Marine Debris in the deep Mediterranean Sea

Michela Angiolillo · Simonepietro Canese

michela.angiolillo@isprambiente.it
MARINE DEBRIS

Any persistent, manufactured or processed solid material of human origin discarded, disposed of or abandoned in the coastal and marine environment (UNEP, 2009)

Beach litter
at the sea surface or washed up on shorelines

Floating debris
transported by wind and currents at the sea surface

Submerged debris
on the sea bottom

DEPTH

HUMAN PERCEPTION

STUDIES NUMBER

social problem
aesthetic impact and influence on public health

Ingestion and entanglement of charismatic organisms

lack of perception and limited accessibility
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Beach litter

Floating debris

Submerged debris
MARINE DEBRIS
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Submerged debris

Limited knowledge about impact of litter to benthic invertebrates on deep seafloor
Most invertebrate species play important key roles in marine ecosystems in deeper seas
**MARINE LITTER SOURCES**

- littering from recreational uses of coast and ports;
- tourism;
- shipyards and ship-breaking yards;
- legal and illegal dumps located near the coast;
- general public litter;
- urban and industrialized areas;
- sewage overflows;
- river discharge;
- introduction by accidental loss and extreme events.

*Main source of marine debris worldwide*

50–80% of all marine debris comes from terrestrial activities

*(Bowmer and Kershaw, 2010)*

**Land-based**
**MARINE LITTER SOURCES**

**Marine-based**

- commercial and recreational shipping
- fishing activities
- maritime traffic
- military and research fleets
- aquaculture sites
- offshore installations (e.g. rigs and platforms)
- legal and illegal dumping at sea

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**20–50% of all marine debris comes from maritime activities as maritime traffic and fishing activities**

(OSPAR, 2009)
Factors Influencing Debris Distribution

Types, amount and accumulation rates vary widely as a result of complex interactions between anthropogenic and environmental factors.

- coastline morphology
- topography
- geography
- hydrodynamics
- oceanographic processes
- temporal variations
- seasonality

extremely irregular distribution of marine debris throughout the oceans

FACTORS INFLUENCING DEBRIS DISTRIBUTION

Types, amount and accumulation rates vary widely as a result of complex interactions between anthropogenic and environmental factors.

Canyons, seamounts, rock banks, mounds, depressions, channels may act as the main vectors for the transport of marine debris, conveying it from the continental shelf into the deep seafloor.

The most common items:

- plastic
- bags
- Food and beverage containers
- glass
- metal objects
- paper
- wood products
- fishing gears
- unidentifiable plastic or polystyrene

320 million tons of plastic per year
(PlasticEurope, 2016)

4.8 to 12.7 million tons of litter per year
ends up in the marine ecosystem
(Jambeck et al, 2015; Tubau et al, 2015; UNEP, 2009)
The predominance of plastics in litter is also the result of its exceptional durability or persistence in the environment (Andrady, 2015)

320 million tons of plastic per year (PlasticEurope, 2016)

4.8 to 12.7 million tons of litter per year ends up in the marine ecosystem (Jambeck et al, 2015; Tubau et al, 2015; UNEP, 2009)
The most common method

- Quantitative study
- Direct inspection of debris
  - size
  - weight
- low costs of operation
- Only soft substrate
- No precise localization of items
- Severe impact on habitats
METHODS - ROV / SUBMERSIBLE / TOWED CAMERA
(Remotely Operated Vehicle)

- Controlled sampling
- Quantitative study
  • debris occurrence
  • debris density
- Every type of substrate
- No impact on habitats
- No direct debris inspection
- Problematic identification in poor-visibility environments

number, type of each item - total sampled area - depth range
→ Density (items/unit of area)
**MEDITERRANEAN SEA**

- Closed basin (2.5 million km²)
- Average depth of 1,500 m
- Deepest recorded point is 5,267 m
- Densely populated (≈466 million)
- Tourism
- Shipping
- Intense traditional fishing activity
- Overfishing (more than 65% of all fish stocks are outside safe biological limits or threatened, EEA, FAO)
- Biodiversity hotspot
- Endemic species

High levels of pollutants
DISTRIBUTION AND ABUNDANCE

- Mediterranean papers: Stefatos et al., 1999; Galgani et al., 2000, 2015; Koutsodendris et al., 2008; Güven et al., 2013; Misfud et al., 2013; Ramirez-Llodra et al., 2013; Sanchez et al., 2013; Bo et al., 2014; Fabri et al., 2014; Ioakeimidis et al., 2014; Angiolillo et al., 2015; Mytilineou et al., 2015; Strafella et al., 2015; Tubau et al., 2015; Pasquiniet al., 2016; Cau et al., 2017; Garcia-Rivera et al., 2017; Inge et al., 2017; Melli et al., 2017; Alvito et al., in press

- World papers: Stefatos et al., 1999; Galgani et al., 2000, 2015; Koutsodendris et al., 2008; Güven et al., 2013; Misfud et al., 2013; Ramirez-Llodra et al., 2013; Sanchez et al., 2013; Bo et al., 2014; Fabri et al., 2014; Ioakeimidis et al., 2014; Angiolillo et al., 2015; Mytilineou et al., 2015; Strafella et al., 2015; Tubau et al., 2015; Pasquiniet al., 2016; Cau et al., 2017; Garcia-Rivera et al., 2017; Inge et al., 2017; Melli et al., 2017; Alvito et al., in press

- 0 to >15,000 items km$^{-2}$
- 40–1,700 m depth
**DISTRIBUTION AND ABUNDANCE**

- Different results
- Different unit of measure
- Difficult comparisons
- Underestimate of debris abundance

<table>
<thead>
<tr>
<th>Location</th>
<th>Depth (m)</th>
<th>Density</th>
<th>Ref.</th>
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</thead>
<tbody>
<tr>
<td>ROV</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Spain canyons, Spain</td>
<td>140–1,731</td>
<td>8,090–15,057 items km⁻²</td>
<td>Tubau et al, 2015</td>
</tr>
<tr>
<td>Sardinia coast, Italy</td>
<td>100–460</td>
<td>0.0175 items m⁻²</td>
<td>Cau et al, 2017</td>
</tr>
<tr>
<td>TRAWLING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gulf of Alicante, Spain</td>
<td>50–700</td>
<td>0.1–43.4 kg km⁻²</td>
<td>Garcia-Rivera et al, 2017</td>
</tr>
<tr>
<td>Calabrian Slope, Italy</td>
<td>1400</td>
<td>0.6±0.4 kg ha⁻¹</td>
<td>Ramirez-Llodra et al, 2013</td>
</tr>
<tr>
<td>Ionian Sea, Greece</td>
<td>40–80</td>
<td>25.18±7.84 pd ha⁻¹</td>
<td>Sanchez et al, 2013</td>
</tr>
<tr>
<td>Saronikos Gulf, Greece</td>
<td>50–350</td>
<td>1,211±594 items km⁻²</td>
<td>Ioakeimidis et al, 2014</td>
</tr>
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</table>

**0 to >15,000 items km⁻²**
The type and abundance of debris can be biased according to the characteristics of the explored sea bottom and employed methods.

80% of litter items caught in benthic trawl nets are plastic objects.

**PLASTIC**

- low density, durability, relatively low cost
- lightness, strength and buoyancy
- Negligible biological decomposition

→ Dispersion in the water column
→ Persistence at the seafloor
→ Formation of fragment and microplastic

(Galgani et al, 2015; Tubau et al, 2015)

- Suffocation

- Entangled or ingestion

- Chemical and physical pollution
The type and abundance of debris can be biased according to the characteristics of the explored sea bottom and employed methods.

70% of litter items assessed by ROVs in rocky habitats is fishing gear. e.g. Angiolillo et al, 2015; Bo et al, 2014; Cau et al, 2017; Fabri et al, 2014
FISHERY-RELATED DEBRIS

- Trammel nets, gillnets, long-lines, cables, anchors, pots, fishing sinker, etc.
- made of nylon or polyamide
- negative buoyancy
- lost or snagged on the bottom

→ Progressive habitat degradation
→ Reduction of the coverage by biota

Lying

Hanging

no apparent injury
FISHERY-RELATED DEBRIS

- Entangled in the rocks
- Remotion of non-target species (by-catch)
- Reduction of the coverage of habitat-forming species
- Reduction of diversity and abundance of associated invertebrates and fishes
- Increase of fast growing epibionts

Abrasions

direct physical damage

Covering

Colony loss
**GHOST FISHING**

- Lost fishing gear in its working position
- Catch durations of derelict gill- and trammel-nets
  30 - 568 days  (Matsuoka et al, 2005)

→ Continue to catch a large spectrum of organisms
→ Restricted movements and reduced foraging ability
→ Cathed organisms die for stress, injuries or starvation
**OTHER DEBRIS**

any kind of garbage (tyres, beverage cans, glass bottles, oil drums, containers and other bigger objects (washing machines, bins), wrecks, pharmaceuticals, etc.)

- Provide artificial substrata for sessile organisms
- Provide shelters for vagile fauna
- Prevent gas exchange
- Alter the natural environment
- Modify the spatial heterogeneity and the community structure
Sponges, corals and gorgonians
• Long-lived species
• Slow-growth
• Low recovery ability
• Ecosystem engineers

**Key ecological role in deep marine environments**

Form three-dimensional habitats enhancing high biodiversity and ecosystem functioning at every level
MEDITERRANEAN VULNERABLE MARINE ECOSYSTEMS (VMEs)

- Sponge ground
- Coral gardens
- Cold Water Corals (CWC)
MEDITERRANEAN VULNERABLE MARINE ECOSYSTEMS (VMEs)

- Sponge ground
- Coral gardens 50-300 m depth
  rocky bottom
- Cold Water Corals (CWC)

Mixed assemblages of:
Black corals
Gorgonians
Scleractinians
MEDITERRANEAN VULNERABLE MARINE ECOSYSTEMS (VMEs)

- Sponge ground
- Coral gardens
- Cold Water Corals (CWC)

> 300 m depth

Assemblages of:
Madrepora oculata
Lophelia pertusa
**MEDITERRANEAN VULNERABLE MARINE ECOSYSTEMS (VMEs)**

- Sponge ground
- Coral gardens 115-1200m
  *soft bottom*
- Cold Water Corals (CWC)

*Isidella elongata*
HABITAT refuge, feeding grounds of commercial species
Longline fishing was the most widespread activity, detected in 45% of the ocean more than trawling (9.4%) (Kroodsma et al. 2018, Science)

- Direct physical damage to benthic sessile organisms
- No direct impacts on the integrity of the seafloor
**THREATS**

- mechanical smoothening
- sediment re-suspension

→ habitat degradation
→ limited nutrition of filter feeders
→ damage vulnerable surrounding habitat

*Isidella elongata*
Critically Endangered

TRAWLING
**MEASURE**

**Annex II Protocol SPA/BD of the Barcelona Convention (December 2017)**

Obligation for signatory countries to establish protection measures

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obligation for specific monitoring activities to fill the knowledge gaps about the spatial distribution, composition and sources of marine debris

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**Scientific Advisory Committee on Fisheries (SAC)**

Report of the first meeting of the Working Group on Vulnerable Marine Ecosystems (WGVME)

Malaga, Spain, 3-5 April 2017

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**EXECUTIVE SUMMARY**

The first meeting of the Working Group on Vulnerable Marine Ecosystems (WGVME) took place from 3 to 5 April 2017 at the La Noria Cooperation Center, Malaga, Spain and was organized in collaboration with the International Union for Conservation of Nature – Mediterranean (IUCN-Med) and Ocean. As agreed by the forty-first session of the GFCM (June 2016, Malta), the meeting discussed appropriate measures related to the protection of VMES according to the FAO mandate. In particular, it addressed issues relating to the definition and management of deep-sea fisheries (DSF) and vulnerable marine ecosystems (VMES) in the Mediterranean, within the framework of the 2004, 2006 and 2009 Resolutions of the United Nations General Assembly (UNGA) and of the FAO International Guidelines for the Management of Deep-sea Fisheries in the High Seas (2009). The UNGA resolutions and the FAO Guidelines provide guidance to States and regional fisheries management organizations (RFMOs) on the long-term conservation and sustainable use of marine living resources in the high seas, including preventing significant adverse impacts (SAIs) on VMES by bottom-contact fishing gear. The meeting reviewed the current GFCM management measures specific to deep-sea fisheries and biodiversity protection and the relevant associated conclusions and recommendations from previous meetings (including SAC, Commission and FAO workshops). The meeting formulated proposals to GFCM SAC to further address the management of DSF and the protection of VMES in the GFCM area of application. This included the adoption of VME indicators (features, habitats and taxa) and management elements for the establishment of a VME encounter protocol, an exploratory deep-sea bottom fishing protocol, and for the mapping of the existing deep-sea fishing areas for the Mediterranean.

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**Habitat Directive 92/43/CEE**

Proposed offshore areas for Natura 2000 network
Marine litter represents a threat to deep ecosystems, making them extremely vulnerable.

- The continuous pressures of human activity cause an impoverishment of the marine resources and could lead to loss of huge resources and value even before knowing and studying it.

- In spite of the scientific consensus considering marine litter as a major threat to ecosystems distribution, baseline abundance, composition and effects of debris on marine communities and its habitats remain poorly known.

- Considerable variation exists in methodologies between regions and investigator, so that no global estimates of benthic litter are available.

- Standardized approaches and specific conservation measures are now an international priority and are needed in order to generate comparable information about temporal and spatial distribution of marine litter and protect unique deep-ecosystems that are progressively threatened to disappear.

- A precautionary approach is needed for reducing the amount of marine litter in the environment.
Thank You