some cases, especially when density of lost gears is low, there is then a question whether lost gears might be better left in the sea. For example, fouled ghost nets may better act as reefs rather than actively catching fish.

Strategies must then to be based on a quantification of the costs and benefits. Data, and costs, are however based on the areas where vessel numbers and patterns of activity will impact strongly on the percentage of total lost nets that are retrieved, and therefore the resulting benefits of a retrieval programme. In addition, in deeper water the costs of retrieval programmes could be considerably greater

Macfayden et al (2009) summarized some of the possible costs and benefits of reducing ghost fishing, related to prevention or curative measures. He noted that (a) gear retrieval programmes may only be cost effective in fisheries where the actual costs of ghost fishing are high; and (b) that preventative measures are likely to be preferable to curative ones. Key determinants of the economic viability of gear retrieval programmes are the number of vessels in the fishery; costs of the retrieval programme; number of nets lost; value of the gear lost; and the percentage of lost nets that can be successfully retrieved. Benefits include (i) a Reduced fish mortality of commercial/target species, marine mammals, birds, reptiles, etc., (ii) a reduced alteration of sea bed features, (iii) reduced littering of beaches, (iv) increasing catches and associated unemployment, and (v) Improved recreational, tourism and diving benefits

A broader management strategic approach implies to establish good practices and changing behaviour. Within FANTARED, specialists agreed on recommendations to be proposed to fishing industry. These include (i) A right amount of gear with restrictions on length, (ii) Marking gear properly (Transponders), (iii) Attention to weather and risks of conflict, and (iv) Better communicate and report losses, carrying net gear retrieving systems

As an example, the European Commission adopted a Regulation (Commission Regulation 356/2005) requiring passive gear (longlines, entangling nets, trammel nets and drifting gillnets) to be marked with the vessel registration numbers. In the project DEEPNET (Hareide *et al.*, 2005), geophysical and acoustic instruments were demonstrated to be the most appropriate methods for underwater detection when optical methods however had limited success. The project finally recommended the use of a miniature, codified passive-sonar transponder (microchip) to identify nets. However, an unfortunate implication of the requirements is that it may create an incentive for skippers to dump back at sea any abandoned gear that they may themselves retrieve in the course of fishing. Some technical measures have been also recommended to reduce the capturing possibilities of lost nets, such as the use of biodegradable thread for fixing the netting to the float line so that it will be released in the event of long submersion, or the use of lead-lines that break more easily, higher hanging ratios (over 50%) to reduce the looseness of the webbing, a major cause of tangling (Sacchi, 2012).

Mitigating the problem of ghost fishing also implies, above all, respect for elementary fishing regulations (for example, observance of regulations on gear marking systems). Interest in developing new management concepts based on Protected Marine Areas (MAPs) has risen over the past ten years, underscored by the feeling that it is possible to pursue commercial fishing activities while preserving threatened species at the same time. In such an example however, the benefits of a sustainable fishing may lead to more impacting fishing of ghost gears.

Microplastics

In addition to large debris, there is growing concern with regards to micro particles measuring less than 5 mm and particles measuring as little as 1 μm have already been identified (Carpenter *et al.*, 1972; Colton *et al.*, 1974; Thompson *et al.*, 2004). Most, but not all micro particles consist of micro plastics. Micro plastics comprise a very heterogeneous group, varying in size, shape, color, chemical composition, density and other characteristics. They can be subdivided by use and source as (i) 'primary' micro plastics, produced either for indirect use as precursors (nurdles or virgin resin pellets) for the production of polymer consumer products, or for direct use, such as in cosmetics, scrubs and abrasives and (ii) 'secondary' micro plastics, resulting from the breakdown of larger plastic materials into increasingly small fragments. This is the result of a combination of mechanisms, including photo, biological, mechanical and chemical degradation.

To date, only a limited number of global surveys have been performed in the aim of quantifying micro plastic distribution. The majority of existing surveys is localized and concentrated on specific areas around the world, such as regional seas, gyres or the poles. Most of these studies focus on sampling the sea surface and/or water column and intertidal sediments (Hidalgo-Ruz et al. 2012). Mean sea surface plastic was found in concentrations up to 115,000 -1050000 particles / km² in the NW Mediterranean Sea (maximum 4860000 particles per km2) (Collignon et al., 2012, Da Lucia et al., 2014, Faure et al., 2015, Suaria et al., 2015), giving an estimated weight over 1000 tons for the whole basin. Recently (Cozar et al., 2015), an evaluation provided an estimation based on samples collected with a 200µm mesh in the whole basin at 423 g km-2 (243,853 items km-2), then between 756 to 2,969 tons for the basin. At this scale, the spatial distribution of plastic concentrations is irregular, with a patchy pattern that may be related to the variability in the Mediterranean surface circulation disabling the formation of permanent accumulation areas. The highest micro plastic concentrations in sediment (Claessens et al., 2011) were found in beach and harbour sediments, not in the Mediterranean Sea but Belgium, with concentrations of up to 391 micro plastics/kg of dry sediment. Similarly, a beach survey on the Mediterranean island of Malta revealed an abundance of pellets on all of the studied beaches (Turner and Holmes, in Cole et al. 2011), with the highest concentrations reaching 1,000 pellets/m2 along the high-tide mark. In Slovenia (Bajt et al., 2015), concentrations were found between 3 and 87 particles per 100g generally with offshore areas less contaminated. Finally, on Kea Island in the South Aegean Sea, microplastics abundance reached the 977 items/m2 with a highly variable abundance of virgin pellets (7-560 pellets/m2) (Kaberi et al., 2013). Micro plastic pollution has also spread throughout the world's seas and oceans, into sediment and even deep Mediterranean Sea (Van Cauwenberghe et al., 2013).

After a large scale study in the Mediterranean Sea, five different types of plastic items were identified (pellets/granules, films, fishing threads, foam, fragments), with the majority of items being fragments of larger rigid objects (87.7%, e.g. bottles, caps) and thin films (5.9%; e.g. pieces of bags or wrappings) (Cozar *et al.*, 2015)

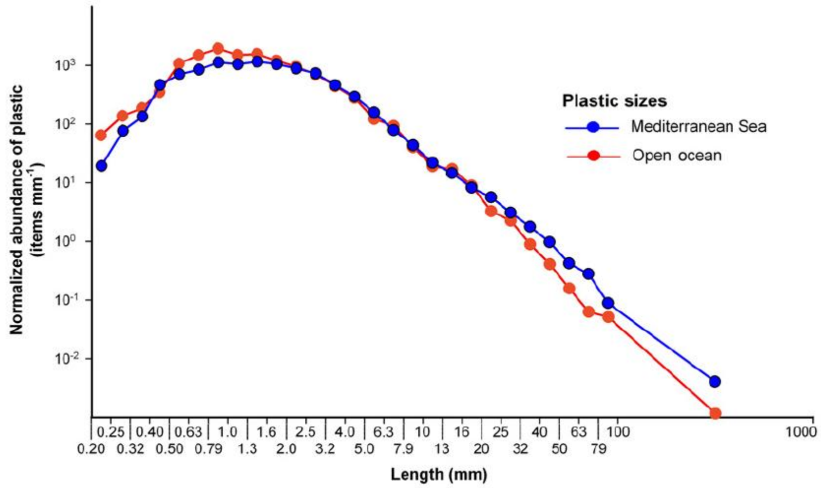


Figure 2.2.5 a: Size distribution and aspect of the floating plastic debris collected in the Mediterranean Sea (n = 3,901 plastic items) compared to those measured for plastic accumulation regions in the open ocean (n = 4,184 plastic Items). Note the logarithmic scale of the axis (After Cozar et al., 2015).

Time trends relating to the composition and abundance of micro plastics are scarce without any information in the Mediterranean Sea. However, available long-term trend data suggests various patterns in micro plastic concentrations. A decade ago, Thompson (2004) revealed a significant increase in plastic particle abundance over time. More recent evidence indicates that micro plastic concentrations in the North Pacific Subtropical Gyre have increased in the last four decades (Goldstein *et al.* 2012), whereas no changes have been observed on the surface of the North Atlantic gyre over a 20-year period (Lavender Law et al., 2010).

Summary of litter data in the Mediterranean Sea

Table 2.2.6: Comparison of mean litter densities from recent data (from 2000) in the Mediterranean Sea. Intervals of values are given in parentheses.

Location	Environmental compartment	Date	Sampling	Depth	Density (min-max)	% plastics	References
Slovenia	Beaches, Macro litter	2007	3 beaches, 150 m-2 per transect	0	12158/km	64	Palatinus, 2009
Slovenia	Macro/Beaches	2007-2013	6 beaches, all litter items >2cm collected on 3x150m per location	0	1.9 litter items / m	74	National Report for MSFD Article 8, 9 and 10 Peterlin *et al.*, 2013
Slovenia	Macro/Beaches	2014-2015	2 samplings, 3 beaches, 1 beach with 2X100mX10m transects, 2 beaches with 100mX10m transects; all litter items >2cm collected	0	3.95 litter items / m	70	DeFishGear/ Institute for Water of the Republic of Slovenia/in press
Balearic	Beaches, Macro litter	2005	32 beaches	N/A	36000/ km (high season)	75 (46% cigarette butts)	Martinez *et al.*, 2009
France /Marseille	Beaches, Macro litter	2011-2012	10 beaches (30 in winter)	N/A	0,076 m-3/day/100m (stranding rates)	80-94	MerTerre 2013 - (www.mer-terre.org)
Turkey	Beaches, Macro Litter	2008-2009	10 beaches	N/A	0.085 to 5.058 items m2	91	Topçu *et al.*, 2013
Spain	Beaches, Macro litter	2013-2014	12 beaches, 100m transects, 4 surveys/year	N/A	11-2263 items/100 m (2013) 27-1955 items/100 m (2014)	66% (2013) 62% (2014)	Ministerio de Agricultura, Alimentación y Medio Ambiente (http://www.magrama.gob.es/es/costas/temas/proteccion-medio-marino/actividades-humanas/basuras-marinas/)
Spain-Mediterranean Sea	Beaches, Macro litter	2013-2014	27 beaches	N/A	11-2137 items / 100 m	48.6%	MARNOBA Project (http://vertidoscero.com/Marnoba_AVC/result.htm)
Croatia (Mjet island)	Beaches, Macro litter	2007	NA	N/A	NA	80	Cukrov & Kwokal, 2010
Greece, Ionian Sea	Beaches, Macro litter	2014-2015	6 beaches	N/A	Mean: 0.715 items / m^2 (range: 0.03 – 6.38)	84.6 %	DeFishGear/ MIO-ECSDE/in press
Italy, North-western Adriatic coast	Beaches, Macro litter	2015	2 beaches	N/A	Mean: 1.139 items/m^2 (range: 0.771 – 1.507)	95%	DeFishGear / ISPRA /in press
Mediterranean sea (15 countries)	Beaches, Macro litter	2002-2006	Beaches	0	NA	>60	ICC, in Unep, 2011
Greece	Beaches, Macro litter	2006-2007	80 Beaches	0	NA	43% (2006) 51% (2007)	Kordella *et al.*, 2013

Spain (Murcia)	Micro plastics Beach	2012	1 Beach	0	2245 microplastics/m2	100	http://surf-and-clean.com/microplasticos/
France	Micro plastics Beach	2011	15 beaches	0	2920 microplastics/m2 (10cmm layer, 0-8000)	100	Klosterman *et al.*, 2012
Greece	Micro plastics Beach	2012	12 beaches	0	10-977 items/m2 (2-4 mm) 20-1218 items/m2 (1-2 mm)	100	Kaberi *et al.*, 2013
Slovenia	M Micro plastics Beach	2014-2015	2 samplings, 1 beach, large (1-5mm) on 3 x 0,25 m2 and small (<1mm) microplastic particles (3x 250 ml)	3-5 cm	Large: 516±224 items/ kg Small: 616±325 items/ kg	> 90%	DeFishGear/ Institute for Water of the Republic of Slovenia/in press
Slovenia	Micro plastics Sediments	2014	27 stations	50 m Maximum	3-80/100g		Bajt *et al.*, 2015
Location	**Environmental compartment**	**Date**	**Sampling**	**Depth**	**Density (min-max)**	**% plastics**	**References**
Kerch Strait/Black Sea	Macro/Sea surface	Before 2008	Visual	Aerial	66 / km²	nd	BSC, 2007
Ligurian coast	Macro/Sea surface	1997-2000	Visual	Surface	1.5-25/ km²	nd	Aliani and Molcart, 2011
North western	Macro/Sea surface	2013	Waveglider	0-4,5m	40,5/ km²	100	Galgani *et al.*, 2013 (CIESM)
Slovenia	Macro/Sea surface	2011	Visual	Surface	1.98 /km2	90	Vlachogianni & Kalampokis, 2014
Slovenia	Macro/Sea surface	2014-2015	2 samplings, 5 transects, visual observation of floating litter >2.5cm, constant speed 3knots for 60 mins	Surface	. 0.0013 items / m2	100	DeFishGear/ Institute for Water of the Republic of Slovenia/in press
Adriatic sea	Macro Litter (>20cm), Sea surface (high sea)	winter 2015	Fixed Line Transect (FLT), repeated, samples (n=7). 1.600 km surveyed in total	N/A	3.79± 0.71 items/ km²	87,6%	DeFishGear/ MIO-ECSDE & Accademia Leviatano/in press
Ionian Sea	Macro Litter (>20cm), Sea surface (high sea)	Winter 2015	Fixed Line Transect (FLT), repeated, samples (n=7). 1.200 km surveyed in total	N/A	2.53± 1.01 items/ km²	89,2%	DeFishGear/ MIO-ECSDE & Accademia Leviatano/in press
Adriatic/ Greek waters	Macro/Sea surface	Since 2008	Visual	Surface	5.66 /km2		Vlachogianni & Kalampokis, 2014
Aegean/ Levantine	Macro/Sea surface	Since 2008	Visual (172.8 km2)	Surface	2.1 km2	83	Unep, 2011
North western	Floating Macro/Sea surface	2006-2008	Visual	Surface	3,13 / km²	85	Gerigny *et al.*, 2012 and Unpublished data (Ecoocean.org)
Greece	Macro/Sea surface		Visual	Surface	2.1 items/km²	83	HELMEPA (Greece) in UNEP, 2011
NW Mediterranean	Floating Micro plastics	2010	40 samples/Manta/330µm mesh	Surface	115000 / km²	> 90%	Collignon *et al.*, 2012

West Sardinia	Floating Micro plastics	2012	30 samples/Manta/500µm mesh	Surface	150 000 items/ km^2		Andrea /Lucia *et al.*, 2014
Mediterranean sea	Floating Micro plastics	2015	39 samples/Manta/200µm mesh		243,853 items/ km^2 (423 g km-2)		Cozar *et al.*, 2015
Slovenia	Floating Microplastics	2012-2014	17 samples/Manta / 300µm	Surface	471900 items / km^2 (13900-3098000)	80% polyethylene	Palatinus *et al.*, 2015
Slovenia	Micro/Sea surface	2014-2015	2 samples river outflow/Manta/308µm mesh 4 samples sea surface/Manta/308µm mesh	Surface	River outflow: Av. 228046±30060 items / km2 Sea surface: Av. 287924±52979,5 items / km2	> 90%	DeFishGear/ Institute for Water of the Republic of Slovenia/in press
Italy/ North Adriatic	Floating Microplastics	2014	11	Surface	63175 items / km^2 (27.3 g / km^2, max at 128800)		Mazziotti *et al.*, 2015
Italy/North Adriatic	Floating Microplastics	2013	29	Surface	1050000 items / km^2 (100000-4860000), 442g / km^2	41%polyethylene	Suaria *et al.*, 2015

Location	Environmental compartment	Date	Sampling	Depth	Density (min-max)	% plastics	References
Malta	Shelf	2005	Trawl (44 hauls, 20 mm mesh)	50-700	102	47	Misfud *et al.*, 2013
Sicily/ Tunisian channel	Shelf	1995	Trawl (fishermen)	0-200 m	401/km^2	75	Cannizarro *et al.* (1995)
Adriatic Sea	Shelf	1997	12 hauls (trawling, 20 mm mesh)	0-200 m	378 +/- 251 / km^2	69,5	Galgani *et al.*, 2000
Northern & central Adriatic	Shelf	2005-2010	trawl trawling	0-200m	5-34 kg/ km^2	NA	From Vlachogianni & Kalampokis, 2014
Montenegro	Shelf/ slopes	2009	trawling	48 - 746 m	6-59% of total catches	NA	Petrovic & marcovic, 2013
Slovenia	Shallow waters	2013	diving	0-25m	Na	55	From Vlachogianni & Kalampokis, 2014
France- Mediterranean	Seabed, slopes	2009	17 canyons, 101 ROV dives,	80-700m	3.01 /km survey (0-12)	12 (0-100)	Fabri *et al.*, 2013
Thyrenian sea	Seabed, Fishing grounds	2009	6 x 1.5 ha samples, trawl, 10mm mesh	40-80m	5960±3023/ km^2	76	Sanchez *et al.*, 2013
Spain-Mediterranean	Seabed, Fishing grounds	2009	Trawling (fishermen)	40-80m	4424±3743/ km^2	NA	Sanchez *et al.*, 2013
Mediterranean sea	Seabed, Bathyal/abyssal	2007-2010	292 tows, Otter/agasiz trawl, 12 mm mesh	900-3000m	0.02- 3264.6 kg/ ·km^2 (including clinkers)	nd	Eva-Ramirez 2013
Slovenia	Macro/Sea floor	2014-2015	2 samplings, 5 locations, each location has transects of 100mx8m	2-17m	0 – 7500 items / km^2	67%	DeFishGear/ Institute for Water of the Republic of Slovenia/in press
Turkey/ Levantine basin,	Seabed, Bottom/Bathyal	2012	32 hauls (trawl, 24 mm mesh)	200-800m	290 litter (3264.6 kg·) /km^2	81.1	Güven *et al.*, 2013
Turkey/ North eastern basin,	Shelf	2010-2012	132 hauls (2.5kts)	20-180	72(1-585 kg)/ hour	73	Eryasar *et al.*, 2014
Mediterranean, Southern France	Shelves & canyons	1994-2009 (16 years study)	90 sites (trawls, 0.045 km2/tow)	0-800 m	76-146/ km^2 (0-2540)	29.5 -74	Galgani *et al.* 2000 & unpublished data
Greece	Shelf	Before 2004	59 sites	30-200	4900 /km^2	55.5	Katsanevakis & Katsarou (2004)
Greece	Shelf	2000-2003	54 hauls (trawl, 1,5 mm mesh)	30-200	72–437 / km^2	55,9	Koutsodendris *et al.* (2008)
Greece	Seabed (fishing ground)	2013	69 hauls (50mm mesh)	50-350	1211±594 items/km2 (Saronikos Gulf)	95,0±11,9 (Saronikos Gulf)	Ioakeimidis *et al.*, 2013
Levantine basin	Seabed (fishing ground)	2013	9 hauls (50mm mesh)	60-420	24±28 items/km2	67,4±7,7	Ioakeimidis *et al.*, 2013

(Cyprus)							
Black sea (Constanta bay)	Seabed (fishing ground)	2013	16 hauls (20mm mesh)	30-60	291±237 items/km2	45,2±4,8	Ioakeimidis *et al.*, 2013
Italy (North Thyrrenian)	Shelf	2010-2011	69 dives (26 areas, 6.03 km_2)	30-300	90 debris items/ km^2 (0- 160)	92% (89% from fishing)	Angiolillo *et al.* (2015)
Italy (Tyrrhenian)	Fishing Grounds (Rocky banks)	2010-2011	ROV observations	70-280 m	0.0029 km^2	-	Bo *et al.* (2014)
Italy, North-western Adriatic Sea	Seabed	2014	16 x 5.7 ha samples, trawl, 24 mm mesh opening	20-30 m	Mean: 721 items/km^2 (range: 99 – 3,036)	92%	DeFishGear / ISPRA /in press

Impact on marine litter

Litter affects marine life at various organizational levels and its impact varies according to the target species or population, environmental conditions and the considered region or country.

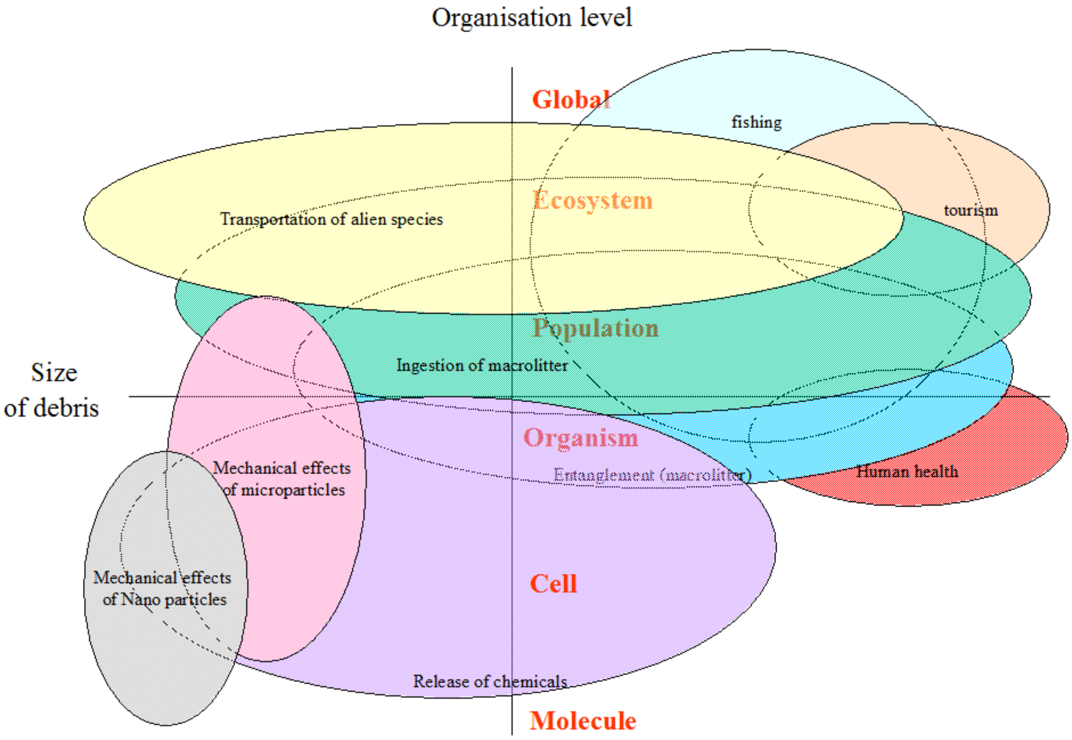


Figure 3: Schematic representation of different types of impacts in relation with size of marine litter and biological organization level.

The concept of harm itself is not obvious, as no acceptable units of measure have been defined. Even the remotest part of the Mediterranean is affected by marine litter with impacts on the environment and coastal communities that are various. It constitutes a major source of aesthetic pollution, may affect ecologically the marine ecosystem but also chemically and mainly, from a socio economic perspective, tourism and fishing activities. Marine litter may also endanger human health and safety.
The problem is compounded by the fact that a very high percentage of marine litter not only does not degrade quickly in the environment (Metal, plastic) and therefore but may support a contribution to marine environmental pollution with secondary pollution (release of chemicals).

Impacts on wildlife

As marine litter affects different ecological compartments, the study of its impact on marine biota of all trophic levels on the same temporal and spatial scale is of increasing importance. With regard to biodiversity, it is essential to focus research on sensitive species such as turtles and marine mammals, seabirds, and filter feeders, invertebrates or fish that may be ingest micro plastics. Protocols have also to be developed to assess early warning effects on key species and key habitats (Deudero & Alomar, in CIESM, 2014). Moreover, the identification of interactions between litter and fauna strongly depends on data collection methods. For example, most data on fish, turtles and cetaceans are provided by stomach contents analyses, stranded individuals or bycatches reflecting only a small snapshot of actual interactions which can be expected. The effect of marine litter on marine populations is difficult to quantify as unknown number of marine animals die at sea and may quickly sink or be consumed by predators, eliminating them from potential detection. New methods for the unbiased estimation of mortality rates and the effects on the population dynamics of many affected species are urgently needed.
So far, 79 studies have investigated the interactions of marine biota with marine litter (mainly plastics) in the Mediterranean basin (Deudero & Alomar, in CIESM, 2014). These studies cover a wide range of depths (0 m to

850 m) and a large temporal scale (1986 to 2014), unravelling a vast array of species affected by litter ranging from invertebrates (polychaetes, ascidians, bryozoans, sponges…), fish and reptiles to cetaceans. Effects from the studies were classified into entanglement, ingestion, and colonization and rafting.

Entanglement / impact derelict fishing gears

In 2015, 340 original publications reported encounters between organisms and marine debris and 693 species with entanglement as the most important consequence (Gall and Thompson, 2015). Birds represented nearly 35% of entangled wildlife followed by fish (27%), invertebrates (20%) mammals (almost 13%) reptiles (almost 5%) and amphibians (less than 1%). Discarded monofilament fishing line is perhaps the single-most dangerous litter item accounting for 65% of entanglements found during ICC campaign in 2007. In fact, derelict fishing gear, which includes fishing line, nets, rope, lures, light sticks, and crab/lobster/fish traps, represented 72% of all entanglements. Lost fishing gear may impact on the environment in a large number of different ways, including (i) continued catching of target species, (ii)capture of non-target fish and shellfish, (iii) entanglement of sea turtles, marine mammals, sea birds and fish in lost nets and debris, (iv) ingestion of gear-related litter by marine fauna (v) physical impact of gears on the benthic environment, and (vi) the ultimate fate of lost gear in the marine environment with degradation products being introduced to the food chain. Factors complicating the analysis of entanglement were demonstrated within the project FANTARED (table 3.1.1a).

Table 3.1.1a: Factors complicating the analysis of marine entanglement trends

Detection	Sampling and reporting biases
Entanglement occur as isolated events scattered over wide range	Virtually no direct, systematic at-sea sampling has been done and there are few long-term surveys.
Entangling debris is not easily seen on live animals at sea because animals may only be partially visible at great distances	Sampling methodologies are inconsistent
Dead animals are difficult to see because they float just beneath the surface and may be concealed within debris masses	Stranding represent an unknown portion of total entanglements
Dead entangled animals may disappear quickly because of sinking or predation.	Shore counts of live entangled animals are biased toward entanglement of survivors carrying small debris
	Entangled animals spend less time ashore and more time foraging at sea
	Some entanglements reflect interactions with active rather than derelict fishing gear
	Many unpublished or anecdotal results
	Recent data only

There is a general lack of available data on marine wildlife in the Mediterranean. For cetaceans, factors that may contribute to the entrapment of organisms in ghost gears (Bearzi, 2002) include (1) the presence of organisms in the nets or in their proximity (2) the water turbidity making the fishing gear less visible; (3) the ambient noise, for cetaceans, in the marine environment that may mask or confuse the echoes produced by fishing gear, and (5) the cetacean capability to detect the net filaments by means of echolocation. Moreover, lack of experience by juvenile or immature individuals may make them more vulnerable to entrapment in gillnets. Types of impacts are various, including ingestion of lost pieces of net (Alon *et al.*, 2009)

In the Mediterranean Sea, monk seals interact with static fishing gear (Cedrian, 2008). In Northern Ionian Sea, Zakynthos fishers endured an overall damage rate of 4.96% out of 1632 net settings. Entanglement in ghost nets is then a probable impact, even not described for now, especially in very coastal waters.

Ghost gears may also damage benthic habitats and can potentially pose safety risks for fishers if they become entangled with active fishing gear.

More generally, proven harm may not be useful for monitoring purposes as organisms may however continue to travel over considerable distances after becoming entangled in ropes, net and lines, hence transforming active fishing gear into marine debris. As a consequence, monitoring of impacts mainly refer to ingested litter, due to difficulties in distinguishing between entanglement in litter and active fishing gear. The current difficulties in interpreting data, together with the low reported numbers of entangled beached animals and problems associated with large-scale harm assessment due to the rarity of stranding, mean this approach can only usefully be applied to specific areas and on the basis of national decisions (Galgani *et al.*, 2013 and 2014). Research may contribute to the development of new, more specific entanglement indicators. (Votier *et al.*., 2011). As an example, guidelines are currently being developed for litter in seabird nest structures as a source of entanglement as the litter found there cannot originate from active fishing gear. Even with some research needed to define behaviours, breeding seasons and the types of litter brought into seabird nests, species such as shags (Phalacrocorax aristotelis) is promising with regards to regards to monitoring of the Mediterranean sea. The species is very common throughout the whole basin and nests on coastal areas in most European and North African countries, together with the Black Sea coast.

Ingestion

More than 62 million of debris items are estimated floating in the Mediterranean (Suaria and Aliani, 2014) and these may affect marine organisms through indirect health effects such as after ingestion. Moreover, some species that are feeding on bottom may also ingest litter directly from the sea floor. Beyond the direct impact on survival, debris ingestion causes sub-lethal effects related, for example, to the decrease of natural food inside stomach and therefore the amount of absorbed nutrients, or the ingestion of toxic substances adsorbed on or released directly from the plastic (Gregory 2009). They may act as endocrine disruptors and therefore can compromise the fitness of individuals (Teuten *et al.*, 2009; Rochman et al., 2013 and 2014).

More than 180 marine species have been documented to absorb plastic debris, among these different species of sea birds (Van Franeker *et al.*, 2011), fish (Boerger *et al.*, 2010) and marine mammals (de Stefanis *et al*. 2013), including plankton species (Cole *et al*. 2014). All species of turtles living in the Mediterranean Sea are listed as globally vulnerable or endangered (IUCN 2013) and have been found to ingest debris. Except in the case of occlusions (Sea turtles, mammals, etc.) or storage by some species (procellariforms), excretion of ingested indigestible particles with feces is very common for all kinds of organisms. Nevertheless, a number of harmful effects of ingested litter have been reported; the most serious effects are the blockage of the digestive tract and internal injuries by sharp objects, which may be a cause of mortality (Katsanevakis, 2008).

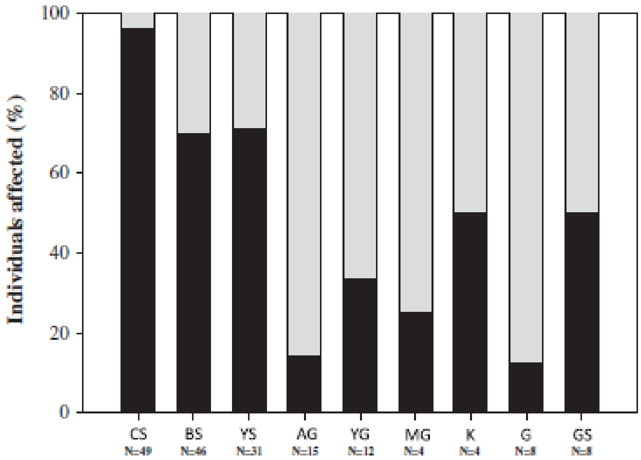


Figure 3.1.2a: In a first assessment of plastic ingestion in Mediterranean seabirds (Codina et al. 2013), plastics were quantified and measured in the in the stomach of 171 birds from 9 species accidentally caught by longlines in the western Mediterranean from 2003 to 2010. Without differences in Plastic characteristics and sex, Cory's shearwaters Calonectris diomedea) showed the highest occurrence (94%) and large numbers of small plastic particles per affected bird, followed by Yelkouan shearwaters (Puffinus yelkouan, 70%), and Balearic shearwaters (Puffinus mauretanicus, 70%). Other species were below 33%.

Sub-lethal effects caused by marine litter ingestion may greatly affect population in the long term. One potential sublethal effect is diminished feeding stimulus and nutrient dilution, i.e. reduced nutrient gains from diets diluted by consumption of debris. This may have serious implications on the population level, because of possible reduced growth rates, longer developmental periods at sizes most vulnerable to predation, reduced reproductive output, and decreased survivorship (McCauley and Bjorndal, 1999). Such sub-lethal effects of marine litter and their impacts on the population level need to be further investigated.

Impacts on fish have been found to vary greatly as a function of their ecological compartments. Highly affected species include *Boops boops*, myctophids, *Coryphaena hippurus*, *Seriola dumerilii*, *Schedophilus ovali* and *Naucrates ductor* (Deudero & Alomar, 2014). Recently (Teresa *et al.*, 2015, in press), tunas and swordfishs from the Mediterranean Sea were identified as targets species with occurrence of micro, meso and larger plastics in more than 18% of the samples. Finally, Spot-scale bioindicators of micro-plastics in Mediterranean Sea bottom ***(****Mullus barbatus, Solea sp.)* and coastal shores *(Mytilus galloprovincialis, Arenicola marina, holothurids) have some interest for a better understanding of harm due of their feeding habits, as detritivorous or filter feeders. Typically, High rates of filtration in mussel support high ingestion rates of microplastics (Van Cauwenberghe et al., 2014).* Ingestion of litter by a wide range of whales and dolphins is also known, Although known rates of incidences of ingested litter are generally low, in the percent range, except in some cases when accidental ingestion may related on feeding on the sea floor. As a counterpart, large filtrating marine organisms, such as baleen whales and sharks, which ingest microplastics by filter feeding, are resident in the Mediterranean Sea and, due to large amounts of water filtrated at each mouthful (approximately 70,000 L of water for *Balaenoptera physalis*) they could face risks caused by the ingestion and degradation of microplastics as suggested through the detection of plastic additives (e.g. phthalates)) in tissues from stranded animals and from skin biopsies (Fossi *et al.*, 2012).

The loggerhead sea turtle (*Caretta caretta*) is the most abundant chelonian in the Mediterranean (Camedda *et al.*, 2014; Casale and Margaritoulis, 2010) and may ingest plastic bags mistaken for jellyfishes (Mrosovsky *et al.*, 2009) when they feed in neritic and offshore habitats. This is a very sensitive species to marine litter and one of the most studied. Despite loggerhead is able to ingest any kind of waste, plastic items seems to be significant more than other kind of marine litter. Different studies in the Mediterranean Sea (Lazar and Gracan, 2011; Campani *et al.*, 2013, Camedda *et al.*, 2014), such as for other seas and oceans demonstrated that plastic is the most frequently ingested anthropogenic debris. There is no difference in litter found in the stranded sea turtles when compared with those excreted by hospitalized ones (Cameda *et al.*, 2014), analysis showing homogeneity in relation of the total abundance, weight and composition among alive and dead individuals.

Plastic fragments and other anthropogenic materials may be directly responsible for the obstruction of digestive tracts (Bugoni *et al.*, 2001; Di Bello *et al.*, 2006) and death (Bjorndal *et al.*, 1994). Furthermore, long retention times of plastic debris in the intestine may cause the releasing of toxic chemicals (e.g. phthalates, PCBs) that may act as endocrine disruptors and therefore can compromise the fitness of individuals (Teuten *et al.*, 2009).

Sea turtle species have different lifestyles at various stages of their lives; they can frequent disparate areas feeding on epipelagic or benthic prey in oceanic and neritic zones. At the early stage of their life individuals probably are mainly inactive, and gradually begin to swim against the tide reaching shallow water. Then adults start to use the sea bottom and the water column as feeding compartment (Casale *et al.* 2008, Lazar *et al.* 2010). Adult loggerheads have been found to show fidelity to their neritic feeding grounds which may be the same ones they recruited to as juveniles (Casale *et al.*, 2012), for these reasons they are likely to ingest waste in different habitat types during their lives.

The transition to the pelagic stage to the neritic one occurs at different range sizes, when the curved carapace length is around 40 cm (Casale *et al.* 2007). If some studies reported that smaller oceanic turtles are more likely to ingest debris than larger turtles, most results in the Mediterranean Sea showed adult specimens of loggerhead with higher values of marine litter if compared with the juvenile (Campani et., al., 2013). Adult individuals are able to discriminate colors to find food but both adults and juveniles ingest plastic materials "preyed" on the sea surface and in the water column.

The loggerhead sea turtle, *Caretta caretta*, demonstrates great tolerance of anthropogenic debris ingestion and the species is generally able to excrete these items (Casale *et al.*, 2008; Frick *et al.*, 2009). Camedda *et al.*, 2014 observed that sea turtles released anthropogenic materials in the feces for longer than a month of hospitalization, with most of the litter expelled within the first 2 weeks. Studies about transit time of substances in gastro-intestinal tracts of loggerhead sea turtles demonstrated that materials (as polyethylene spheres) are expelled in about 10 days (Valente *et al.*, 2008). Therefore, they conclude that considering the mean distance covered in 10 days by *C. caretta,* the litter defecated during the hospitalization into the tanks is likely to be a sample of debris present at a distance of less than 120 km (Camedda *et al.*, 2014).

Table 3.1.2a: Ingestion rate of Litter in Mediterranean Sea turtles. Size is given in shell length.

Area	Date	size	Individuals/ deads	With ingested litter (%)	live individuals	With ingested litter (%)	Total	With litter (%)	References
Sardinia (E&W)	2008-2012	21-73	30	20	91	12	121	14,04	Camedda *et al.*, 2013
Tuscany	2010-2011	29-73	31	71			31	71	Campani *et al.*, 2013
Adriatic	2011-2004	25-79	54	35,2			54	35,2	Lazar & Gracan, 2011
Spain	nd	34-69	54	79,6			54	79,6	Tomas *et al.*, 2012
Lampedusa	2001-2005	25-80	47	51,5	33	44,7	79	48,1	Casale *et al.*, 2008
Malta	1988	20-69			99	20,2	99	20,2	Grammentz, 1988
France	2011-2012	nc	2	0	54	24	56	19,6	Dell'Amico & Gambaiani, 2012
France	2003-2008		20	36			20	36	Claro & Hubert, 2011
Balearic islands	2002-2004	36-57	19	37,5			19	37,5	Revelles *et al.*, 2007
Linosa	2006-2007	26,7-69					32	93,5	Botteon *et al.*, 2012
Italy/Spain (Murcia)	2001-2011				155	50	155	50	Casini *et al.*, 2012

Transport of species/ New habitats.

Organisms are shown in most cases to utilize the debris items in oceans as habitat to hide in, adhere to, settle on and move into new territories (Barnes, 2002; Gregory, 2009). This type of dispersion is not really new as dead woods, ash, coconuts or other floating fruits are means that have promoted colonization by sea for millions of years. This has become however a real problem because of the recent proliferation of floating particles, mostly plastic. Then, 250 billion microplastics floating in the Mediterranean Sea (Collignon *et al.*, 2012) are all potential carriers for alien, harmful species and so-called "invasive" species (Maso *et al.*, 2003).

As described by Katsanevakis *et al.* (in CIESM, 2014) the first animals colonizing plastic surfaces at sea after biofilm made of microorganoisms are suspension feeders (polychaetes, bryozoans, hydroids and barnacles). Unicellular organisms are also present on floating debris. Foraminifera, diatoms, dinoflagellates, including harmful species (Maso *et al*, 2003), coccolithophorids, radiolarians and ciliates are frequently seen as well as algae that many species are widely described (Carson *et al.*, 2013, Collignon *et al.*, 2014) with a distribution "in patches" that is affected by factors such as location, temperature, salinity, plankton abundance, plastic concentration (Carson *et al.*, 2013). The abundance of some species may be increased with the roughness and size of fragments, especially on polystyrenes and they may benefit from local conditions such as light or the presence of food. Mobile scavengers and predators, such as Peracarid crustaceans and crabs, gradually join and ultimately there can be a wide variety of other animals. The plastic may be entirely covered in just a few months. Most if not all of the colonisers grow to adult and, under proper conditions, can reproduce – so the raft becomes a source of larvae (eg which may colonise other nearby plastic). This can drastically change the directions, spread and chance of success for aliens to spread and establish. As an example, Among the rich fauna found on floating plastics sampled in the north western Mediterranean sea, substantial specimens of a single species of benthic foraminifer, *Rosalina globularis*, were found (Jorissen *et al.*, in CIESM, 2014) because this is very rare foraminiferal taxa with a planktonic (*Tretomphalus*) stage, enabling the colonization of floating plastics during sexual reproduction and dispersion of gametes at the surface that is only possible part of the time when temperature is above 18°C.

. Although there are many studies on the colonization of fixed plastic panels, the colonization process of floating marine litter and the relevant ecological succession needs further research, as it is inherently different when compared to fixed submersed plastic panels (interaction with the atmosphere, effects of weather conditions, direct sunlight etc.).

The large availability of floating litter can assist the transport of species beyond their natural boundaries and their introduction to environments where they were previously absent (Ciesm, 2014). Barnes (2002) estimated that human litter more than doubles the rafting opportunities for biota, assisting the dispersal of alien species. This role is not well understood, especially in the Mediterranean sea at a point where marine litter has not been included as potential vector of introduction of alien species in any of the recent assessments on primary pathways for introduction (Zenetos *et al.*, 2012; Katsanevakis *et al.*, 2013; Galil *et al.* 2014; Nunes *et al.* 2014) where shipping, corridors (Suez Canal and inland corridors), aquaculture and aquarium trade have been identified as the most important pathways. However, as stated by CIESM (2014), thirteen species alien to the Mediterranean are known to colonize floating litter elsewhere in the world. Furthermore, more than 80% of the known alien species in the Mediterranean might have been introduced by colonizing marine litter or could potentially use litter for further expanding their range (secondary invasion). In many cases, plastic can be colonized more easily than vessel hauls (metal) and of litter may arrive in the Mediterranean through the Suez Canal with a non-negligible potential to raft Red Sea organisms (Galil *et al.*, 1995).

By sinking, debris may also impact the deep sea environment. These areas may be affected with waste dumped and deep currents sometimes subject to significant intensity. Litter, then, in providing solid substrates and new habitats, may impact the distribution of benthic species, even in remote areas (Katsanevakis *et al.*, 2007; Mordecai *et al.*, 2011; Bergmann and Klages, 2012, Pham *et al.*, 2014).

Both total abundance and the number of species showed an increasing trend in the impacted surfaces, because the litter provided refuge or reproduction sites. A marked gradual deviation in the community structure of the impacted surface from a control and a clear successional pattern of change in the community composition of the impacted surfaces were demonstrated (Katsavenakis *et al.*, 2007).

More than 40% of the plastics on trawling grounds from the Mediterranean were colonized by biofilms of micro-organisms, and in some areas, up to 12 % of plastics were totally covered by larger organisms, suggesting indirect effects on benthic communities (Sanchez *et al.*, 2013).

To date, incrustation of nano- and micro-planktonic or benthic organisms on marine litter has not been described in the deep but sponges, sea anemones, hydroids and Scleractinian corals, Polychaetes, Bryozoa, Molluscs, Echinoderms, Tunicates and rockfishs were found fixed on litter from ultradeep areas (Ramirez lodra, 2011, 2012 and 2013, Fabri *et al.*, 2013, Sanchez *et al.*, 2013), most of them being suspension feeders. As a consequence, the presence of marine litter may alter diversity as it increases habitat heterogeneity.

Field experiment on shallow soft substrata (Katsanevakis *et al.*, 2007) found a marked gradual change in the community structure because of marine litter with a clear successional pattern of change in the mega-fauna community composition, the establishment of new intraspecific and interspecific competition for hard substratum and shelter and new predator-prey interactions.

Overall, the Mediterranean Sea is a receiver rather than a source of species (Katsavenakis, In CIESM, 2014). Plastic litter provides more opportunities both in number and surface area, surface characteristics, lower speed favouring settlement, and a larger dispersion than ships travelling port to port. This favor the secondary dispersion after primary invasion mainly through Gibraltar and the Suez Canal. As a consequence dispersion to multiple locations decreases options for containing or remove any alien, increasing risks of significantly impact on fisheries, aquaculture, tourism, water treatment etc.

Marine litter and human health

Marine litter, stranded or floating, is considered a public health issue (Sheavily & Register, 2007). Typically, large sized debris may affect human from molecular (toxicity) to individual level. Pieces of glass, discarded syringes and medical waste may harm beach users. In some UK beaches, up to 4% of injuries by needles are observed on beaches (anonymous, 2012). Evaluating harm is however difficult as most incidents are unrecorded and measures such as cleaning, ruling and public information may prevent from associated risks. Entanglement can also pose a threat to swimmers, and divers who can become entangled in submerged or floating debris such as fishing nets and ropes. Even uncommon, this is regularly reported for monofilament nets (Mouat *et al.*, 2010). Because of the toxicity of their components to human, especially plasticizers and additives (Flint *et al.*, 2012; Oellman *et al.* 2009) and because of the possible leaching of poisonous chemicals (Thompson *et al.*, 2009, Andrady, 2011), plastics may be considered as potential biohazard. To date, concentrations at sea remain very low (Flint *et al.*, 2012) and may not be relevant in terms of chronic contamination. The risk to human is however important when considering accidental inputs of debris, from containers as an example, with massive presence of toxic compounds or harmful debris. Microplastic related harm to human is still under discussion. From individual to population level, Magnification of ingested litter or microlitter trough the food chain and the consumption of sea food has not been demonstrated as harmful. If recent studies have demonstrated the injury of digestive gland cells after litter ingestion in *et al.*(Von moos *et al.*, 2012), the excretion of litter containing pellets is well documented (Cole et al, 2013) and one may expect an intestinal transit to decrease potential risks of litter bio magnification.

As a counterpart, the introduction of vast quantities of plastic debris, both micro and macro, into the ocean environment over the past half century has massively increased the amount of raft material and consequently increased the opportunity for the dispersal of many and various marine organisms. It is now an abundant substrate for microbial colonization, physically and chemically distinct from natural substrates and could support distinct microbial communities. Different types of substrates, including fishing lines, hooks, plastic bottles and metal cans were shown to adsorb pathogens to fish, in vitro (Pham *et al.*, 2012). Also because they play an important role in the formation of primary biofilms, bacteria are also transported (Zettler *et al.*, 2013; Carson *et al.*, 2013), a "plastisphere" ecosystem whose consequences are not controlled (Zettler *et al.*, 2013) when the question of transport of pathogens has now become crucial and may potentially support impact on human health.

Secondary pollution from marine litter

In the recent years, secondary pollution from leaching of pollutants from litter has been extensively studied including in the Mediterranean Sea to estimate the contribution of marine litter in the pollution of the sea by metallic or organic chemicals (Chalkiadaki, 2005, Rochman et *al*., 2013) and to understand if litter, beyond its unfavorable effects as debris, acts as secondary sources of pollutants, particularly over the long periods of time that it takes to decompose. The results of the studies showed that marine litter indeed acts as a secondary source of pollutants. Plastic additives (PAs) that can leach out of the matrix over time and exert toxic and endocrine disruptive effects on marine organisms when plastics are ingested (Oehlmann *et al.*, 2009) and transfer or enhanced bioaccumulation of persistent organic pollutants (POPs) may also occur as a consequence of the high sorption capacity of many plastics for lipophilic compounds (Rochman *et al.*, 2013).
Phthalates generally do not persist in the environment, but may leach from plastic debris on a fairly steady basis. Di-(2-ethylhexyl) phthalate (DEHP) is the most abundant phthalate in the environment but is metabolized in its primary metabolite, MEHP (mono-(2-ethylhexyl) phthalate), that can be used as marker of exposure to DEHP (Barron *et al.*, 1989). High concentrations of these plastic-associated contaminants and nonylphenol have been measured in small planktivorous fish and recent laboratory experiments (Rochman *et al.*, 2014) indicated that they might alter endocrine system function of fish. In large filter-feeding organisms (basking shark and fin whale) of the Mediterranean Sea, Fossi *et al.*, (2014), showed that the presence of harmful chemicals may be linked to the intake of plastic derivatives by water filtering and plankton ingestion. There is also an increased concern regarding persistent, bioaccumulative (PBT), and toxic chemicals such as polycyclic aromatic hydrocarbons (PAH) and pesticides adsorbed onto plastics, which then become vectors for the bioaccumulation of these highly toxic pollutants in fatty tissues (Mato *et al.*, 2002; Ogata *et al.*, 2009; Rios *et al.*, 2007; Rochman *et al.*, 2013), posing a long term risk to the environment. The most common synthetic polymers in beached samples were found to be polyethylene (PE), polypropylene (PP), polystyrene (PS) and polyurethane (PU). Beaches located downstream from industries and/or port facilities presented higher quantity of plastic debris and microplastics as well as higher concentrations of POPs (PAH, PCB and DDT). PCBs and DDE sorb to debris with a partition coefficient, Kd of approximately 100,000-1,000,000 over seawater. Similarly, phenanthrene, a PAH, partitions to plastic debris 13,000-fold over seawater (Engler, 2012). Most of these chemicals can potentially affect organisms (Teuten *et al.*, 2007) having endocrine disruptors potency and affect population viability. Based on data from beaches on the Greek coast (Karapanagioti *et al.*, 2011), Pellets near port facilities may reach PAH concentrations as high as $\mu g\ g^{-1}$ exhibiting congener patterns from petrogenic sources. PCB contamination is higher in aged pellets than in any of the other types and the more chlorinated congeners recorded higher concentrations in the proximity of urban areas. The highest total DDT levels are found near industrial sites and port facilities. Though there are no defined levels of toxicity for persistent organic pollutants adsorbed to plastic particles, it is probable that effects may exist as these pollutants are known to desorb in certain conditions (Endo *et al.*, 2013). Nevertheless, modelling studies by Koelmans *et al.* (2013) showed that ingestion of contaminated plastics does not necessarily lead to increased bioaccumulation in the organisms. One of the reasons is the limited retention time of the material which prevents complete desorption of co-transported contaminants during gut passage. Finally, relationships between harm (at a specific endpoint) and particle size are still to be determined, especially for nanoparticles below 30 – 100 nm in size due to a possible uptake (Von Moos, in CIESM, 2014).

In an example of litter collected around Athens (Chalkiadaki, 2005, Table 3.3a), the various categories of litter obviously contributed for metal contamination in different percentages on the various beaches with Zn as the most important metal found on debris.

Table 3.3a: Heavy metals in mixed waste collected on beaches from Greater Metropolitan Area of Athens (2007-2008). Data are expresses as mg/kg (After UNEP, 2011)

	Zn	**Cr mg/kg**	**Cu mg/kg**	**Ni mg/kg**	**Pb mg/kg**	**Cd mg/kg**
Plastic packaging	191± *99*	11.6± *7.9*	32.4± *22*	3.67± *0.85*	33.7± *49.0*	1.*52*±*3.79*
Other plastics	637± *816*	32.4± *78*	237± *757*	3.35±*1.95*	193± *332*	7.51±*15.4*
Textiles	150±*88.1*	39.8±*92.7*	35.4±*29.1*	2.73±*2.44*	68.3±*106*	0.22±*0.19*
Paper packaging	102±*37.9*	13.87±*14*	25.2±*8.38*	6.43±*9.73*	13.4±*0.44*	1.43±*4.39*
Printed paper	68.0±*28.4*	12.7±*6.22*	35.7±*26.6*	3.61±*1.34*		0.08±*0.12*
Other categories of paper	97.9±*49.5*	11.6±*5.75*	10.9±*5.95*	4.33±*2.58*		0.08±*0.06*
Composite	34.9±*21.2*	6.18±*1.41*	13.3±*7.01*	1.96±*1.88*	1.05±*0.74*	0.06±*0.01*
Organic	412± *562*	52.5± *39.3*	625±*1428*	12.4±*9.61*	15.5±*22.6*	0.92±*1.53*

In another experiment, leaching from plastic bags and cigarette butts was evaluated measuring desorption of metals extracted using sea water for 3 months. Data indicated a possible release of 0.8 kg of Zn per km of beach. (Table 3.3b).

Table 3.3b: Metal content (mg/km) measured on plastic bags and cigarette butts (3 months extraction using seawater) collected on a Greek beach (Unep, 2011). Samples consisted of 1,170 plastic bags and 14083 cigarette tips collected on the 16,200 m beaches that were cleaned by HELMEPA in 2002

	Cd	**Cu**	**Pb**	**Zn**
Plastic bags	0.027-0.54	0.068-.220	0.300-1.390	6.70-9.70
Cigarettes butts	2.50-10.3	156-234	49-87	451-838

Socio-economic impacts

The collection, treatment and disposal of solid waste involve considerable economic and environmental costs. Generating less waste would therefore be better both for the economy and the environment of the region.

Litter in the marine environment gives rise to a wide range of economic and social impacts and negative environmental are more often also interrelated and frequently dependent upon one another (Ten Brink *et al.*, 2009). Ghost fishing for example, can result in harm to the environment, economic losses to fisheries and reduced opportunities for recreational fishing (Macfadyen *et al.*, 2009). Understanding these impacts remains limited particularly for socio-economic effects. For the European commission, the total costs of marine litter is estimated at 263 million euros (Arcadis, 2014) with a probable more important value for the closed Mediterranean sea due to the population in the region, maritime traffic and tourism. The social impacts of marine litter are rooted in the ways in which marine litter affects people's quality of life and include reduced recreational opportunities, loss of aesthetic value and loss of non-use value (Cheshire *et al.,* 2009).

In the Mediterranean, there is little or no reliable data on what the exact costs are. Furthermore, the loss of tourism and related revenues due to marine litter both on the beaches and in the sea, although recognized and considered, has not been quantified in detail. Economic Impacts the most often described include the Loss of aesthetic value and visual amenity, discouraging users in polluted areas (Ballance *et al.,* 2000), the loss of non-use value (Mouat *et al.,* 2010), Public health and safety impacts (extent and frequency of incidents), Navigational hazards (fouling and entanglement in derelict fishing gear, burnt out water pumps, Collisions with large marine litter can damage, etc.) that are often unreported, and impacts on fishing, fishing boats and fishing gears (cleaning) as well as the costs that burden local authorities and other bodies for monitoring and clean-ups.

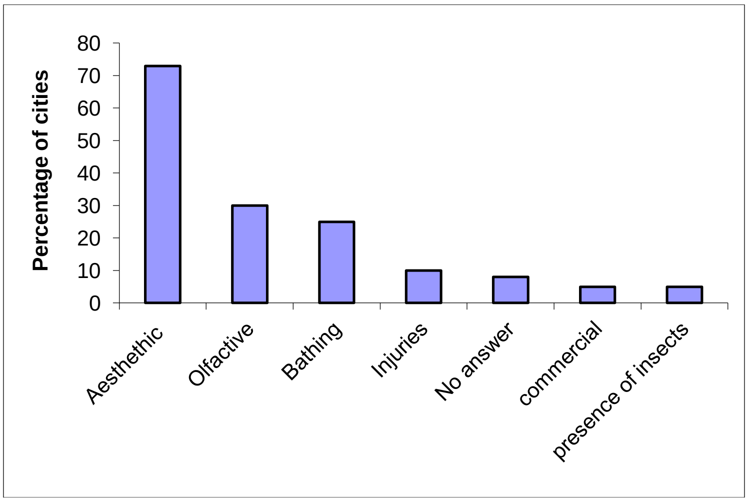


Figure 3.4a: Impacts of marine litter as perceived by 40 different towns/cities managers along the coasts of France (37), Monaco (1) and Italy (2). Data were collected through a questionnaire and results are expressed as % or towns/cities citing a type of impact as significant (data from Cedre, 2000, in Galgani et al., 2011).

In practice, the wide diversity of impacts makes measuring the full economic cost resulting from marine litter extremely complex (Mouat *et al.,* 2010). Direct economic impacts such as increased litter cleansing costs are clearly easier to assess than the economic implications of ecosystem degradation or reduced quality of life due to the wide variety of approaches for valuing the environment and detrimental anthropogenic impacts.
The economic impacts of marine litter are most often small-scale, rely on anecdotal evidence and focus on particular aspects of the marine litter problem such as ghost fishing for example. The understanding of the economic significance of marine litter therefore remains relatively limited (Ten Brink *et al.,* 2009).
Main costs are related to:
(i) Litter cleansing costs: Removing marine litter (and further disposal, management costs, etc.) is a necessary task. As an example, the town Nice 5France) involve 40 persons a year, 5 boats and 1 plane to locate and collet litter from beaches and adjacent waters, with associated costs of more than 2 million euros each year (Galgani *et al.,* 2011) to ensure beaches remain aesthetically attractive. In Spain, more than 60 k€ are spent annually to remove litter from harbours.
(ii) Losses to tourism. Marine litter can reduce tourism revenue and consequently weaken coastal economies. It remains unclear at what density litter starts to deter tourists but it has been shown outside the Mediterranean Sea that a drop in beach cleanliness standards could reduce revenue by up to more than 50% (Ballance *et al.,* 2000).
It was found that 85% of beach users would not visit a beach with 2 or more large debris items per meter. In extreme cases such as urban beaches, marine litter can also lead to the closure of beaches.
(iii) Losses to fisheries. Marine litter has a twofold impact on fisheries by increasing costs to fishing vessels as well as reducing potential catches and revenue through ghost fishing (see paragraph 2.2.4). The direct costs include repairing damage to the vessel and equipment, disentangling fouled propellers, replacement of lost gear, loss in earnings from reduced fishing time, restricted and/or contaminated catch and cleaning of nets. Studies in Northern Europe demonstrated experienced losses reaching 25-40000 € per vessel/year (Mouat *et al.,* 2010).
(iv) Losses to aquaculture: Entangled propellers and blocked intake pipes present the most common problems for aquaculture operators and can result in costly repairs and lost time (UNEP 2009). In addition, the time required to remove debris floating in or around stock cages and to clean nets can represent a significant cost to

aquaculture organisations, In the range of 1 hour per month for cleaning and could cost up to 1500€ per incident (Hall 2000)
(v) Costs to shipping costs from marine litter are resulting from vessel damage and downtime (Ten Brink *et al.*, 2009), litter removal (manual or not) and management in harbours and marinas (UNEP 2009), and emergency rescue operations to vessels (pleasure or commercial) stricken by marine litter (Macfadyen *et al.*, 2009). However, the vast majority of incidents are unreported.
(vi) Costs to power stations: The effects of marine litter on power stations can include blockage of cooling water intake screens, increased removal of debris from screens and additional maintenance costs (Mouat *et al.*, 2010).
(vii) Ecosystem degradation: The potential for marine litter to contribute to ecosystem deterioration is a critical concern. However, damage is extremely complex to evaluate and has not been addressed by research. Establishing what the long-term effects of marine litter will be on the environment is similarly highly complex and difficult to translate in costs.

Table 3.4a: A summary of impact of marine Litter on economic sector with estimated importance in the Mediterranean Sea. (Derived from Mouat et al., 2010)

SECTOR	IMPACT	IMPORTANCE IN THE MEDITERRANEAN
MUNICIPALITIES	Health risks	++
	Legal action	+
	Hidden costs	?
	Disposal	++
	Beach cleaning	+++
	negative publicity	++
	Beach awards	+
TOURISM	Beach awards	+
	negative publicity	++
	Area promotion	++
	Reduced revenue	+++
	Reduced recreational opportunities	++
	Loss of aesthetic amenity	++
INDUSTRY	Damage to equipment	+
	Increased maintenance	+
	Plant/ staff downtime	+
	Removal of litter	+
AQUACULTURE	Manual removal of litter	+
	Vessel damage and staff downtime	+
	Net cleaning	+
SHIPPING	Vessel damage	+
	Costs of rescue	+
	Statutory duty	+
	Negative publicity	+
	Harbors cleaning and dredging	+
	Harbors awards	+
NGOs	Operational costs	++
	Financial assistance	++
	Volunteer’s time	+++
FISHING	Repairing damage to fishing gear	++
	Replacement of lost gear	++
	Reduced and/or contaminated catch	++
	Reduced fishing time	+
	Gear cleaning	+

ECOSYSTEM SERVICES	Degradation costs	+

Marine litter monitoring programmesin the Mediterranean

Monitoring

Monitoring is an important part of any management strategy as no strategy can be evaluated without monitoring data. The relative success of different tactics cannot also be determined and finally, monitoring is also necessary for the setting of targets.

Without some degree of information on trends and amounts across all compartments, a risk-based approach to litter monitoring and measures is impossible. In the Mediterranean Sea, countries must draw up their monitoring programmes in a coherent manner by ensuring monitoring methods are consistent across the region. This will facilitate the comparison of results and take into account relevant trans-boundary impacts and features.

Marine debris monitoring generally consist of various approaches such as beach surveys, at-sea surveys, estimates of the amounts entering the sea and impacts. Beach surveys are widely viewed as the simplest and the most cost effective but they may not relate to true marine pollution and, because they may be affected by weather, the stranded debris may not necessarily provide a good indicator of changes in overall abundance.

Buried litter is usually not sampled, though it may be a considerable proportion of beach litter. Some beaches will better indicate specific sources of debris than others due to their location (remote beaches or urban beaches tracking ship and urban pollution respectively).

Despite more intensive sampling required to assess spatial scale, at-sea surveys probably reflect overall debris abundance (CMS, 2014). Surveys can also only assess stock and not accumulation, From-deck observation, Trawl surveys and Aerial surveys are the most accepted methods, depending on the size of litter, but the recent development of floating drones (Galgani *et al.*, 2013) will support large scale automated monitoring in the future. Seabed surveys are conducted with divers, submersibles and remote-operated vehicles. It is possible to obtain both accumulation and stock data in this marine compartment.

There is actually no regular monitoring of micro particles in the Mediterranean Sea. Another approach to monitoring is to look at impacts directly. Entanglement data does suffer from not always being expressed as a proportion of the population, because of a lack of population estimates, and can wrongly be conflated with within-species prevalence. Moreover, distinction between active gears and litter when sampling stranded organisms is too difficult to enable regular and consistent monitoring. Ingestion data provide consistent data but restricted to deceased and stranded individuals as opposed a sample from the population at large. Moreover, Species that can be considered for monitoring purposes must meet a number of basic requirements, like (i) sample availability (adequate numbers of beached animals, by-catch victims or harvested species), (ii) Regular plastic consumption (high frequency and amounts of plastic over time in stomachs), and (iii) feeding habits (stomach contents should only reflect the marine environment).

The last approach for monitoring marine debris is at-source input monitoring. This may concern ship inputs (records from port waste reception facilities and garbage log books) or land based sources (inputs from rivers) and both is considered to be the most indicative of changes related to reduction measures.

In the Mediterranean Sea, there is very little coverage of any other marine compartment than beach and stranded debris, the most mature indicator and the one for which most data is available.

As major future decisions within the Mediterranean will be based on measures, monitoring efforts should be shouldered by quality control/quality assurance (training, inter-comparisons, use of reference material for microplastics, etc.) to assist survey teams. Protocols do exist (UNEP, 2009, MSFD/Galgani *et al.*, 2013, UNEP/MAP, 2014) considering standard list of categories of litter items in order to enable the comparison of results. Items may be attributed to a given source e.g. fisheries, shipping etc., or a given form of interaction (ingestion), hence facilitating identification of the main sources of marine litter pollution and the potential harm caused by litter. This will also enable a targeted implementation of measures.

Comprehensive and regular surveys of marine litter on beaches have been made in many areas, often over a number of years, by various NGOs in the Mediterranean region. Valuable information about the quantity and composition of marine litter found on beaches has been available in most of the countries and the statistic sheets give an overview of debris found in the Mediterranean countries. There is however a lack of official statistics of most of the Mediterranean Countries. The challenges in dealing with this problem are not due to lack of awareness or the lack of data from various regions but the lack of standardization and compatibility between methods used and results obtained in these projects, and makes it difficult to compare data from different regions and to make an overall assessment of the marine litter pollution situation for the entire Mediterranean region. This problem will be solved in the years to come with the implementation of the Marine Litter regional Action Plan committed to coordinate and harmonize monitoring. Nevertheless the existing programs are indicators of approaches which could be used to address the problem of Marine Litter in the Mediterranean.

Most programmes that are existing or have existed in most Mediterranean countries involve(d) NGOs with various objectives such as cleaning or to educate local/regional/national authorities, industry stakeholders and the wider public. Helmepa, MiO-esdce, Medasset, Legambiante and acadomia leviatano, EcoOcean, vertidoscero, Clean Coast, Ocean Conservancy (International Coastal Cleanup) are some indicative examples involved in successful Marine Litter monitoring programmes that have taken place in the Mediterranean. Some of them are cooperating together and interrelated.

The “Clean Coast” programme (Alkalay *et al.*, 2007, in Unep, 2011) shows that the litter problem can only be solved by introduction of a holistic mechanism, backed up by a measurement index, and applied over the long-term. Some argue that a country should not embark on a solution to the marine litter problem until the sources of the litter have been analyzed and identified. However the programme shows that “Action First” by countries, may be the key. A strategy pursued for a long enough time, will create a self -perpetuating mechanism that will generate success, not only for the residents of a country but for neighboring countries as well. A combined international action of such kind may be the beginning of a turnover in reducing marine and coastal litter.

Science based coordinated monitoring is not organized at the basin scale but its implementation is in progress within the UNEP/MEDPOL regional Action plan.

The MEDITS survey programme (International Bottom Trawl Survey in the Mediterranean, http://www.sibm.it/SITO%20MEDITS/principaleprogramme.htm) intends to produce basic information on benthic and demersal species in term of population distribution as well as demographic structure, on the continental shelves and along the upper slopes (80-800m) at a global scale in the Mediterranean Sea, through systematic bottom trawl surveys and using a common standardized sampling methodology and protocols. The Last version (7) of the protocol is incorporating a common protocol for the voluntary collection of data on marine litters, in agreements with the requirements of the MSFD. It will enable to organize the collection of data on regular basis and provide assessments at the basin scale. To date 1280 sampling stations are considered, on irregular basis for some, covering mainly but not only the European coats with a strong potential to an extension to the wider basin. As an example, the figure is giving results from the gulf of lion where monitoring was started in 1994 enabling consistent evaluation of trends. The analysis of results demonstrated the absence of change for plastics quantities during the period.

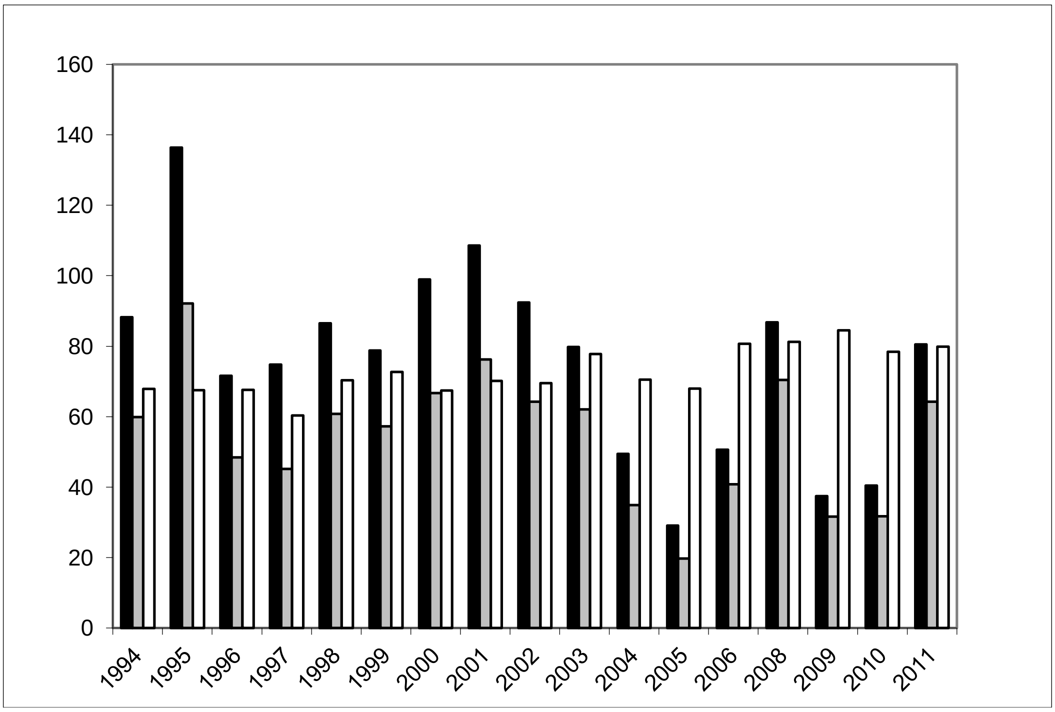


Figure xx: *Evolution of seabed litter densities in the gulf of Lion (, France) between 1994 and 2011. Data was collected from MEDITS cruises and expressed as Total Items/km2 (black), Plastic items/ km2 (Grey) and percentage of plastic (White). (http://www.sibm.it/SITO%20MEDITS/principaleprogramme.htm)*

There is no Monitoring of impact in the Mediterranean Sea but good scientific and technical basis to start it. The loggerhead turtle, classified worldwide as “endangered” (IUCN, 2013), is adopted worldwide as bio-indicator of environmental conditions as the pollution contamination. The use of sea turtles for monitoring ingested litter in the Mediterranean Sea was first suggested in 2010 by MSFD task group (*Galgani et al.*, 2010) after many years of research. Protocols were implemented (Matiddi *et al.*, 2011; Galgani *et al.*, 2013) providing support to monitoring.

Its extended spatial distribution in the Mediterranean Sea (Casale and Margaritoulis, 2010, Oliver, 2014; Darmon *et al.*, 2014), and the regular occurrence of anthropogenic waste in the stomach contents (Tomas *et al.*, 2002; Lazar and Gracan 2011; De Lucia *et al.*, 2012; Bentivegna *et al.*, 2013; Travaglini *et al.*, 2013; Camedda *et al.* 2013 and 2014) are interesting criteria for the use of this species as assessment and monitoring tool for marine litter in biota. Monitoring remains to be implemented and will need reinforced coordination, capacity building, quality assurance and harmonization.

There is a potential for using litter Ingested by other species as indicator of harm. In the North Sea, an indicator using fulmar to assess temporal trends of ingested litter is available (OSPAR EcoQO, Van Franeker *et al.*, 2011). However alternative species for the Mediterranean Sea, such as shearwaters have limited distribution indicating local interest only. Other species, such as fish with higher incidence of ingested debris (Boops sp. for example, Deudero *et al.*, 2014), Crustacea (Nephrops nephrops, Murray and Cowie, 2011), echinoderms or mollusks, may also be considered as target species for microplastics but need more research to justify a standard for monitoring recommendation at this point, as information is fragmented and incidence is generally low.

the known incidence of ingested plastic is too low in mammals, in the percent range, to use this group for ingestion monitoring, or it concerns species that occur in too low frequencies in the Mediterranean sea (Cuvier´s beaked whales, MacLeod, 2009; Sperm Whales, Jacobsen *et al.*, 2010) to be used in a monitoring system. Studies of litter in stomach contents of marine mammals are then certainly recommended, also from the viewpoint of knowledge of harm, but not as a monitoring tool.

Baselines and targets in the context of monitoring

There is currently no accepted Mediterranean or sub regional baseline against which to measure progress. Due to the poor differences between the Mediterranean sub regions in terms of litter densities, the unequal spread of available data-sets, and because some countries belong to two or more sub regions (Italy, Greece), it was recommended recently (UNEP/MAP/CORMON, 2015) that common baselines for the various litter indicators (beaches, sea surface, sea floor, microplastics, ingested litter) must be considered at the level of the entire basin (Mediterranean Sea) rather than at the sub regional level (Table 4.2a).

Table 4.2a: Proposed baselines for monitoring marine litter in the Mediterranean Sea (UNEP /MAP/CORMON, 2015)

Indicator	minimum value	maximum value	mean value	Proposed baseline
16. beaches (items/100 m)	11	3600	920	450-1400
17. Floating litter(items/km2)	0	195	3.9	3-5
17. sea floor(items/km2)	0	7700	179	130-230
17 Microplastics (items/km2)	0	892000	115000	80000-130000
18 (Sea Turtles)				
Affected turtles (%)	14%	92.5%	45.9%	40-60%
Ingested litter(g)	0	14	1.37	1-3

The amount of existing information may be limited set definitive baselines that may be adjusted after monitoring programmes could provide additional data. Considering that some of the litter found in the Mediterranean should be generated in other seas, it is quite important to harmonize as far as possible the monitoring programmes with other Regional Seas Conventions (e.g. OSPAR). Each Region should then adapt a common master list including the more frequent items in order to produce harmonized shorter lists, also more useful and practical for the field work.

Environmental targets are qualitative or quantitative statement on the desired condition of the different components of marine Mediterranean waters. They are important for management as they will enable to (i) link the aim of achieving objectives such as Good Environmental Status (GES) to the measures and effort needed, (ii) measure progress towards achieving the objective by means of associated indicator(s), (iii) assess the success or failure of measures to prevent marine litter from entering the seas and to support management and stakeholder awareness (Interwies *et al.*, 2013).

The definition of targets is a political choice that can be based on levels of acceptance and levels of ambition in the transition towards a good environmental status in the marine environment. As discussed during the conference of Berlin (2013, http://www.marine-litter-conference-berlin.info/) target setting undergoes an iterative process, starting from a conceptual understanding of the desired condition and the change that is required to achieve it. Broad based targets (maintain level of Marine litter, reduce the amount of litter at sea, etc.) and "trend-based" targets (e.g. reduce the amount of litter transported by rivers, decrease the number of visible litter items on beaches) are possible options. Typically broad targets will have many advantages such as a common concern enabling harmonized actions, political commitment, coordinated actions and cooperation. Another approach would be to provide some flexibility in the extent of reductions towards a common goal. For example, for a target to reduce the amount of litter per square meter of beach, contracting parties and possibly Regional Seas might have different quantitative goals. This could reflect their different starting points on this.

Our current lack of knowledge with regards to metrics to be used is such that absolute targets are difficult to set; as a result, many Contracting Parties are formulating trend targets instead. The design of most protocols enables regional adaptation and the discrimination of litter items; they are therefore likely to detect changes in litter types and enable a proper assessment of the various measures implemented. Interwies *et al.*, 2013) provided an overview of potential aspects to set targets on marine litter. They may consider (i) Location (Beachs, floating, estuaries, marine life, etc.), (ii) Composition or types (Plastic bags, cigarette bugs, microparticles, sanitary wastes, etc.), (iii) Sources an pathways (Rivers, ship-based litter, landfills, etc.), (iv) Sectors (Fisheries, recreation, industrial pellets, etc.), and (v) Measures (Reduce urban waste production, Improved waste collection of land-based sources/sectors, Improved collection of ship-based waste in the port reception facilities, Improved waste water treatment, reduce consumer littering, Inspection at sea, etc.). These kinds of knowledge gaps lead to problems when trying to determine the relative importance of different sources and pathways globally and regionally, which are important for devising management strategies and tactics. Subsequently they lead to difficulties in setting quantitative targets on marine litter at any level, whether global, regional or by sector.

It may be possible to circumvent some of these issues by using trend targets and 'operational' measures. In December 2013, the Contracting Parties of the Barcelona Convention adopted the Regional Action Plan on Marine Litter Management in the Mediterranean. The plan defined only general objectives which are (i) The prevention an reduction to the minimum marine litter pollution in the Mediterranean and its impact on ecosystem services, habitats, species in particular the endangered species, public health and safety, (ii) The removal to the extent possible already existent marine litter by using environmentally respectful methods, (iii) A better knowledge on marine litter, and (iv) A management in accordance with accepted international standards and approaches and in harmony with programmes and measures applied in other seas.

The Mediterranean Action Plan describes also some strategic, operational objectives and lists a series of prevention and remediation measures that should be considered and implemented by the actors. The establishment of both "state" and "pressure" complementary targets can then better reflect and support the effectiveness of specific operational objectives.

It is clear that there is more data on beach debris than for debris in the water column, even though there is not so much information available in Mediterranean marine waters to set quantitative thresholds related to the reduction of marine litter stranded on beaches.

Quantitative reduction targets for beach/floating/ seabed litter and microplastics should nevertheless be considered. In this respect, higher targets will be easier to determine through monitoring than if weak targets had been set as It may not be technically possible, or at higher cost, to measure a slight (few %) change that could just reflect a "background noise". Moreover, an apparent failure to achieve a modest target may be cited by some as evidence that more ambitious targets are not feasible, and should not be pursued (CMS 2014).

There is quite a wide diversity of targets that may be defined by Mediterranean countries, in terms of nature, ambition and measurability, even between neighboring countries. Most countries involved in reduction plans have defined targets as a reduction in the overall amount of litter present in the marine environment or in any of its compartments (coast, seafloor, water column) or biota. Within the context of various management schemes, reviewed by Arcadis (2014) some contracting parties have proposed various targets such as (i) Reduction of litter from beaches based on a five year moving average, (ii) Negative annual trend in beach litter, (iii) Reduction in litter on sea surface, water column and seabed, (iv) Reduction towards zero over the longterm of harmful litter, (v) Entanglement and strangulation reduced towards a minimum, (vi) Less than X% of sea turtles having more than Xg of plastic in their stomachs, (vii) Various targets regarding better waste collection in coastal regions, (viii) Reduced inflow from rivers and sewers, and (ix) Targets dedicated to education, as related to changes in behaviour (littering, etc.).

In the Mediterranean, France opted for a "Significantly reduce the amount of waste in the marine environment" for instance when Spain established targets regarding the special category of marine litter originating from fisheries on both beaches and the sea floor. With regards to the implementation of actions, Italy and Spain, for example, are supporting respectively "an increasing effort in collecting waste on the sea-bed" and "the Improvement of knowledge on the characteristics and impacts of marine litter, including their origin and dispersion". Concerning time frames, few countries are considering deadlines, such as Achievement by 2020 (Spain), Reduction or no increase in marine litter originating from fisheries in relation to the reference levels established in 2012 (Spain), Reduction of waste in coast, water column and seafloor between 2012 and 2020 (Slovenia) and reduction of Microplastics beyond the levels of 2011/2012 (Slovenia).

Where Contracting parties are hesitant about establishing quantitative state targets, pressure/operational-oriented targets can complement their efforts, as they refer to human processes and activities which are easier to monitor and influence. Formulating a sub-set of targets for specific sources of marine litter (e.g. litter generated by fisheries) or even particular types of items (e.g. reduce the average occurrence of the top identifiable items found on reference beaches) should facilitate breaking down such a complex issue into more quantifiable and complementary elements. Most actors may use beach litter as an indicator to assess the reduction of marine litter or directly relate beach litter to a target formulated. This is quite positive, as it reflects the intention to implement beach litter monitoring programmes widely in the Mediterranean. If done in line with a common protocol, it will constitute a cost-effective methodology and a critical step towards a harmonized and comparable monitoring approach across the region. Further specification and harmonization are now needed in terms of how trends and reductions are to be determined (time scales for example) and have comparable reference periods. This may enable comparability and for this reason, other countries should be encouraged to consider beach litter as a common indicator to be adopted.

The setting of marine debris targets will encourage the implementation of monitoring programmes and different types of targets are relevant to different types of information gaps (at-sea targets for improving the state of information about abundance, operational targets such as estuarine monitoring for improving information on pathway, source and regional differences). However, due to a large set of factors affecting the quantities and distribution of marine litter in a certain area, it can be very challenging to detect clear reduction trends in the sea that can be associated to the implementation of measures in a particular area.

A proposal of a headline reduction target for marine litter on beaches was proposed by Arcadis (2014), based on (i) the targets already in use at the level of Europe, Contracting Parties or UNEP/regional seas, (ii) the expectations of the general public and the stakeholders concerning an effective marine litter policy, (iii) the analyzed occurrence of key marine litter types, loopholes and pathways retrieved from 343 recent beach screenings in the four European regional seas, (iv) the modelled impact on marine litter of the different policy options, and (v) the assessed impact on marine litter that dedicated policy measures for specific litter items could have.

In September 2014, an aspirational target of reducing marine litter by 30 % by 2020 compared to 2015, for the ten most common types of litter found on beaches, as well as for fishing gear found at sea, with the list adapted to each of the four EU regions (EU communication 2014/398). As stated by Arcadis (2014) for European regional seas, measures targeting cigarette butts have resulted in reductions of total number of beach litter items of up to 18%, reductions in plastic carrier bags of up to 13%, bottle caps up to 7%, cotton buds up to 2% and deposit refund systems for beverage packaging up to 12%, depending on the specificities of the regional sea concerned. The level of ambition of the proposed target remains high as depending on the litter management policies from Contracting Parties and may not fit for indicator EI 17. Floating litter may be transported from one country/ sub basin to another, and sea bed litter is accumulating for long period, with low degradation rates. Moreover, sources of microplastics cannot be distinguished by uses, etc., and it will be difficult to relate targets with measures. With regards to the coordinated monitoring strategy in the Mediterranean sea and technical or scientific considerations, Accessible targets were proposed by Medpol (Unep/map/Cormon, 2015 and Table 4.2b) considering baselines that may be optimized after 2015 first results from monitoring. Targets may focus on the total amount of marine litter first with some specific targets on individual items when impacts of reduction measures can be evaluated. For floating and sea floor litter, a significant decrease will enable to overcome the constraints of diffuses and uncontrolled sources (Tran boundary movements, influence of currents) and permanent accumulation processes on sea floor. Ingested litter in sea turtles will then focus on the number of affected animals and the amount of ingested debris by number or weight.

Table 4.2b: Operational targets for the Mediterranean Sea as proposed within the Unep/MAP Marine Litter Regional Action Plan (Unep/map/Cormon, 2015)

ECAP INDICATORS	TYPE OF TARGET	MINIMUM	MAXIMUM	RECOMMENDATION	REMARK
BEACHES (EI16)	% decrease	significant	30	20% by 2025 or 2030	Not 100% marine pollution
FLOATING LITTER (EI 17)	% decrease	-	-	Statistically Significant	sources are difficult to control (trans border movements)
SEA FLOOR LITTER (EI 17)	% decrease	stable	10% in 5 years	Statistically Significant	15% in 15 years is possible
MICROPLASTICS (EI 17)	% decrease	-	-	Statistically Significant	sources are difficult to control (trans border movements)
INGESTED LITTER (EI 18)					Movements of litter and Animals to be considered
Number of turtles with ingested litter (%)	% decrease in the rate of affected animals	-	-	Statistically Significant	
Amount of ingested litter	% decrease in quantity of ingested weight(g)	-	-	Statistically Significant	

Management and reduction Measures

The prevention of marine litter necessitates the inclusion of a vast amount of activities, sectors and sources that cannot be addressed by a single measure. In its report, the berlin conference (http://www.marine-litter-conference-berlin.info/), the following guiding principles provided an umbrella structure which serves as a framework in guiding any of the following marine litter measures:
- The principle of prevention establishes that any marine pollution measure should primarily aim at addressing the prevention at the source as removal of already introduced waste is very costly and labour intensive, especially compared with prevention measures,
- The polluter-pays-principle has a preventive function in that externalities from polluting activities should be borne by the polluter causing it. The application of this principle is however limited by the difficulty in determining the polluter and also the extent of (environmental) damage.
- The precautionary principle is based on the understanding that measures must not be postponed in the light of scientific uncertainties. It plays an important role in setting targets and addressing the issue of micro-particles, despite an incomplete scientific knowledge on the specific sources and consequences of marine litter.
- The ecosystem-based approach as an approach to ensure that the collective pressures of human activities
- The principle of public participation, an important aspect in creating awareness for the problem of marine litter
- The principle of integration, meaning that environmental considerations should be included in economic development. This principle constitutes a key element of the Protocol on Integrated Coastal Zone Management in the Mediterranean.

Implementing measures to reduce Marine litter is a real challenge as most sources are diffuse disabling any control and management. Then, measures and actions taken should respond to the major sources and input pathways, but also consider the Feasibility and the consideration of specificity of this pollution in the Mediterranean Sea. The main groups of items found on beaches in the Mediterranean are sanitary items (mostly cotton bud sticks), cigarette butts and cigar tips, as well as packaging items and bottles, all related to coastal-based tourism and recreation. This indicate direct disposal, intentionally or through neglect, on the beaches or inland (river banks, dumpsites, etc.) as the main input pathways. The fishing and shipping industries are also considered major sources of marine litter. In the Mediterranean Sea, the following measures were seen to be most effective in tackling the problem (Table5.3a)

Table 5.3a: Main measures for the reduction of Litter in the Mediterranean Sea (after the Mediterranean expert meeting held during the Berlin Conference (2013, http://www.marine-litter-conference-berlin.info/)

TYPES	MEASURES
Sea based litter	Port reception facilities; No-special-fee system (also for marinas); Fishing for Litter; Removal of Abandoned & Lost & Discarded Fishing Gear.
Land-based litter	The inclusion of Marine litter as an integrated part of municipal solid waste management; An Improved waste management, including the ban on illegal dumping, especially in tourism hotspots; The Upgrade, redesign and improved maintenance of sewage system, including the storage of wastewater; The establishment of "Guidelines for Management of Coastal Litter"); The transfer of skills/knowledge to Mediterranean countries in the South and East; Education and outreach on marine litter impacts; Incentives/disincentives for littering; Ban smoking on beaches and the Introduction of dissuasive taxes (plastic bags or/ as «tourist tax", etc.)
Clean-up measures	Compulsory cleaning of inland pathways (rivers, near landfills etc.), beach cleaning by local communities and/or private companies (i.e. of the tourism sector); Incentives for beach cleaning (e.g. awards, like the "Blue flag award").
Production	Smart production (Ban on single-use plastic bags, packaging guidelines, Elimination of certain products (microbeads), use of paper/carton made cotton swabs, extended producer responsibility measures and voluntary agreements with plastic industry for return and restoration integrated management systems
Knowledge and data	Standard monitoring programme(s) that consistently describe the litter, their

	sources an quantities; information sharing around the Mediterranean,

In comparison, a meeting of stakeholders held in the Mediterranean within the European project Marlisco (Poitou and Poulain, 2015) concluded that the most promising measures in terms of reduction of marine litter were (i) a great national cause with an action plan, (ii) deposit system for bottles, (iii) Public awareness at the national level, (iv) Collection and processing of Marine Litter at sea by fishermen, (v) the development of litter collection in rain sewer, (vi) Optimize waste collection system,(vii) the reduction of waste at source, and (viii) A tax for plastic producers

Focus should also be directed on management strategies that deal with debris known to be of high impact on marine species – such as fishing gear, soft plastic and microplastic fragments. The numbers we do have on debris abundance also suggest that prevention must be addressed before removal can be effective.

Fishing for Litter is as one of the most important measures that would lead to the reduction and removal of marine litter from sea. It is one of the most successful concepts by involving one of the key stakeholders, the fishing industry. The initiative not only involves the direct removal of litter from the sea, but also raises awareness of the problem inside the industry as a whole. All types of marine litter are targeted depending on the gear type used. Most amounts are from seafloor litter collected with bottom-contacting gear. Filled bags are deposited on the quayside where the participating harbours monitor the waste before moving the bag to a dedicated skip for disposal. This reduces the volume of debris washing up on our beaches and also reduces the amount of time fishermen spend untangling their nets. The objectives and aims of the scheme can gain the support of the fishing industry, port authorities and local authorities. Furthermore, it can contribute to changing practices and culture within the fishing sector, provide a mechanism to remove marine litter from the sea and seabed, and raise awareness among the fishing industry, other sectors and the general public. Fishermen are usually not financially compensated for their engagement, just the disposal logistics are for free. The best environmental practices and techniques should be used for this purpose due to the fact that such interventions may also have a very negative impact on marine environment and ecosystems. (Mouat *et al.*, 2010) suggested that the health and safety aspects of implementing these types of initiatives would be the same as normal fishing activities (operations) and therefore there would likely not be any additional implications with regard to hazardous and other substances that might be caught in trawls and collected on board vessels. Moreover, the experience of Fishing for Litter projects in the North Sea developing since 2000 indicates that there have been no instances of accidents or injuries directly related to the collection, storage or transfer to shore of marine litter collected as part of these projects.

Fishing for litter projects are recent in the Mediterranean Sea where four main projects are being developed currently (Zorzo Gallego,2015), including (i) *Contrats Bleus, started in 2008* (3 french mediterranean harbors, with financial compensation and best practices), (ii) Ecological bags on board (38 vessel Spanish East Coast collecting floating and seabed litter), *Ecopuertos* (Andalusian Coast, Spain, 5 trawlers collecting sea bed litter) and DeFishGear with seven participating Adriatic countries during one year and targeting seabed litter and fishing gear (http://www.defishgear.net)**.** Although voluntary participation of fishermen in the projects, costs such as waste management, mainly litter collection at harbour and litter disposal, and coordination and data recording works need to be not covered by fishermen. Further implementation is actually considered within the Mediterranean Regional Action Plan, developing best practice adapted to the context of the basin (Zorzo Gallego, 2015).

Given the complexities of environmental problems and the impact of environmental policies on social and economic activities, specific environmental problems are usually addressed by employing a “policy mix” consisting of various command and control instruments, economic instruments, and persuasive instruments. Using economic instruments alone usually is not the ideal and only solution. Regulation or voluntary agreements may also be appropriate where there are a limited number of polluters, therefore the costs of setting up a scheme based on an economic instrument may outweigh the benefits (http://www.unep.org/regionalseas/marinelitter/other/economics/default.asp).

Oosterhuis *et al.* (2014) analysed the Economic instruments to reduce marine litter. Poor waste management, limited awareness of the public and inadequate interventions from industry and policy-makers are the main causes of the presence of litter at Sea. There is very sparse information about the links between the amount of overall polluting material (e.g. plastic bags) and the extent to which this becomes marine litter (e.g. plastic in the sea). There are, though, a few studies that have attempted to attribute marine litter to particular sectors and economic activities. In the Mediterranean, recreational and beach-related tourism activities account for a large part of all litter found on the beach while the shipping industry contributes another and sewage related debris for a minor part (see paragraph 2.1.1). The cost of cleaning marine litter can be significant with municipalities spending millions of euros each year removing beach litter. Marine litter also impacts negatively on the fishing industry causing a decrease of total revenue in the few percent range. As a result of the complexities caused by the diverse origin of marine litter, a wide range of instruments have been proposed to deal with it across multiple sectors. Some of them are regulatory policy instruments which focus on adopting relevant legislation to help minimise marine litter, such as the EU Directive 2000/59/EC on port reception facilities for ship-generated waste and cargo residues). Other instruments, economic in nature, attempt to influence the amount of marine litter through taxes, charges, or subsidies.

There is no market to determine the desired level of marine litter and any transaction costs would render them prohibitively expensive as a result of time-consuming procedures involving large number of individuals and firms. Policy instruments to limit marine litter include direct regulation of activities that contribute to marine litter by legislation (increase of standards for port facilities, ban of plastics bags, etc.) or economic instruments that provide (dis)incentives that allow firms and individuals greater flexibility in their approach to pollution management.

Command-and-control measures may be preferred when there is an urgent need but economists argue that economic instruments are more cost efficient as means to reduce marine litter. Moreover, economic instruments can stimulate gradual changes in the behaviour of users by allowing environmental costs or benefits to be internalised into the prices of products or activities that reduce litter (Lanoie *et al.*, 2011, cited by Oosterhuis *et al.*, 2014).

Effectiveness is key determining factor for economic instruments. The cost of implementation is another important factor that influences which instrument to opt for and it focuses on how to allocate scarce resources (e.g. public funds) to meet a certain environmental objective. This is the case of the cost of ghost gears.

There is a wide range of economic instruments that can make use of either positive or negative financial incentives in order to tackle the marine litter problem: Financial disincentives (penalties, taxes and charges) are applied to discourage behaviour that may contribute to the problem of marine litter. Charges and taxes can be seen as price tags on economic activities and may be collected on consumptive or productive activity that contributes to marine litter. Financial penalties however do not recognise a “pollute and pay”. The challenge for policymakers is then to set taxes and penalties at an appropriate level in order to enable certain targets of marine litter reduction to be met.

Financial incentives (deposit-refund schemes, subsidies, direct payments, price differentiation, and preferential treatments) are applied to stimulate behaviour in the form of encouraging recycling and reuse of materials and proper waste disposal. Subsidies and fiscal incentives are remunerations (Engel *et al.*, 2008) and deposit-refund schemes reward those consumers who return packaging material. Price differentiation can be used to encourage consumers to choose products and services that lead to less environmental damage. Preferential treatment is often a government-supported scheme that positively discriminates in favour of firms that are more environmentally friendly. Economic instruments that have been identified in the literature as a means to reduce marine litter are more or less Effectives (Table 5.3b).

Table 5.3b: Effectiveness of economic instruments to reduce marine litter as evaluated from real experiments/situations worldwide (after Oosterhuis *et al.*, 2014).

ECONOMIC INSTRUMENT	TYPE OF LITTER	EFFECTIVENESS	COSTS	REMARKS
Penalties	General	Limited if weak political support, conditional on the ability to identify the polluter	high	
Taxes on tourists	General	high in areas where tourism is prominent activity but may be Limited by opposition with the tourism sector and inadequate infrastructures	high	loss of competitiveness, less tourist arrivals
Taxes	plastic bags	High (reduction in plastic bag use by 90% in Ireland since 2002), effective for limiting the demand but less for recycling	low	possible losses of jobs in plastic industry
Deposit refund schemes	General	more effective than environmental but may be limited by corruption in some countries and	high	
Deposit refund schemes	bottles	limited by consumer preferences	high except when using containers	higher demand for non-refillable containers, cleaner public areas, job creation

Deposit refund schemes	plastic bottles	limited by consumer demand		
Subsides	general	Conditional to political support	high	
Direct payment awards	general	Conditional to political support, may be limited by local corruption in some countries	high	
Direct payment awards	plastic bags	low		
Direct payment awards	fishing gears, bottles (to fishermen)	high with increased rate of participation	low when compared to litter removal	additional income for fishermen
Price differentiation	plastic bags	Low		

Unfortunately and for the Mediterranean Sea, there is no unique economic instrument and the choice of an appropriate intervention is case specific, largely depending on the source and nature of pollution, the country's institutional characteristics and infrastructure, consumer preferences, perception and habitual behavior and the economy's overall sectorial composition.
From non-Mediterranean experiences, it appears that (i) Taxes and charges can be very successful in reducing their use at a relatively low cost, (ii) The collection of tourist taxes, although there is a high risk these might be used for other purposes can further support waste collection and treatment in coastal areas, (iii) Deposit-and-refund schemes can achieve high return rates in some countries, especially for bottles and cans, but depending on the cost of implementation, and (iv) Rewards for fishing vessels that return waste to shore have been shown to both reduce marine litter as well as complement fishermen's income.

Research Gaps, Knowledges needs and proposals as basis for stting priorities for actions (with consideration to derelict fishinggears)

Both the implementation of the management schemes and improvement of knowledge on marine litter are long term processes. Research and monitoring have become critical for the Mediterranean Sea where not so much information is available. MEDPOL (Unep/MAP, 2013), MSFD (Galgani *et al.*, 2011), the European project STAGES (http://www.stagesproject.eu) and the CIESM (Ciesm, 2014) recently reviewed the gaps and research needs in support to knowledge, monitoring and management of marine litter. This requires scientific cooperation among parties involved, due to complexity of issues ad prior to reduction measures.
Accumulation rates vary widely in the Mediterranean Sea and are subject to factors such as adjacent urban activities, shore and coastal uses, winds, currents, accumulation areas. Additional basic information is still required before a correct global debris assessment can be provided. For this, more valuable and comparable data could be obtained by standardizing our approaches. In terms of distribution and quantities, Identification (size, type, possible impact), evaluation of accumulation areas (closed bays, gyres, canyons, and specific deep sea zones) and sources of litter, including rivers and diffuse inputs are the necessary steps, enabling then the development of GIS and mapping systems to locate hotspots.
An important aspect of litter research to be established is the evaluation of links between hydrodynamic factors. This will give a better understanding of transport dynamics and accumulation zones. Further development and improvement of modelling tools must be considered for the evaluation and identification of both the sources and fate of litter in the marine environment. Comprehensive models should define source regions of interest and accumulation zones and backtrack simulations should be initiated at those locations where monitoring data are collected.
The project STAGES (http://www.stagesproject.eu) stated that a better understanding about rates of degradation of different types of litter (plastics, degradable materials, bio plastics, etc.) and related leachability of pollutants. At present the lower limit of detection for plastic particles is around 1µm. It seems likely that even smaller particles of litter (nanoparticles) may exist, however we need to develop appropriate methodology to quantify these. We also need a better understanding of the potential sink/types and habitat where this material is most likely to accumulate as the knowledge of the accumulation and environmental consequence of microplastic/nanoplastics particles is relatively limited.
Biota indicators provide indications of harm. Pilot-scale monitoring is therefore an important step towards monitoring litter harm in terms of determining baselines and/or adapting the strategy to local areas. A better

understanding of entanglement (lethal or sub lethal) under different environmental conditions and how litter is ingested by marine organisms are key questions. For ingestion of litter by sea turtles, the precise definition of target (GES) and the identification of Parameters/biological constraints and possible bias sources to be considered when defining the good environmental status are the priority research needs. Work on other "sentinel" species (fishes and invertebrates) is also important as it may provide additional protocols supporting the measurement of impacts, especially for microplastics. Finally, the use of new approaches and the development of new metrics to assess entanglement in, or ingestion of Marine Litter may open new perspectives in the context of monitoring.

With regards to the transport of species, many questions remain open and need to be further studied (Katsavenakis, CIESM, 2014). The increase in the probability of translocation of species because of floating litter, the identification of species (including pathogens for both marine organisms and human) in the Mediterranean that settle on marine litter, the nature of constraints for the colonization of floating plastic, which Mediterranean alien or native species colonize floating litter, the identification of Red Sea species enter the Mediterranean via floating litter are key questions to consider for a better understanding of harm.

For monitoring, we often lack the information to determine the optimum sampling strategy and required number of replicates in time and space. This is an even bigger problem for microplastics, for which in addition, there is uncertainty about the optimal sampling scheme. Since the study of microplastics in the Mediterranean Sea is still in an early stage of development, a harmonization of sampling protocols for the water surface is highly recommended. Moreover, the comparability of available data remains highly restricted, especially with respect to different size class categories, sampling procedures, analytical methods and reference values. Actual categorization probably needs to be amended by a further subdivision of the smallest size class of microplastics to include nanoplastics (Van Moos, CIESM 2014).

From the economic/management point of view (Unep, 2011), problem of marine litter has not been successfully addressed in the Mediterranean because of (i) the lack of international legal instruments (except for IMO/MARPOL Annex V) or Global Programmes, (ii) the lack of coordination, (iii) the poor regulatory framework to organize the management of coastal waste (bad practices, poor classification of waste, no monitoring of production, lack of penalties and application of laws) and (iv) the problems that are encountered in the application of economic instruments (inconsistent information, lack of tools, few information on social and economic consequences, need for transparency, isolated awareness and educational campaigns).

Evaluation of direct costs and loss of income to tourism and fishery (incomes and stock losses, including protected/endangered species), Evaluation of costs due to clogging of rivers, coastal power plant cooling systems and/or wastewater purification systems, effectiveness of market based instruments related to marine litter, the development of common methodologies to evaluate the costs of removal (collection and elimination of marine litter) are key questions.

Aside the implementation of the ECAP/MEDPOL regional plan on Marine Liter and with a necessity to be integrated within the development of national and local strategies, the support of a better management through, (i) the development of common methodologies to collect social and economic data, (ii) Assessment of socially acceptable levels of marine litter to the public and industry, (iii) the development of social and economic impact indicators (aesthetic impact, effects on fishing industry/maritime sector and human health), and finally the Education of public (tourists, fishermen, general public) has now become critical. A prerequisite to these the consideration of laws with an harmonization of national Mediterranean systems (jurisdictional measures and institutional structures) with conventions to support management schemes dedicated to marine litter.

In terms of measures, the development of tools to assess the effectiveness of monitoring, measures intended to reduce the amount of marine litter and/or effectiveness programmes educational and sensibilisation on cleanliness, the development of port reception facilities taking into consideration the Mediterranean maritime traffic, the consideration /elimination of transborder marine litter, including the intervention in case of critical situation (Example of the Concordia) are the main priorities dedicated to the management of marine waters that have to complement management measures to reduces inputs

Derelict fishing gears

Knowledge about the extent of ghost fishing is still very limited due to the costs and practical difficulties of underwater survey work and partial knowledge about amount losses. There are actually no overall estimates of the extent of the problem for the Mediterranean as a whole. Research will have then first to assess the presence of DFG in fishing areas and on fishing grounds including deep water fisheries especially in areas where there is no information (Eastern and southern Mediterranean Sea). Evaluating the interest of retrieval for each area/sub-region is also an important point before going on "cleaning". Finally, there are also research gaps on the environmental impacts of ghost gear, including the impacts of management responses, notably gear retrieval

programmes. Research on economy and costs of gear loss and ghost fishing, or on the relative costs and benefits of different management responses will also be a necessary step before effective reduction measures.
Macfayden (Unep 2009) identified more specific gaps. They include rates of gear losses, ghost fishing mortality, measures of the extent to which entanglement occurs or affects species at the population level, incidence and aesthetic impact of ghost fishing nets as a source of marine litter, the ultimate fate and impact of lost gear (particulate matter), the impact, feasibility and costs/benefits of different management measures, tailored to particular fisheries, the economic valuation of net loss and ghost fishing impacts, the environmental impacts of management responses, the specification of Codes of Practice for minimising gear loss in particular fisheries; and some technical issues related to different management measures (marking of gear, new materials).
Outputs from European projects also provided key messages and questions such as the extent to which lost nets continue to catch fish, the importance of studies in those fisheries for which there is virtually no information, the estimation of total ghost fishing catches in the basin, the assessment of the different types of environmental impacts of ghost fishing and management responses and the collection of data on ghost fishing and management responses.
Appropriate management responses are likely to be variable for different fisheries, as are the research gaps, but prevention based on Codes of Practices and improved communication between active and passive gear users is almost certainly better than retrieval programmes.

In conclusion, marine litter in the Mediterranean has become a critical issue. Les mesures de gestion et de reduction sont encore a developer et a coordonner. Cependant un certain nombre de points doivent etre encore abordés afn de mieux connaitre le problem. Un certain nombre de questions essentielles devront etre prises en compte afin de donner des bases scientifiques et techniques consistantes a la surveillance en vue d'une meilleure gestion et de science based reduction measures. Les actions suivantes paraissent les plus pertinentes pour un avenir proche with a list of actions and research to be initiated in order to improve basic knowledge and to support monitoring and management:

1) Develop a basin scale model with consideration to sources (rivers, cities, maritime routes, tourism, fishing, etc.) in order to follow the transport of marine litter.

2) Map the hot spots (accumulation areas, areas at risk) of marine litter (beaches, floating, sea bed, impact of litter) at the basin scale.

3) Determine the sinks for marine litter (budgets, fluxes, etc.) and better understand degradation

4) Define a GIS platform to support the integration and the analysis of all monitoring data

5) Develop an ecological Quality Objective (ECOQ) for ingestion of litter in indicator species suitable for monitoring (sea turtles) and support implementation of the monitoring of this indicator (capacity building, technology transfer).

6) List (Inventory of) species (also biofilms) settled on litter in the MED, with consideration to the development of standardised protocols and the assessment of species at risk (pathogens, toxic species, etc.)

7) Develop of a database on rafted species to better explain the risk of dispersion and the possible colonisation of new areas. Favour a Better understanding of the ecology of microorganisms living on/with litter, their role in the degradation of microplastics, identification of species involved and populations/assemblages in coastal waters, and finally developing strategies, methods and standards

8) Evaluate the distribution and changes of microplastics, from beaches to the seafloor/ deep seafloor. Quantify ingested microplastics in key species, from coastal epipelagic to demersal species

9) Support the rationalisation of monitoring (common and comparable monitoring approaches (standards/baselines; inter calibration, data management system and analysis / quality insurance). This must include the definition of specific baselines and targets for important litter categories that may individually targeted by reduction plans or measures by the Mediterranean countries (cigarette butts, plastic bags, cotton buds, etc.)

10) Identify new indicator species for impact (entanglement, ingestion, microplastics, and rafted species) through laboratory and field evaluation, and definition of thresholds for harm.

11) Evaluate the quantity and localization of lost fishing gears

12) Evaluate the potential loss of fish stocks due to main types abandoned / lost fishing gears

13) Favor the integration and cooperation among the various sectorial branches of the administration (fisheries, tourism, environment, industry, port activities etc.).

14) Harmonize clean ups to favor a common science based protocol that enable to collect relevant scientific information

15) Ensure the involvement and cooperation of administrative stakeholders at different levels and regional/national scales

References

Achite M., S.Ouillon (2007) Suspended sediment transport in a semiarid watershed, Wadi Abd, Algeria (1973–1995). J. Hydrol. 343, 187–202.

Alampei I., Malotidi V., Vlachogianni T., M.Scoullos (2014) Feel Act! To Stop Marine Litter: Lesson plans and activities for middle school learners. MIO-ECSDE, 2014 (http://mio-ecsde.org/project/alampei-i-malotidi-v-vlachogianni-th-scoullos-m-know-feel-act-to-stop-marine-litter-lesson-plans-and-activities-for-middle-school-learners-mio-ecsde-2014/).

Aliani S., Griffa A., A.Molcard (2003) Floating debris in the Ligurian Sea, north-western Mediterranean, Marine Bulletin, 46, 1142-1149.

Alkalay R., Pasternak G., Zask A., A. Ran (2007) “Israel’s ‘Clean Coast’ Programme successfully tailors solution to Marine Litter Problem”, in *the INECE Newsletter*, issue 14, April 2007

Alon A., Brenner O., Scheinin A., Morick D., Ratner E., Goffman O., D. Kerem (2009) Laryngeal Snaring by Ingested Fishing Net in a Common Bottlenose Dolphin (Tursiops truncatus) Off the Israeli Shoreline. Journal of Wildlife Diseases: July 2009, Vol. 45, No. 3, pp. 834-838. Doi: http://dx.doi.org/10.7589/0090-3558-45.3.834

Amaral-Zettler L. , Zettler E., T.Mincer (2011) The Microbial Community on Marine Plastic Debris: Life in the "Plastisphere". American Geophysical Union, Fall Meeting 2011, abstract #B51I-0536.

Anastasopoulou G, Mytilineou C., C. Smith, K. Papadopoulou (2012) Plastic debris ingested by deep-water fish of the Ionian Sea (Eastern Mediterranean). Deep Sea Research I, http://dx.doi.org/10.1016/j.dsr.2012.12.008

Andrady A. (2011) Micro plastics in the Marine Environment. Mar. Pollut. Bull. 2011, 62 (8), 1596-1605.

Angiolillo M., Lorenzo B., A. Farcomeni, Bo M., Bavestrello G., Santangelo G., Cau A., Mastascusa V., Sacco F., S. Canese (2015) Distribution and assessment of marine debris in the deep Tyrrhenian Sea (NW Mediterranean Sea, Italy). Marine Pollution Bulletin, in press.

Anonymous (2012) Marine litter issues, impact and actions. Report from from the Scottish ministry of environment. ISBN: 9781782560821, 14 pages. Available at http://www.scotland.gov.uk/Publications/2012/09/6461

Arcadis (2014) Marine litter study to support the establishment of an initial headline reduction target-SFRA0025? European commission / DG ENV, project number BE0113.000668, 127 pages.

Arthur C., Murphy P., Opfer S., C.Morishige (2011) Bringing together the marine debris community using "ships of opportunity" and a Federal marine debris information clearinghouse. In: Technical Proceedings of the Fifth International Marine Debris Conference. March 20–25, 2009. NOAA Technical Memorandum NOS-OR&R-38. p 449-4532)

Ayaz A., Acarli D., Altinagac U., Ozekinci U., Kara A., O.Ozen (2006) Ghost fishing by monofilament and multifilament gillnets in Izmir Bay, Turkey. Fisheries Research 79 (2006) 267–271

Ayaz A., Ünal V., Acarli D., U. Altinagac (2010) Fishing gear losses in the Gökova Special Environmental Protection Area (SEPA), eastern Mediterranean, Turkey. J. appl. Ichthyol. 26: 416-419.

Bajt O., Szwek K., Horvat P., Pengal P., M. Gregg (2015) Microplastics in sediments and fish of the gulf of Trieste. MICRO 2015. Seminar of the Defishgear projct, Abstract book, Piran 4-6 may 2015, p 53

Bakir A., Rowland S.J., R.C.Thompson (2014) Enhanced desorption of persistent organic pollutants from microplastics under simulated physiological conditions, Environmental Pollution, 185, 16-23

Barnes D.K., Galgani F., Thompson R.C., M.Barlaz (2009) Accumulation and fragmentation of plastic debris in global environments. Philosophical Transactions of the Royal Society B 364, 1985–1998. doi:10.1098/rstb.2008.0205

Barnes D., Walters A., L. Gonçalves (2010) Macroplastics at sea around Antarctica, Marine Environmental Research 70 (2010) 250-252

Barnes RL.(2011) Regulating the disposal cigarette butts as toxic hazardous waste. Tobacco control 20:i45-i48. 2011.

Bartol S., J.Musick (2003) Sensory biology of sea turtles. In: Lutz, P.L., Musick, J.A., Wyneken, J. (Eds.), The Biology of Sea Turtles, vol. 2CRC Press, Boca Raton, FL, pp. 79-102.

Baulch S., C.Perry (2014) Evaluating the impacts of marine debris on cetaceans. Mar Pollut Bull., 80 (1-2):210-21. doi: 10.1016/j.marpolbul.2013.12.050. Epub 2014 Feb 11.

Bearzi G. (2002) Interactions between cetacean and fisheries in the Mediterranean Sea. In: G. Notarbartolo di Sciara (Ed.), Cetaceans of the Mediterranean and Black Seas: state of knowledge and conservation strategies. A report to the ACCOBAMS Secretariat, Monaco, February 2002. Section 9, 20 p.

Benhardouze, W., Tiwari, M., Aksissou, M., M.Godfrey (2012). Diet of loggerheads stranded along the Mediterranean coast of Morocco. In Bradai, M. N., Casale, P. (Eds) Proceedings of the Third Mediterranean Conference on Marine Turtles, Barcelona Convention - Bern convention - Bonn Convention (CMS). Tunis, Tunisia, pp. 33.

Bentivegna, F. (2002) Intra-Mediterranean migrations of loggerhead sea turtles (*Caretta caretta*) monitored by satellite telemetry. Mar. Biol. 141, 795-800.

Bentivegna F., Valentino F., Falco P., Zambianchi E., S.Hochscheid (2007) The relationship between loggerhead turtle (*Caretta caretta*) movement patterns and Mediterranean currents. Mar. Biol. 151, 1605-1614.

Bentivegna, F., S.Hochscheid (2011) Satellite tracking of marine turtles in the Mediterranean. Current knowledge and conservation implications. UNEP (DEPI)/MED WG. 359/inf.8 Rev.1. UNEP/RAC/SPA- Tunis, pp. 19.

Bentivegna F., Travaglini A., Matiddi M., Baini M., Camedda A., De Lucia A., Fossi M. C., Giannetti M., Mancusi C., Marchiori E., Poppi L., Serena F., L.Alcaro (2013) First data on ingestion of marine litter by loggerhead sea turtles, Caretta caretta, in Italian waters (Mediterranean sea).Proceedings of the Biology and ecotoxicology of large marine vertebrates and sea birds: potential sentinels of Good Environmental Status of marine environment, implication on European Marine Strategy Framework Directive. 5-6 June, Siena.

Bergmann M., M.Klages (2012) Increase of litter at the Arctic deep-sea observatory HAUSGARTEN. *Marine Pollution Bulletin* 64, 2734-2741.http://dx.doi.org/10.1016/j.marpolbul.2012.09.018

Bjorndal K.A., Bolten A.B., C.Lagueux (1994) Ingestion of marine debris by juvenile sea turtles in coastal Florida habitats. Mar. Pollut. Bull. 28, 154-158.

Bo M., Bava S., Canese S., Angiolillo M., Cattaneo-Vietti R., G.Bavestrello (2014) Fishing impact on deep Mediterranean rocky habitats as revealed by ROV investigation. Biological Conservation 171 (2014) 167–176

Boerger C.M., Lattin G.L., Moore S.L., C.Moore (2010) Plastic ingestion by planktivorous fishes in the North Pacific Central Gyre. Mar. Pollut. Bull. 60, 2275-2278

Boopendranath M. (2012) *Waste minimisation in fishing operations.* Fishery Technology, 49(2), p. 109-119.

Bowman D., Manor-Samsonov N., A.Golik (1998) Dynamics of Litter Pollution on Israeli Mediterranean Beaches: A Budgetary, Litter Flux Approach. *Journal of Coastal Research*, Vol. 14, No. 2 (spring, 1998), pp. 418-432
.
Brander S., Fontana R., T.Mata (2011) The ecotoxicology of plastic marine debris. American Biol Teacher 73(8):474478

Bugoni L., Krause L., M.Petry (2001) Marine debris and human impacts on sea turtles in Southern Brazil. Mar. Pollut. Bull. 42, 1330e1334.

Brochier F. (2012) Analysis of existing marine assessments in Europe (North East Atlantic, Baltic Sea, Mediterranean and Black Sea). Preparatory document for the UN Regional Regular Process (UNRRP) meeting. IOC-UNESCO report, version 3, 26 pages.

Browne M., Dissanayake A., Galloway T., Lowe D., Thompson R.C. (2008) Ingested microscopic plastic translocates to the circulatory system of the mussel *Mytilus edulis*. Environ Sci Technol., 42(13):5026-31.

Brown J., Macfadyen G., Huntington T., Magnus J., J. Tumilty (2005) Ghost Fishing by Lost Fishing Gear. Final Report to DG Fisheries and Maritime Affairs of the European Commissn. Fish/2004/20. Institute for European Environmental Policy / Poseidon Aquatic Resource Management Ltd joint report, 96 pages.

Brown J., G.Macfadyen (2007) Ghost fishing in European waters: Impacts and management responses. Marine Policy, 488–504.

Camedda A., Massaro G., Briguglio P., G. De Lucia (2012) Marine Litter in stomach contents and fecal pellet of Marine Turtles in Sardinian coast. Biology and ecotoxicology of large marine vertebrates: potential sentinels of Good Environmental Status of marine environment, implication on European Marine Strategy- Framework Directive - Workshop abstracts - Accademia dei Fisiocritici, Siena, 31st January 2012, pp. 40

Camedda A., Matiddi M., Massaro G., Coppa S., Perilli A., Ruiu A., Briguglio P., G.De Lucia (2013) Five years data on interaction between loggerhead sea turtles and marine litter in Sardinia. Proceedings of the Biology and ecotoxicology of large marine vertebrates and sea birds: potential sentinels of Good Environmental Status of marine environment, implication on European Marine Strategy Framework Directive. 5-6 June, Siena

Camedda A., Marra S., Matiddi M., Massaro G., Coppa S., Perilli A., Ruiu A., Briguglio P., G.De Lucia (2014). Interaction between loggerhead sea turtles (*Caretta caretta*) and marine litter in Sardinia (Western Mediterranean Sea). Marine Environmental Research, 100, 25-32.

Campani T., Baini M., Giannetti M., Cancelli F., Mancusi C., Serena F., Marsili L., Casini S., M.C. Fossi (2013) Presence of plastic debris in loggerhead turtle stranded along the Tuscany coasts of the Pelagos Sanctuary for Mediterranean Marine Mammals (Italy). Mar. Pollut. Bull. 74, 225-230.

Cardona L., Revelles M., Carreras C., San Felix M., Gazo M., A. Aguilar (2005) Western Mediterranean immature loggerhead turtles: habitat use in spring and summer assessed through satellite tracking and aerial surveys. Marine Biology, 147(3), 583-591.

Carpenter, E.J., Smith, K.L., 1972. Plastics on the Sargasso sea surface. Science, 175, 1240–1241

Carreras C., Pont S., Maffucci F., Pascual M., Barcelo A., Bentivegna F., Cardona L., Alegre F., SanFelix M., Fernandez G., A.Aguilar (2006) Genetic structuring of immature loggerhead sea turtles (*Caretta caretta*) in the Mediterranean Sea reflects water circulation patterns. Marine Biology 149, 1269–1279. doi:10.1007/s00227-006-0282-8

Carreras C., Pascual M., Cardona L., Marco A., Bellido J.J., Castillo J., Tomas J., Raga J., Sanfelix M., G.Fernandez (2011) Living together but remaining apart: Atlantic and Mediterranean loggerhead sea turtles (*Caretta caretta*) in shared feeding grounds. Journal of Heredity 102: 666–677.

Carson H., M.S. Nerheim, K.A. Carroll, M. Eriksen (2013) The plastic-associated microorganisms of the North Pacific Gyre Marine Pollution Bulletin, 75, 1–2, 126-132.

Casale P., Freggi D., Basso R., R.Argano (2005) Interaction of the Static Net Fishery with Loggerhead Sea Turtles in the Mediterranean: Insights from Mark-recapture Data. The Herpetological Journal 15: 201–203.

Casale P., Cattarino L., Freggi D., Rocco M., R.Argano (2007). Incidental catch of marine turtles by Italian trawlers and longliners in the central Mediterranean. Aquatic Conservation: Marine and Freshwater Ecosystems 17, 686–701. doi:10.1002/aqc.841

Casale P., Abbate G., Freggi D., Conte N., Oliviero M., R.Argano (2008) Foraging ecology of loggerhead sea turale Caretta caretta in the central Mediterranean Sea: evidence for a relaxed life history model. Marine Ecology Progress Series 372, 265-276

Casale P., Mazaris A.D., Freggi D., Vallini C., R.Argano (2009) Growth rates and age at adult size of loggerhead sea turtles (*Caretta caretta*) in the Mediterranean Sea, estimated through capture-mark-recapture records. Scientia Marina 73, 589–595. doi:10.3989/scimar.2009.73n3589

Casale P., D.Margaritoulis (2010) Sea Turtles in the Mediterranean: Distribution, Threats and Conservation Priorities. IUCN: Gland, Switzerland. 304 pages

Casale P.(2011) Sea turtle by-catch in the Mediterranean. Fish and Fisheries 12: 299–316.

Casale P., Affronte M., Scaravelli D., Lazar B., Vallini C., P.Luschi (2012) Foraging grounds, movement patterns and habitat connectivity of juvenile loggerhead turtles (*Caretta caretta*) tracked from the Adriatic Sea. Marine Biology 159, 1527–1535. doi:10.1007/s00227-012-1937-2

Casale P, P. Mariani (2014) The first 'lost year' of Mediterranean sea turtles: dispersal patterns indicate subregional management units for conservation. Marine Ecology-Progress Series 498: 263–274.

Casale P., Freggi D., Furii G., Vallini C., Salvelini P., Velini G., Deflorio M., Totaro G., Raimond S., Fortuna C., B. Godley (2014) Annual survival probabilities of juvenile loggerhead sea turtles indicate high anthropogenic impact on Mediterranean populations. Aquatic Conserv: Mar. Freshw. Ecosyst. (wileyonlinelibrary.com). DOI: 10.1002/aqc.2467

Casini S., Caliani I., Giannetti M., Maltese S., Coppola D., Bianchi N., Campani T., Ancora S., Marsili L., M.Fossi (2012) Non invasive ecotoxicological investigations in Caretta caretta in the Mediterranean: implications for descriptor 8 and 10 of the Marine Strategy Framework Directive. In Biology and ecotoxicology of large marine vertebrates: potential sentinels of Good Environmental Status of marine environment implication on European Marine Strategy- Framework Directive - Workshop abstracts – Accademia dei Fisiocritici, Siena, 31st January 2012, pp. 18.

CBD (2012) Secretariat of the Convention on Biological Diversity and the Scientific and Technical Advisory Panel—GEF. Impacts of Marine Debris on Biodiversity: Current Status and Potential Solutions, Montreal, Technical Series No. 67, 61p.

Cebrian D. (2008) Seals-fisheries interactions in the Mediterranean monk seal (Monachus monachus): related mortality, mitigating measures and comparison to dolphin-fisheries interactions. Transversal Working Group on by catch/incidental catches. O Headquarters, Rome (Italy), 15-16 September 2008, 21 pages.

Cerim, H., Filiz, H., Gülsahin, A. and M.Erdem (2014). Marine Litter: Composition in Eastern Aegean Coasts. Open Access Library Journal, 1, e573. doi: http://dx.doi.org/10.4236/oalib.1100573.

Chalkiadaki M. (2005) The contribution of marine litter to marine environmental pollution with trace metals, Postgraduate thesis, Laboratory of Environmental Chemistry, University of Athens, Athens, 2005 (cited from Unep,2011).

CIESM (2014) Plastic Litter and the dispersion of alien species and contaminants in the Mediterranean sea. Ciesm Workshop N°46 (Coordination F Galgani), Tirana, 18-21 juin 2014, 172 pages.

Claro, F., P.Hubert (2011) Impact des macrodéchets sur les tortues marines en France métropolitaine et d'Outre-mer. Rapport SPN 2011/XX. MNHN-SPN, Paris, 51p.

CleanUp Greece/HELMEPA/MIO-ECSDE, "Public Awareness and Education for the Management of Marine Litter in the Mediterranean", Athens, 2007 (cited fom UNEP, 2011)

CMS (2014) MIGRATORY SPECIES, MARINE DEBRIS AND ITS MANAGEMENT. Review under Resolution 10.4 on Marine Debris from the CONVENTION ON MIGRATORY SPECIES. 11th MEETING OF THE CONFERENCE OF THE PARTIES, Quito, Ecuador, 4-9 November 2014 Unep report: UNEP/CMS/COP11/Inf.27. 175 pages

Codina-García M., Militão T., Moreno J., J.González-Solís (2013) Plastic debris in Mediterranean seabirds. Marine Pollution Bulletin 77 (2013) 220–226

Cole M., Lindeque P., Halsband C., T.S. Galloway (2011) Microplastics as contaminants in the marine environment: A review. Marine Pollution Bulletin 62 (2011) 2588–2597

Collignon A., Hecq J., Galgani F., Voisin P., A.Goffard (2012) Neustonic microlastics and zooplankton in the western Mediterranean sea. Marine Pollution Bulletin 64, 861-864

Collignon A., Hecq J., Galgani F., Collard F., A.Goffart (2014). Annual variation in neustonic micro- and meso-plastic particles and zooplankton in the Bay of Calvi (Mediterranean–Corsica). Marine Pollution Bulletin, 79(1-2), 293-298. Publisher's official version: http://dx.doi.org/10.1016/j.marpolbul.2013.11.023

Colton, J.B., Knapp, F.D., Burns, B.R., 1974. Plastic particles in surface waters of the northwestern Atlantic. Science 185, 491–497.

Cózar A., Sanz-Martín M., Martí E., González-Gordillo J., Ubeda B., Gálvez J., Irigoien X., C. Duarte (2015) Plastic Accumulation in the Mediterranean. Sea, PLoS ONE 10(4): e0121762. doi:10.1371/journal.pone.0121762

Darmon G., Miaud C., Claro F., Gambaiani D., Dell'Amico F., F.Galgani (2014) Pertinence des tortues caouannes comme indicateur de densité de déchets en Méditerranée Dans le cadre de la Directive Cadre Stratégie pour le Milieu Marin (indicateur 2.1 du descripteur n°10). CONTRACT report, CNRS/ IFREMER, 13/3212068, 34 pages.

Della Torre C., Bergami E., Salvati A., Faleri C., Cirino P., Dawson K., I. Corsi (2014) Accumulation and Embryotoxicity of Polystyrene Nanoparticles at Early Stage of Development of Sea Urchin Embryos Paracentrotus Lividus. dx.doi.org/10.1021/es502569w | Environ. Sci. Technol. 2014, 48, 12302−12311

De Lucia A., Caliani G., Marra I., Camedda S., Coppa A., Alcaro L., M. Matiddi (2014) Amount and distribution of neustonic micro-plastic off the Western Sardinian coast (Central-Western Mediterranean Sea). Marine Environmental Research. DOI: 10.1016/j.marenvres.2014.03.017.

De Stephanis R., Giménez J., Carpinelli E., Gutierrez-Exposito C., A.Cañadas (2013) As main meal for sperm whales: plastics debris. Mar. Pollut. Bull. 69, 206e214.

Derraik, J.G.B. (2002) The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin 44: 842-852. doi:10.1016/S0025-326X(02)00220-5.

De Lucia G.A., Matiddi M., Travaglini A., Camedda A., Bentivegna F., L.Alcaro (2012) Marine litter ingestion in loggerhead sea turtles as indicator of floating plastic debris along Italian coasts. Proceedings of the Biology and ecotoxicology of large marine vertebrates: potential sentinels of Good Environmental Status of marine environment, implication on European Marine Strategy Framework Directive. 31 January, Siena.

De Lucia, G.A., Caliani, I., Marra, S., Camedda, A., Coppa, S., Alcaro, L., Campani, T., Giannetti, M., Coppola, D., Cicero, A.M., Panti, C., Baini, M., Guerranti, C., Marsili, L., Massaro, G., Fossi, M.C., M.Matiddi (2014) Amount and distribution of neustonic micro-plastic off the western Sardinian coast (Central-Western Mediterranean Sea). Marine Environmental Research 100:10-16. doi:10.1016/j.marenvres.2014.03.017

Deudero S., C. Alomar (2014) Revising interactions of plastics with marine biota: evidence from the Mediterranean. CIESM worshop “Marine Litter in the Mediterranean an Black Seas” CIESM ed., Tirana, Albania, 18 - 21 June 2014, 79-86 (http://www.ciesm.org/online/monographs/)

Di Bello A., Valastro C., Staffieri F., A.Crovace (2006) Contrast Radiography of the Gastrointestinal Tract in Sea Turtles. Veterinary Radiology & Ultrasound 47, 351–354. doi:10.1111/j.1740-8261.2006.00152.x

Engel S., Pagiola S., S.Wunder (2008). Designing payments for environmental services in theory and practice: an overview of the issues. Ecol. Econ. 65,663-674.

European Commission (2012) Overview of EU Policies, Legislation and Initiatives Related to Marine Litter. Commission Staff Working Document, SWD (2012 365 final), Brussels, 33 pages

Eryasar A., Özbilgin H., Gücü A., S. Sakınan (2014) Marine debris in bottom trawl catches and their effects on the selectivity grids in the north eastern Mediterranean. Marine Pollution Bulletin 81 (2014) 80–8

Eriksen M., Lebreton L., Carson H., Thiel M., Moore C., Borerro J., Cummins A., Wilson S., Galgani F., Ryan P.G., J.Reisser (2014). Marine Plastic Pollution in the World’s Oceans. PLOS One, DOI: 10.1371/journal.pone.0111913

European Commission’s /DG Environment (2011), Science for Environment Policy | In-depth Reports | Plastic Waste: Ecological and Human Health Impacts. The Science Communication Unit/ the University of the West of England (UWE) eds., 44 pages

Fabri M., Pedel L., Beuck L., Galgani F., Hebbeln D., A.Freiwald (2014). Megafauna of vulnerable marine ecosystems in French mediterranean submarine canyons: Spatial distribution and anthropogenic impacts. Deep-sea Research Part Ii-topical Studies In Oceanography, 104, 184-207. Publisher's official version: http://dx.doi.org/10.1016/j.dsr2.2013.06.016, Open Access version:http://archimer.ifremer.fr/doc/00154/26513/

FANTARED 2 (2003) EC contract FAIR-PL98-4338, A study to identify, quantify and ameliorate the impacts of static gear lost at sea. ISBN No. 0 903941 97 X, 2003.

FAO (1995) Code of Conduct for Responsible Fisheries. 1995.41pp. ISBN: 9251038341, Articles 7.2 and 7.6.9.

FAO (1991) Recommendations for the Marking of Fishing Gear. Supplement to the Report of the Expert Consultation on the Marking of Fishing Gear. Victoria, British Colombia, Canada, 14–19 July 1991. 48pp. ISBN 92-5-103330-7.

IMO (2002) International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78) Annex V, Regulation 3.

Article 1, Council Regulation (EC) 2371/2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy OJ L 358/59, 31.12.2002.

Flint S., Markle T., Thompson S., E. Wallace (2012) Bisphenol A exposure, effects, and policy: A wildlife perspective. Journal of Environmental Management 104 (2012) 19-34

Fossi M.C., Panti C., Guerranti C., Coppola D., Giannetti M., Marsili L., R.Minutoli (2012a) Are baleen whales exposed to the threat of microplastics? A case study of the Mediterranean fin whale (*Balaenoptera physalus*). Marine Pollution Bulletin 64, 2374-2379. doi.org/10.1016/j.marpolbul.2012.08.013.

Fossi M., Guerranti C., Coppola D., Baiani M., Giannetti M., Campani T., Clo S., S.Desabata (2012b). Preliminary assessment of microplastics threat in Mediterranean basking sharks (*Cetorhinus maximus*): implication for the MSFD. In: Poster Presented at the International Conference on Prevention and Management of Marine Litter, 10-12/04/2013.

Fossi MC., Casini S., Caliani I., Panti C., Marsili L., Viarengo A., Giangreco R., Notarbartolo di Sciara G., Serena F., Ouerghi A., M.Depledge (2012) The role of large marine vertebrates in the assessment of the quality of pelagic marine ecosystems. Marine Environmental Research, 77, 156-158.

Fotopoulou K.N., H.Karapanagioti (2012). Surface properties of beached plastic pellets. Mar. Environ. Res., 81, 70–77.

Foti M., Giacopello C., Bottari T., Fisichella V., Rinaldo D., C.Mammina (2009) Antibiotic resistance of Gram Negatives isolates from loggerhead sea turtles (*Caretta caretta*) in the central Mediterranean Sea. Mar. Pollut. Bull. 58, 1363-1366.

Galgani F., Souplet A., Y. Cadiou (1996) Accumulation of debris on the deep sea floor off the French Mediterranean coast, Marine Ecology Progress Series, 142,225-234

Galgani F., Leaute J.P., Moguedet P., Souplet A., Verin Y., Carpentier A., Goraguer H., Latrouite D., Andral B., Cadiou Y., Mahe J.C., Poulard J.C., P.Nerisson (2000) Litter on the Sea Floor Along European Coasts. Marine Pollution Bulletin 40, 516–527. doi:10.1016/S0025-326X(99)00234-9

Galgani F., Henry M., Orsoni V., Nolwenn C., Bouchoucha M., C.Tomasino (2011) MACRO-DECHETS en Méditerranée française: Etat des connaissances, analyses des données de la surveillance et recommandations. Rapport IFREMER, RST.DOP/LER-PAC/, 2011, 42 pp.

Galgani F., Hanke G., Werner S., L.De Vrees (2013). Marine litter within the European Marine Strategy Framework Directive. Ices Journal of Marine Science, 70(6), 1055-1064. DOI: http://dx.doi.org/10.1093/icesjms/fst122,

Galgani F., Claro F., Depledge M., C.Fossi (2014). Monitoring the impact of litter in large vertebrates in the Mediterranean Sea within the European Marine Strategy Framework Directive (MSFD): constraints, specificities and recommendations. Marine Environmental Research, 100, 3-9. Doi: http://dx.doi.org/10.1016/j.marenvres.2014.02.003

Galgani F., Piha H., Hanke G., Werner S., & GES MSFD group (2011) Marine Litter: Technical Recommendations for the Implementation of MSFD Requirements. EUR 25009 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2011. JRC67300 (http://publications.jrc.ec.europa.eu/repository/handle/111111111/22826)

Galgani F., Fleet D., van Franeker J., Hanke G., De Vrees L., Katsanevakis S., Maes T., Mouat J., Oosterbaan L., Poitou I., R.C.Thompson (2011) Monitoring marine litter within the European Marine Strategy Framework Directive (MSFD): Scientific and technical basis. Fifth International Marine Debris Conference, Honolulu Hawaii 20-25 Mar 2011. Oral Presentation Extended Abstracts 4.c.5., 164-168

Galgani F., Hanke G., Werner S., Oosterbaan L., Nilsson P., Fleet D., Kinsey S., Thompson R.C., van Franeker J., Vlachogianni T., Scoullos M., Mira Veiga J., Palatinus A., Matiddi M., Maes T., Korpinen S., Budziak A., Leslie H., Gago J., G.Liebezeit (2013) Monitoring Guidance for Marine Litter in European Seas, JRC Scientific and Policy Reports, Report EUR 26113 EN, 120 p. (https://circabc.europa.eu/w/browse/85264644-ef32-401b-b9f1-f640a1c459c2)

Galil B.S. (2006) "Shipwrecked: shipping impacts on the biota of the Mediterranean Sea" in "*The ecology of transportation: managing mobility for the environment"* (ed. J.L. Davenport and J. Davenport), Environmental pollution, 10, pp. 39–69.

Gall S., R. Thompson (2015) The impact of debris on marine life.Marine Pollution Bulletin. Vo 92, 1–2, 170–179.

GESAMP (2010) Proceedings of the GESAMP International! Workshop on microplastic particles as a vector in transporting persistent bioaccumulating and toxic substances in the oceans. GESAMP/IMO/FAO/UNESCO/WMO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection. Reports and Studies, 82, 68 p.

Gerigny O., Henry M., Tomasino C., F.Galgani (2011). Déchets en mer et sur le fond. in rapport de l'évalution initiale, Plan d'action pour le milieu marin - Mediterranée Occidentale, rapport PI Déchets en mer V2 MO, pp. 241-246 (http://www.affairesmaritimes.mediterranee.equipement.gouv.fr/IMG/pdf/Evaluation_initiale_des_eaux_marines_web-2.pdf)

Gerin R., Poulain P.-M., Taupier-Letage I., Millot C., Ben Ismail S., C.Sammari (2009). Surface circulation in the Eastern Mediterranean using Lagrangian drifters (2005-2007). Ocean Sci. 5, 559-574.

Gregory M. (2009) Environmental implications of plastic debris in marine settings entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. Philos Trans R Soc Lond B Biol Sci. Jul 27, 2009; 364(1526): 2013–2025. doi: 10.1098/rstb.2008.0265

Güven O. Gülyavuz H., M. Deval (2013) Benthic Debris Accumulation in Bathyal Grounds in the Antalya Bay, Eastern Mediterranean. Turkish Journal of Fisheries and Aquatic Sciences 13: 43-49 (2013) DOI: 10.4194/1303-2712-v13_1_06

Hanke G., H.Piha (2011) Large scale monitoring of surface floating marine litter by high resolution imagery. Presentation and extended abstract, 5th International Marine Debris Conference. 20.-25. March 2011, Hawaii, Honolulu.

Hareide, N-R., Garnes G., Rihan D., Mulligan M., Tyndall P, Clark M., Connolly P., Misund R., McMullen P., Furevik D. M., Humborstad O-B, Høydal K. and Blasdale T. 2005. A preliminary Investigation on Shelf Edge and Deep water Fixed Net Fisheries to the West and North of Great Britain, Ireland, around Rockall and Hatton Bank. www.fiskeridir.no/fiskeridir/content/download/4204/27785/file/Rapport.pdf

Harrison J., Sapp M., Schratzberger M., A.Osborn (2011) Interactions between Microorganisms and Marine Microplastics: A Call for Research. Marine Technology Society Journal, Volume 45, Number 2, pp. 12-20(9)

HELMEPA. (Hellenic Marine environment Protection Association).(2011) Annual Report 2010, Athens, Greece, (http://www.helmepa.gr/)

Hidalgo-Ruz V., Gutow L., Thompson R.C., M.Thiel (2012) Microplastics in the marine environment: a review of the methods used for identification and quantification. Environmental Science and Technology 46, 3060-3075.

Hochscheid S., Bentivegna F., G.Hays (2005) First records of dive durations for a hibernating sea turtle. Biol Lett 1:82–86.

Hoarau L., Ainley L., Jean C., S.Ciccione (2014) Ingestion and defecation of marine debris by loggerhead sea turtles, *Caretta caretta*, from by-catches in the South-West Indian Ocean Marine Pollution Bulletin, 84, 90–96.

Houar T., Boudouresque C., Barcelo A., Cottalorda J., Formentin J., Jullian E., Kerlidou B., E. Pironneau (2012) Occurrence of a lost fishing net within the marine area of the Port-Cros national Park (Provence, northwestern Mediterranean Sea). Sci. Rep. Port-Cros natl. Park, 26, 109-118.

Interwies E., Görlitz S., Stöfen A., Cools J., Van Breusegem W., Werner S., L. de Vrees (2013) Issue Paper to the "International Conference on Prevention and Management of Marine Litter in European Seas", Final Version, 16th May 2013 (http://www.marine-litter-conference-berlin.info/downloads.php), 111 pages.

IUCN (2013) IUCN Red List of Threatened Species. Version 2013.1. www.iucnredlist.org/ (accessed November 2013.).

Ioakeimidis C., Zeri C., Kaberi E, Galatchi M., Antoniadis K., Streftaris N., Galgani F. Papathanassiou E., G. Papatheodorou (2014) A comparative study of marine litter on the seafloor of coastal areas in the Eastern Mediterranean and Black Seas. Marine Pollution Bulletin, 89, 296–30.

Jacobsen J.K., Massey L., F.Gulland (2010) Fatal ingestion of floating net debris by two sperm whales (Physeter macrocephalus). Mar. Pollut. Bull., 60, 765-767.

Karapanagioti H.K., Endo S., Ogata Y., H.Takada (2011) Diffuse pollution by persistent organic pollutants as measured in plastic pellets sampled from various beaches in Greece. Mar. Pollut. Bull., 62 (2), 312–317.

Katsanevakis S., Verriopoulos G., Nicolaidou A., M.Thessalou-Legaki (2007) Effect of marine litter on the benthic megafauna of coastal soft bottoms: A manipulative field experiment. *Marine Pollution Bulletin,* 54, 771–778.

Keller J.M., McClellan-Green P.D., Kucklick J.R., Keil D.E., M.Peden-Adams (2006) Effects of organochlorine contaminants on loggerhead sea turtle immunity: comparison of a correlative field study and in vitro exposure experiments. Environ. Health Perspect., 114, 70-76

KIMO (Kommunenes Internajionale MilkjØosorganisajion, Local Authorities International Environmental Organisation) (2010). Economic Impacts of Marine Litter. Report, Sept 2010, Hollum- Ameland, The Netherlands, (www.kmointernational.org/MarineLitter.aspx).

Kershaw P.J., H.Leslie (eds.) (2012) Sources, fate & effects of microplastics in the marine environment. A global assessment: GESAMP working group 40, UNESCO-IOC, Paris, 45pp.

Klosterman F. (2012) occurrence of meso plastics in sediments from the Mediterranean Sea coast. Bachelor thesis, University of Osnabrueck, 50p.

Kordella S., Geraga M., Papatheodorou G., Fakiris E., I.Mitropoulou (2013) Litter composition and source contribution for 80 beaches in Greece, Eastern Mediterranean: A nationwide voluntary clean-up campaign. Aquatic Ecosystem Health & Management, Volume 16, Number 1, 111-118.

Koutsodendris A., Papatheodorou G., Kougiourouki O., M.Georgiadis (2008) Benthic marine litter in four Gulfs in Greece, Eastern Mediterranean; abundance, composition and source identification. Estuarine, Coastal and Shelf Science 77, 501-512.

Kukulka T., Proskurowski G., Morét-Ferguson S., Meyer D., K.Law (2012) The effect of wind mixing on the vertical distribution of buoyant plastic debris. Geophys. Res. Letters, Vol. 39, L07601, doi:10.1029/2012GL051116

Laglbauer B., Franco-Santos R., Andreu-Cazenave M., Brunelli L., Papadatou M., Palatinus A., Grego M., T.Deprez (2014) Macrodebris and microplastics from beaches in Slovenia, Marine Pollution Bulletin, 89, 356–366. http://dx.doi.org/10.1016/j.marpolbul.2014.09.036.

Laist D. (1987) Overview of the biological effects of lost and discarded plastic debris in the marine environment. Marine Pollution Bulletin 18: 319 - 326.

Lanoie P., Laurent-Lucchetti J., Johnstone N., S.Ambec (2011) Environmental policy, innovation and performance: new insights on the Porter hypothesis. J. Econ. Manag. Strat. 20, 803-842.

Lazar B., Gračan R., Zavodnik D., N.Tvrtković (2008) Feeding ecology of ”pelagic” loggerhead turtles, Caretta caretta, in the northern Adriatic Sea: proof of an early ontogenetic habitat shift. In: Kalb, H., Rohde, A.S., Gayheart, K., Shanker, K. (Eds.), Proceedings of the Twentyfifth. Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFSSEFSC-582. p. 93.

Lazar B., Gracan R., Katic J., Zavodnik D., Jaklin A., N.Tvrtkov (2010) Loggerhead sea turtles (*Caretta caretta*) as bioturbators in neritic habitats: an insight through the analysis of benthic molluscs in the diet. Mar. Ecol. 32, 65-74.

Lazar B., R.Gracan (2011) Ingestion of marine debris by loggerhead sea turtle, Caretta caretta in the Adriatic Sea. Mar. Pollut. Bull. 62, 43-47.

Lebreton L., Greer S., J.Borrero (2012) Numerical modelling of floating debris in the world's oceans, Marine Pollution Bulletin 64, 653-661.

Lechner A., Keckeis H., Lumesberger-Loisl F., Zens N., Krusch R., Tritthart M., Glas M., E.Schludermann (2014) The Danube so colourful: A potpourri of plastic litter outnumbers fish larvae in Europe's second largest river. Environmental Pollution 188, 177-181.

Levy A., Brenner O., Scheinin A., Morick D., Ratner E., Goffman O., D.Kerem (2009) Laryngeal Snaring by Ingested Fishing Net in a Common Bottlenose Dolphin (Tursiops truncatus) Off the Israeli Shoreline. Journal of Wildlife Diseases: July 2009, Vol. 45, No. 3, pp. 834-838. doi: http://dx.doi.org/10.7589/0090-3558-45.3.834

Licitra G., Serena F., Mancusi C., C. Grazzini (2012) GIONHA. Insieme per la tutela e la valorizzazione del nostro mare. I risultati, 88 pages.
(http://www.arpat.toscana.it/documentazione/catalogo-pubblicazioni-arpat/gionha-insieme-per-la-tutela-e-la-valorizzazione-del-nostro-mare-i-risultati).

Limpus C., D.Limpus (2001) The loggerhead turtle, Caretta caretta, in Queensland: breeding migrations and Wdelity to a warm temperate feeding area. Chel Conserv Biol 4(1):142–153.

Lithner D., Larsson A., G. Dave (2011) Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition. Science of the Total Environment 409 (2011) 3309–3324.

Llorca M., Farré M., Karapanagioti H., D.Barceló (2014) Levels and fate of perfluoroalkyl substances in beached plastic pellets and sediments collected from Greece. Marine Pollution Bulletin 87 (2014) 286–291.

Loizidou X., Loizides M., D. Orthodoxou (2014) A novel best practices approach: The MARLISCO case, Mar. Poll. Bull., Volume 88, Issues 1–2, 15 November 2014, Pages 118-128, http://dx.doi.org/10.1016/j.marpolbul.2014.09.015.

Ludwig W., Dumont E., Meybeck M., S.Heussner (2009) River discharges of water and nutrients to the Mediterranean Sea: major drivers for ecosystem changes during past and future decades? Prog. Oceanogr., 80, 199–217.

Macfayden G., Huntington T., R. Cappell (2009) Abandoned, lost or otherwise discarded fishing gear. Food and Agriculture Organization of the United Nations publ., Rome: i-xix + 1-115.

Malta Environment and Planning Authority (2005) State of the Environment Report Malta, 2005, Malta Environment and Planning Authority(in UNEP, 2011).

Mamaca E., Girin M., Le Floch S., R. Elzir (2009) Review of chemical spills at sea and lessons learnt. A technical appendix to Interspill 2009 conference white paper. Report of the Interspill 2009 conference, Marseille, 40 p. (www.itopf.com/uploads/interspill09_hnsappendix.pdf).

Marine Resources & Coastal Zone Management Program (2005), "Collection and Identification of Solid Waste Caught off the Coasts of El-Mina and Tripoli-Lebanon", Interim Report August-December, 2005, Institute of the Environment, University of Balamand, Lebanon, 2005

Margaritoulis D., Argano R., Baran I., Bentivegna F., Bradai M.N., Caminas J.A., Casale P., De Metrio G., Demetropoulos A., Gerosa G., Godley B.J., Haddoud D.A., Houghton J., Laurent L., B.Lazar (2003). Loggerhead turtles in Mediterranean Sea: present knowledge and conservation perspectives. In: Bolten, A.B., Witherington, B.E. (Eds.), Loggerhead Sea Turtles. Smithsonian Institution Press, Washington, DC, pp. 175e198.

Makhoukh M. (2012) Pollution par les déchets solides en Algérie. Sratégie de gestion Integrée des zones cotieres en Agerie? Bilan et diagnostic. /MATE-PAP RAC/ 2012, 42 pages.

Martinez-Ribes L., Basterretxea G., Palmer M., J.Tintore (2007). Origin and abundance of beach debris in the Balearic Islands. Sci. Mar. 71: 305–314.

Maso M., Garces E., Pages F., J.Camp (2003). Drifting plastic debris as a potential vector for dispersing Harmful Algal Bloom (HAB) species. Sci. Mar. 67, 107–111.

Matiddi M., van Franeker J.A., Sammarini V., Travaglini A., L.Alcaro (2011) Monitoring litter by sea turtles: an experimental protocol in the Mediterranean. In: Proceedings of the 4th Mediterranean Conference on Sea Turtles. 7 -10 November, Naples, p. 129.

Mazziotti C., Bertaccini E., Benzi M., Martini S., Lera S., Silvestri C., C.Ferrari (2015), Sea surface miroplasticcs distribution on Emilia Romagna coast: Defishgear project preliminary results. Micro 2015. Seminar of the Defishgear projct, Abstract book, Piran 4-6 may 2015, p 41

Mehlhart G., M.Blepp (2012) Study on land sourced litter in the marine environment. Review of sources and literature. Report fp the Öko-Institut e.V., n° 8976, Darmstadt / Freiburg 26.01.2012, 128p

Menna M., Poulain P. M., Zodiatis G., I.Gertman (2012) On the surface circulation of the Levantine sub-basin derived from Lagrangian drifters and satellite altimetry data. Deep Sea Research Part I: Oceanographic Research Papers, 65, 46-58.

Mifsud R., Dimech M., P.Schembr (2013) Marine litter from circalittoral and deeper bottoms off the Maltese islands (Central Mediterranean). Mediterranean Marine Science 14: 298-308.

Minister for the Environment and Heritage (2004) Senator the Hon. Ian Campbell Media Release. 30 November 2004 /http://www.deh.gov. au/minister/env/2004/mr30nov04.htmlS

Moore S.L., M.Allen (2000) Distribution of anthropogenic and natural debris on the mainland shelf of the Southern California Bight. Marine Pollution Bulletin 40, 83–88.

Morritt D., Stefanoudis P., Pearce D., Crimmen O., P.Clark (2014) Plastic in the Thames: A river runs through it. Marine Pollution Bulletin, 78, 196–200.

Mouat J., Lopez Lozano R., H. Bateson (2010) Economic Impacts of Marine Litter: Assessment and priorities for response. Report of the OSPAR Commission, ISBN 978-1-906840-26-6, 117 pages.

Musick J., C.Limpus (1997) Habitat utilization and migration in juvenile sea turtles. In: Lutz PL, Musick JA (ed.) The biology of sea turtles. CRC, Boca Raton, FL, 137–163.

Mrosovsky N. (1981) Plastic jellyfish. Marine Turtle Newsletter 17: 5–7.

Mrosovsky N., Ryan G.D., A.James (2009) Leatherback turtles: the menace of plastic. Mar. Pollut. Bull. 58, 287-289.

Mouat J., Lozano R.L., H.Bateson (2010) Economic Impacts of Marine Litter. Report.KIMO, Lerwick, UK. (Kommunenes Internasjonale Miljoorganisasjon), 117 p.

MSFD GES TSG Marine Litter (Galgani F., Piha H., Hanke G., Werner S., Alcaro L., Matiddi M., Fleet D., Kamizoulis G., Maes T., Osterbaan L., Thompson R., Van Franeker J., Mouat J., Meacle M., Carroll C., Detloff K., Kinsey S., Nilsson P., Sheavly S., Svärd B., Veiga J., Morison S., Katsanevakis S., Lopez-Lopez L., Palatinus A., Scoullos M., De Vrees L., Abaza V., Belchior C., Brooks C., Budziak A., Hagebro C., Holdsworth N., Rendell J., Serrano López A., Sobral P., Velikova V., Vlachogianni T., Wenneker B. Marine Litter) (2011) Technical Recommendations for the Implementation of MSFD Requirements. EUR 25009 EN. Luxembourg (Luxembourg): Publications Office of the European Union; 2011. JRC 67300 http://publications.jrc.ec.europa.eu/repository/handle/111111111/22826

MSFD TG Marine Litter (Galgani F, Hanke G., Werner S., Oosterbaan L., Nilsson P., Fleet D., Kinsey S., Thompson R., Palatinus A., Van Franeker J., Vlachogianni T., Scoullos M., Veiga J., Matiddi M., Alcaro L., Maes T., Korpinen S., Budziak A., Leslie H., Gago J., G.Liebezeit (2013) Guidance on Monitoring of Marine Litter in European Seas. EUR 26113. Luxembourg (Luxembourg): Publications Office of the European Union; 2013. JRC83985
http://publications.jrc.ec.europa.eu/repository/handle/111111111/30681

O'Brine T., R.Thompson (2010) Degradation of plastic carrier bags in the marine environment. Marine Pollution Bulletin, 60, 2279-2283. doi:10.1016/ j.marpolbul.2010.08.005

Oehlmann J., Schulte-Oehlmann U., Kloas W., Jagnytsch O., Lutz I., Kusk K., Wollenberger L., Santos E., Paull G., Van Look K., C. Tyler (2009) A critical analysis of the biological impacts of plasticizers onwildlife. Phil. Trans. R. Soc. B, 364, 2047-2062. doi: 10.1098/rstb.2008.0242

Oliver G. (2014) Donnees historiques et nouvelles observations concernant les tortues marines (Reptilia, Chelonii) sur les cotes francaises de Mediterranee (1996-2010). Bulletin de la Société herpétologique de France, 25–57.

Oosterhuis F., Papyrakis E., B. Boteler (2014) Economic instruments and marine litter control*, Ocean & Coastal Management, 102, 47-54.

OSPAR (2009) Marine litter in the North-East Atlantic Region: Assessment and Priorities for Response. Report. OSPAR Commission, London, UK.

OSPAR (2015) Study report on sources of microplastics relevant to marine protection. Report of the Meeting of the Environmental Impact of Human Activities Committee (EIHA) Santander (Spain): 13 - 17 April 2015, EIHA 15/5/Info.2-E (L), agenda item 5, 41 pages

Palatinus A., Gast J., Bisjak T., Cesnik U., Grivec T., Pipan U., Kovan Viserc M., Krzan A., M.Peterlin (2015). Sea surface microplatics and distribution in the Slovenian part of the Trieste bay. Preliminary results. Micro 2015. Seminar of the Defishgear projct, Abstract book, Piran 4-6 may 2015, p 39

Pawson M.G. (2003) The catching capacity of lost static fishing gears: introduction. Fish. Res., 64: 101-105.

Pham P., J.Jung, J. Lumsden, Dixon D., N. Bols (2012) The potential of waste items in aquatic environments to act as fomites for viral haemorrhagic septicaemia virus. Journal of Fish Diseases, 35, 73–77. doi:10.1111/j.1365-2761.2011.01323.x

Pham C., Ramirez-Llodra E., Claudia H. S., Amaro T., Bergmann M., Canals M., Company J., Davies J., Duineveld G., Galgani F., Howell K., Huvenne Veerle A., Isidro E., Jones D., Lastras G., Morato T., Gomes-Pereira J., Purser A., Stewart H., Tojeira I., Tubau X., Van Rooij D., P.Tyler (2014). Marine Litter Distribution and Density in European Seas, from the Shelves to Deep Basins. Plos One, 9(4), e95839. Publisher's official version. http://dx.doi.org/10.1371/journal.pone.0095839

Plastic - Europe (2013) http://www.plasticseurope.fr/Document/plastics---the-facts2013.aspx?Page=DOCUMENT&FolID=2

Plotkin P., A. Amos (1990) Effects of anthropogenic debris on sea turtles in the northwestern Gulf of Mexico. Pages 736–743 in R. Shomura, and H. Yoshida, editors. Proceedings of the 2nd international conference on marine debris. National Oceanic and Atmospheric Administration, Honolulu.

Plotkin P.,Wicksten M.K., A.Amos (1993) Feeding ecology of the loggerhead sea turtle Caretta caretta in the North-Western Gulf of Mexico. Mar. Biol. 115, 1-15.

Poeta G, C.Battisti, A. Acosta (2014) Marine litter in Mediterranean sandy littorals: Spatial distribution patterns along central Italy coastal dunes. Marine Pollution Bulletin, 89, 168-173 http://dx.doi.org/10.1016/j.marpolbul.2014.10.011.

Poitou I., C. Poulain (2015) Forum National France sur les déchets marins, rapport projet Européen Marlisco, Mer-terre, fevrier 2015, 18 pages.

Poppi L., Zaccaroni A., Pasotto D., Dotto G., Marcer F., Scaravelli D., S.Mazzariol (2012) Post-mortem investigations on a leatherback turtle Dermochelys coriacea stranded along the Northern Adriatic coastline. Is. Aqua. Org. Vol. 100: 71–76, 2012 doi: 10.3354/dao02479

Poulain P., Menna M., E. Mauri (2012) Surface Geostrophic Circulation of the Mediterranean Sea Derived from Drifter and Satellite Altimeter Data. Journal of Physical Oceanography, 42(6). 973-990, 2012. doi: 10.1175/JPO-D-11-0159.1

Price A., Jaoui K., Pearson M., A. Jeudy de Grissac (2014) An alert system for triggering different levels of coastal management urgency: Tunisia case study using rapid environmental assessment data. Marine Pollution Bulletin, 80, 88–9.

Purroy A.,Requena S., Gili J., Canepa A., R.Sardá (2014) spatial assessment of artisanal fisheries and their potential impact on the seabed: the Cap de Creus regional case study (northwestern Mediterranean Sea) Scientia Marina, 78(4), 449-459.

Ramirez-Llodra E., Brandt A., Danovaro R., De Mol B., Escobar E., German C.R., Levin L.A., Martinez-Arbizu P., Menot L., Buhl-Mortensen P., Narayanaswamy B.E., Smith C.R., Tittensor D.P., Tyler P.A., Vanreusel A., M.Vecchione(2010) Deep, diverse and definitely different: Unique attributes of the world’s largest ecosystem. Biogeosciences, 7, 2851–2899.

Ramirez-Llodra E., Tyler P.A., Baker M.C., Bergstad O.A., Clark M.R., Escobar E., Levin L.A., Menot L., Rowden A.A., Smith C.R., C. Van Dover (2011) Man and the last great wilderness: Human impact on the deep sea. PLoS ONE 6(8): e22588.

Ramirez-Llodra E., De Mol B., Company J.B., Coll M., F.Sardà (2013) Effects of natural and anthropogenic processes in the distribution of marine litter in the deep Mediterranean Sea. Progress in Oceanography, Volume 118, 273-287. DOI: http://dx.doi.org/10.1016/ j.pocean.2013.07.027

Rinaldi E., Buongiorno Nardelli B., Zambianchi E., Santoleri R., P.Poulain (2010) Lagrangian and Eulerian observations of the surface circulation in the Tyrrhenian Sea. Journal of Geophysical Research: Oceans (1978–2012), 115(C4).

SAC/GFCM (2013). Report of the thirteenth session of the Sub-Committee on Marine Environment and Ecosystems (SCMEE). FAO HQs, Rome, Italy, 18–20 February 2013. CGPM / GFCM, Ref. GFCM-SAC-SCMEE-2013, 55p.http://archimer.ifremer.fr/doc/00166/27698/

Rochman C., Hoh E., T. Kurobe (2013) Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress. Nature, Scientific Reports, 3, 3263-66.

Rochman CM., Tomofumi Kurobe T., I.Flores (2014) Early warning signs of endocrine disruption in adult fish from the ingestion of polyethylene with and without sorbed chemical pollutants from the marine environment Science of the Total Environment, 493 (2014) 656–661.

Romeo T., Battaglia P., Peda C., Consoli T., Andaloro F., C.Fossi (2015) First evidence of presence of plastic debris in stomachs from large pelagic fish in the Mediterranean Sea. Marine pollution Bulletin, *In press.*

Sacchi J. (2008) Impact des techniques de pêche sur l’environnement en Méditerranée. Etudes et Revues (Commission générale des pêches pour la Méditerranée): i-ix + 1-62 + 1-8.

Sacchi J. (2012) Impact of fishing techniques on the continental slope and mitigation measures, primarily focusing on trawling for deep-sea crustaceans and ghost net fishing. IN Mediterranean Submarine Canyons: Ecology and Governance. Gland, Switzerland and Málaga, Spain: IUCN, pages 58-64.

Sánchez P., Masó M., Sáez R.,.De Juan S., Muntadas A., M. Demestre (2013) Baseline study of the distribution of marine debris on soft-bottom habitats associated with trawling grounds in the northernMediterranean. Scientia Marina 77(2), 247-255, Barcelona (Spain) ISSN: 0214-8358

Schofield G., Hobson V. J., Fossette S., Lilley M. K., Katselidis K. A., G.Hays (2010) Biodiversity Research: fidelity to foraging sites, consistency of migration routes and habitat modulation of home range by sea turtles. Diversity and Distributions 16: 840-853.

Schuyler Q., Hardesty B.D., Wilcox C., K.Townsend (2012) To Eat or Not to Eat? Debris Selectivity by Marine Turtles.PLoS ONE 7:e40884. doi:10.1371/journal.pone.0040884

Schuyler Q., Hardesty B.D., Wilcox C., K.Townsend (2013) Global analysis of anthropogenic debris ingestion by sea turtles. Conserv. Biol. 28, 129–139.

Sheavly S., K.Register (2007) Marine Debris & Plastics: Environmental Concerns, Sources, Impacts and Solutions. Journal of Polymers and the environment, 15(4):301-305. DOI:10.1007/s10924-007-0074-3.

Sigler M. (2014) The Effects of Plastic Pollution on Aquatic Wildlife: Current Situations and Future Solutions. Water Air Soil Pollut (2014) 225:2184, DOI 10.1007/s11270-014-2184-6

Simmonds M. (2011) Eating Plastic: A Preliminary Evaluation of the Impact on Cetaceans of Ingestion of Plastic Debris. Submission to the IWC Scientific Committee, pp. 1–14.

Slavin C., Grage A., M. Campbell (2012) Linking social drivers of marine debris with actual marine debris on beaches. Marine Pollution Bulletin 64 1580–1588.

Strafella P., G. Fabi, A. Spagnolo, F. Grati, P. Polidori, E. Punzo, T. Fortibuoni, B. Marceta, S. Raicevich, I. Cvitkovic, M. Despalatovic, G. Scarcella (2015) Spatial pattern and weight of seabed marine litter in the northern and central Adriatic Sea. Marine Pollution Bulletin 01/2015; 91(1):120-127. DOI:10.1016/j.marpolbul.2014.12.018

Suaria G., S.Aliani (2014) Floating debris in the Mediterranean ea. Marine Pollution Bulletin Volume 86, Issues 1–2, 15, Pages 494–504.

Suaria G., Avio C., Lattin G., regoli F., S. Aliani (2015) Neustonic microplastics in the Southern Adriatic Sea. Preliminary results. Micro 2015. Seminar of the Defishgear projct, Abstract book, Piran 4-6 may 2015, p 42

Swimmer Y., Arauz R., Higgins B., McNaughton L., McCracken M., Ballestero J., R.Brill (2005) Food color and marine turtle feeding behavior: can blue bait reduce turtle bycatch in commercial fisheries? Mar. Ecol. Prog. Ser. 295, 273-278

Ten Brink P., Lutchman I., Bassi S., Speck S., Sheavly S., Register K., C.Woolaway (2009) Guidelines on the Use of Market-based Instruments to Address the Problem of Marine Litter. Institute for European Environmental policy (IEEP), Brussels, Belgium.

Teuten E., Saquing J., Knappe D., Barlaz M., Jonsson S., BjÃrn A., Rowland A., Thompson R., Galloway T., Yamashita T., Ochi D., Watanuki T., Moore C., Viet P., Tana P., Prudente M., Boonyatumanond R., Zakaria M., Akkhavong K., Ogata K., Hirai H., Iwasa S., Mizukawa I., Hagino U., Imamura A., Saha M., H. Takada (2009) Transport and release of chemicals from plastics to the environment and to wildlife. Philosophical Transactions of the Royal Society B, 364, 2027–2045.

Tomás J., Guitart R., Mateo R., J.Raga (2002). Marine debris ingestion in loggerhead sea turtles, Caretta caretta, from the Western Mediterranean. Mar. Pollut. Bull. 44, 211-216.

Thompson R. C., Moore C., vom Saal F. S., S.Swan (2009) Plastics, the environment and human health: current consensus and future trends. Phil. Trans. R. Soc. B 364. (doi:10.1098/rstb.2009.0053).

Topcu T., G.Ozturk (2013) Origin and abundance of marine litter along sandy beaches of the Turkish Western Black Sea Coast. Mar. Env. Res., 85, 21-28

Travaglini A., Matiddi M., Ciampa M., Alcaro L., F. Bentivegna (2013) Marine litter in loggerhead sea turtles (Caretta caretta) from Central and Southern Italian waters: analysis from dead and alive turtles. Proceedings of the Biology and ecotoxicology of large marine vertebrates and sea birds: potential sentinels of Good Environmental Status of marine environment, implication on European Marine Strategy Framework Directive. 5-6 June, Siena.

Triessing P., Roetzer A., M. Stachowitsch (2012) Beach Condition and Marine Debris: New Hurdles for Sea Turtle Hatchling Survival. International Journal of Turtle and Tortoise Research. Chelonian Conservation and Biology, 2012, 11(1): 68–77.

Turra A., Manzano A., Dias R., Mahiques M., Silva D., F Moreira (2014) Three-dimensional distribution of plastic pellets in sandy beaches: shifting paradigms. Nature, Scientific Reports, 4, 4435, doi:10.1038 /srep04435

Tweehuysen G. (2015) Sampling River litter: Preliminary results. Micro-2015. Seminar of the Defishgear projct, Abstract book, Piran 4-6 may 2015, p 29.

UNEP/IOC/FAO (1991) "Assessment of the state of pollution of the Mediterranean Sea by persistent synthetic materials which may float, sink or remain in suspension", MAP Technical Reports Series No. 56, 1991

UNEP/MAP/MEDPOL (2004) "Guidelines on management of coastal litter for the Mediterranean region", MAP Technical Reports Series No. 148, UNEP/MAP, Athens, 2004

UNEP (2009), Marine Litter A Global Challenge, Nairobi: UNEP. 232 pp.

UNEP (2012) Réunion du groupe de correspondance sur le bonEtat écologique et les cibles Module thématique: Pollution et Détritus, Sarajevo, 29-30 octobre 2012, UNEP(DEPI)/MED WG.379.inf 4.4, 24 pages.

UNEP (2013) Regional action plan on Marine litter, UNEP (DEPI)/MED WG. 379/5, 28 pages.Plan for the Marine Litter Management in the Mediterranean, Meeting of Medpol foacl pointrs, Barcelona, 18-

UNEP/MAP (2014) Main elements of a draft Integrated Monitoring and Assessment Programme , UNEP(DEPI)/MED WG.411/3, 265 page

UNEP/ MAP/ CORMON (2015) 1st Report of the Informal Online Working Group on Marine Litter UNEP (DEPI)/MED WG.411/Inf.10, 59 pages.

United Nations, (2012) Report of the United Nations Conference on Sustainable Development, Rio de Janeiro, Brazil, 20–22 June 2012 A/CONF.216/16

Ugolini A., Ungherese G., Ciofini M., Lapucci A., M. Camaiti (2013) Microplastic debris in sandhoppers. Estuarine, Coastal and Shelf Science, Volume 129, 1 September 2013, Pages 19-22.

Van cauwenberghe L., Vanreusel A., Maes J., C.Janssen (2013) Microplastic pollution in deep Sea sediments. Environ Pollut. 2013 Nov;182:495-9. Doi: 10.1016/j.envpol.2013.08.013. Epub 2013.

Van Franeker J.A. (2004) Save the North Sea Fulmar-Litter-EcoQO Manual Part 1: Collection and dissection procedures. Wageningen, Alterra, Alterra-rapport 672.

Van Franeker J.A., Heubeck M., Fairclough K., Turner D., Grantham M., Stienen E., Guse N., Pedersen J., Olsen K., Andersson P., B. Olsen (2005) 'Save the North Sea' Fulmar Study 2002-2004: A regional pilot project for the Fulmar-Litter EcoQO in the OSPAR area. Wageningen, Alterra, Alterra-rapport 1162. 70 blz. ; 19 fig.; 8 tab.; 19 ref.

Van Franeker J.A. & the SNS Fulmar Study Group (2008). Fulmar Litter EcoQO Monitoring in the North Sea. Results to 2006. IMARES report nr C033/08. Wageningen IMARES, Texel.

Van Franeker J.A., Blaize C., Danielsen J., Fairclough K., Gollan J., Guse N., Hansen P.L., Heubeck M., Jensen J.K., Le Guillou G., Olsen B., Olsen K.O., Pedersen J., Stienen E., D.Turner (2011) Monitoring plastic ingestion by the northern fulmar *Fulmarus glacialis* in the North Sea. Environ. Pollut. 159, 2609-2615.

Valavanidis A., T. Vlachogianni (2011) MARINE LITTER: Man-made Solid Waste Pollution in the Mediterranean Sea and Coastline. Abundance, Composition and Sources Identification. SCIENCE ADVANCES ON ENVIRONMENTAL CHEMISTRY, TOXICOLOGY and ECOTOXICOLOGY, www.chem-tox-ecotox.org, 15 pages

Vianello A., Boldrin A., Guerriero P., Moschino V., Rella R., Sturaro A., L. Da Ros (2013) Microplastic particles in sediments of Lagoon of Venice, Italy: first observations on occurrence, spatial patterns and identification, Estuarine, Coastal and Shelf Science, doi: 10.1016/j.ecss.2013.03.022.

Vianello A., Acri F., Aubry F., Boldrin A., Camati E., Da Ros L., Merceta T., V. Moschind (2015) Occurrence of floating microplastics in the North Adriatic Sea: prelmiminary results. Micro 2015. Seminar of the Defishgear projct, Abstract book, Piran 4-6 may 2015, p 43

Vlachogianni T. (MIO-ECSDE), V. Kalampokis (2014) Marine Litter Monitoring in the Adriatic. A review of available data and applied methods. Project report, Defishgear project (http://defishgear.net/), 20 pages

Von Moos N., Burkhardt-Holm P., A. Köhler (2012) Uptake and Effects of Microplastics on Cells and Tissue of the Blue Mussel *Mytilus edulis* L. after an Experimental Exposure.Env. Sc. Tech., 46(20):11327-35.

Votier S., Archibald K., Morgan G., L.Morgan (2011) The use of plastic debris as nesting material by a colonial seabird and associated entanglement mortality. Mar. Pollut. Bull. 62, 168-172.

White M., Haxhiu I., Kararaj E., Perkeqi D., Petri L., Sacdanaku E., Boura L., L.Venizelos (2013) Plastic debris at an important sea turtle foraging ground in Albania. In Blumenthal J., Panagopoulou A., Rees A. F. (Compilers) Proceedings of the thirtieth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFC-640, pp. 73-74.

Würtz M. (ed.) (2012). Mediterranean Submarine Canyons: Ecology and Governance. Gland, Switzerland and Málaga, Spain: IUCN. 216 pages.

Zambianchi E, Iermano I., S. Aliani (2014) Marine litter in the Mediterranean Sea, An Oceanographic perspective. In Ciesm Workshop N°46 (Coordination F Galgani), Tirana, 18-21 juin 2014, 172 pages.

Zarfl C., Fleet D., Fries E., Galgani F., Gerdts G., Hanke G., M. Matthies (2011) Microplastics in oceans. Marine Pollution Bulletin, 62, 1589–1591

Zettler E., Mincer T., L.Amaral-Zettler (2013) Life in the “Plastisphere”: Microbial Communities on Plastic Marine Debris. Environ. Sci. Technol., 2013, 47 (13), pp 7137–7146, DOI: 10.1021/es401288x

Zorzo Gallego (2015) Guide on best practices for fishing for litter in the Mediterranean. UNEP/MAP document, 17p, in press