Plastic Busters MPAs Info Day

MARLICE 2019

International Forum on Marine Litter and Circular Economy

MEDITERRANEAN REGION SESSION I - BIODIVERSITY AND MARINE LITTER: RESEARCH AND MEASURES

Novel approach on marine litter impacts on biota through Plastic Busters MPAs

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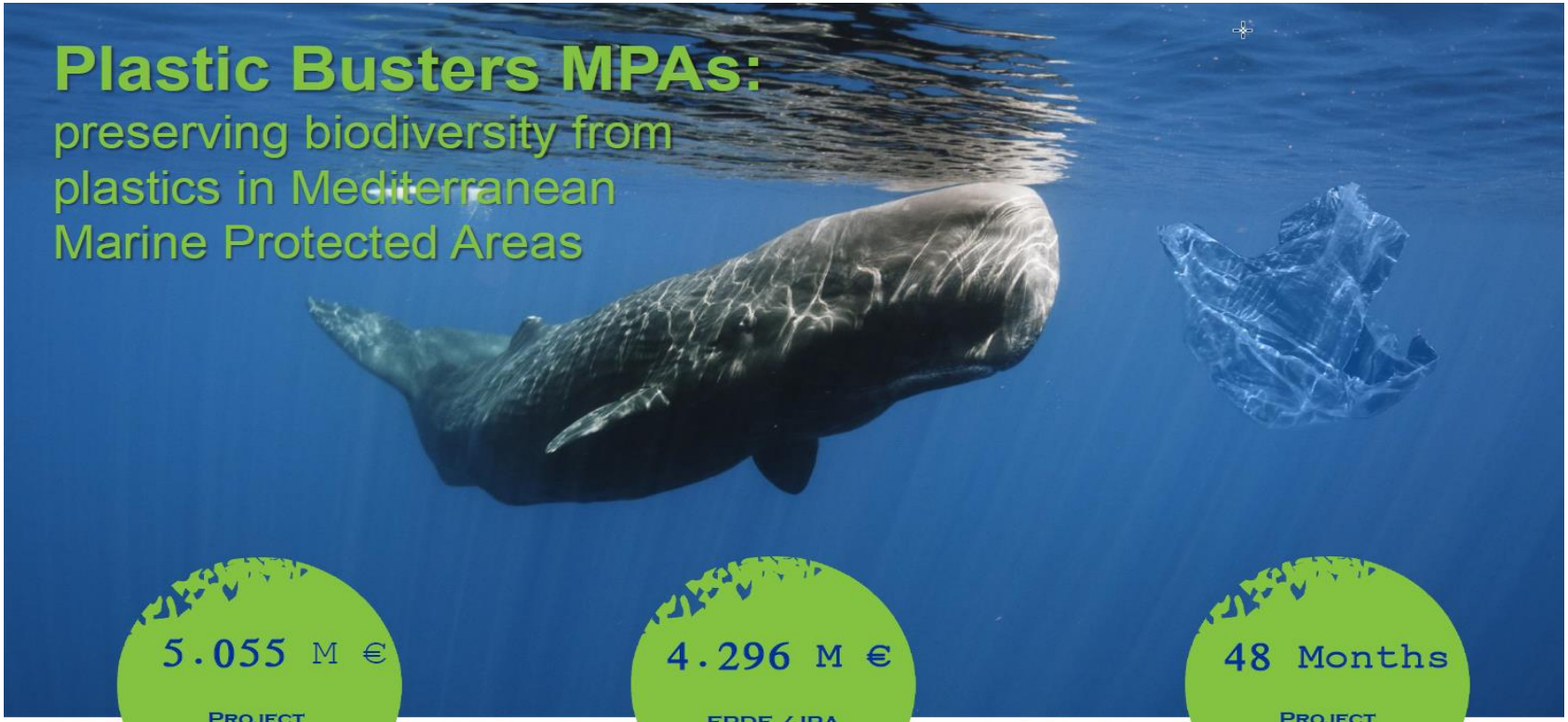
Plastic Busters MPAs:
preserving biodiversity from plastics in Mediterranean Marine Protected Areas



5.055 M €
PROJECT BUDGET

4.296 M €
ERDF / IPA

48 Months
PROJECT DURATION

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Impact of marine litter in biota

Marine litter can **impact biodiversity** in a number of ways, namely through litter **ingestion**, **entanglement** (e.g., in ghost nets), facilitation of the **transportation** of marine organisms via rafting on litter items, **damages to benthic habitats** and communities as well as through release and diffusion of **toxic compounds** that can potentially lead to bio-accumulation and biomagnification.

Ingestion

Entanglement

Marine litter as transport vector and a habitat

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Ingestion: State of the Art
D3.2.1

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- ✓ Plastic litter can be ingested **intentionally** (foraging techniques, colour, age stage) or **accidentally** (filter-feeding and secondary ingestion).
- ✓ Plastic ingestion may **directly cause mortality** or can affect animals by **slower sub-lethal physical** and **chemical effects**.
- ✓ From **2013 to 2018**, more than **40 papers** have been published on the incidence of **marine litter ingestion** in marine organisms in the **Mediterranean basin**.
- ✓ Most of the research was carried out on the **Western Mediterranean Sea**, whereas the Ionian Sea and the Central Mediterranean Sea, the Adriatic Sea, and the Aegean Levantine Sea were less investigated.

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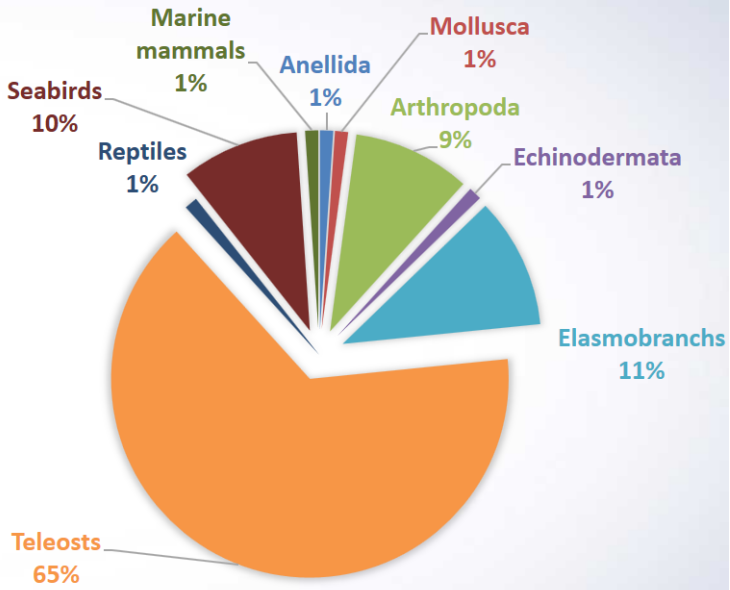
State of the art: Species

- ✓ Over the same period, in these studies litter ingestion has been **investigated** on **94 Mediterranean species**, belonging to different taxonomic groups.
- ✓ Among these, in only **74 out of 94** species the **ingestion** of marine litter items **has been documented**.
- ✓ While **fish** species represent the **majority of the affected species**, also a **considerable number** of **endangered species** have been reported to ingest marine litter.
- ✓ All Mediterranean **sea turtles** (*Caretta caretta*, *Chelonia mydas* and *Dermochelys coriacea)* and some **marine mammals** (*Physeter microcephalus, Balaenoptera physalus, Tursiops truncatus, Grampus griseus and Stenella coerulealba*) were found to be **affected by debris ingestion** in published studies.



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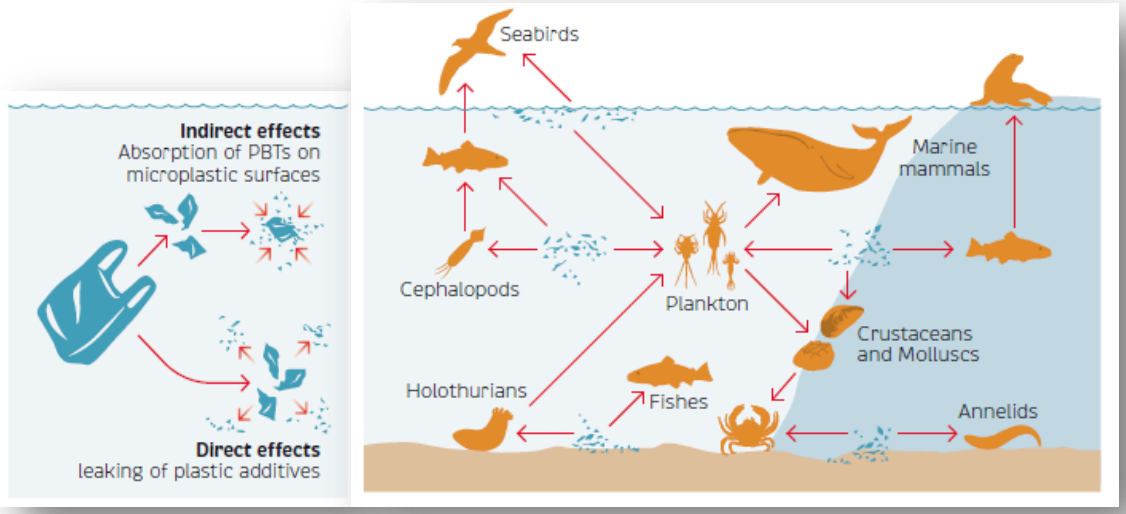
Impact of microplastics on marine organisms

1 - Transport of persistent, bioaccumulating toxic (PBT) substances from plastics
2 - Leaching of additives from the plastics such as phthalates
3 - Physical harm
4 - Virus and bacteria

Multiple Stress



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Species to be investigated

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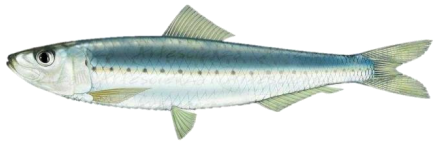
THREATENED OR ENDANGERED SPECIES

Stranded or resulting from accidental mortalities organisms. Regarding **living specimens**, several biological materials can be collected, using a non-invasive technique, in rescue facilities (sea turtles and birds). **Skin biopsies sampling** in cetaceans is well established techniques. **Special permits** are required for transport and necropsy and it is advantageous to involve regional or national networks to maximize sample retrieval.



COMMERCIALLY HARVESTED SPECIES

Specimens and samples can be easily become available through **fishing activities**. Invertebrates and fish can be obtained from existing active **monitoring programs** or from *ad hoc* monitoring campaigns using fishing vessels.

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The two Pillars of International Governance: MSFD and IMAP

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

Marine Litter and the Barcelona Convention Ecosystem Approach

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

IMAP Common Indicator 22:

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

IMAP Common Indicator 22:

Trends in the amount of litter in the water column including micro plastics and on the seafloor.

IMAP Candidate Indicator 24:

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

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

Marine Litter within the EU MSFD

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

Criteria D10C1 - Primary:

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

- ✓ amount of litter washed ashore and/or deposited on coastlines, including analysis of its composition, spatial distribution and, where possible, source (10.1.1)
- ✓ amount of litter in the water column (including floating at the surface) and deposited on the seafloor, including analysis of its composition, spatial distribution and, where possible, source (10.1.2)
- ✓ amount, distribution and, where possible, composition of microparticles (in particular microplastics) (10.1.3)

Criteria D10C2 - Primary:

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

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

Criteria D10C3 - Secondary:

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

Criteria D10C4 - Secondary:

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

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18.5.2017 EN Official Journal of the European Union L 125/43

COMMISSION DECISION (EU) 2017/848

of 17 May 2017

laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU

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

Descriptor 10

Properties and quantities of marine litter do not cause harm to the coastal and marine environment

DOES ML ADVERSELY AFFECT THE HEALTH OF THE SPECIES ?

The quantification of marine litter ingestion is not enough…
we need to investigate the effects on health!

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Bioindicators for monitoring marine litter ingestion and impacts on Mediterranean Biodiversity

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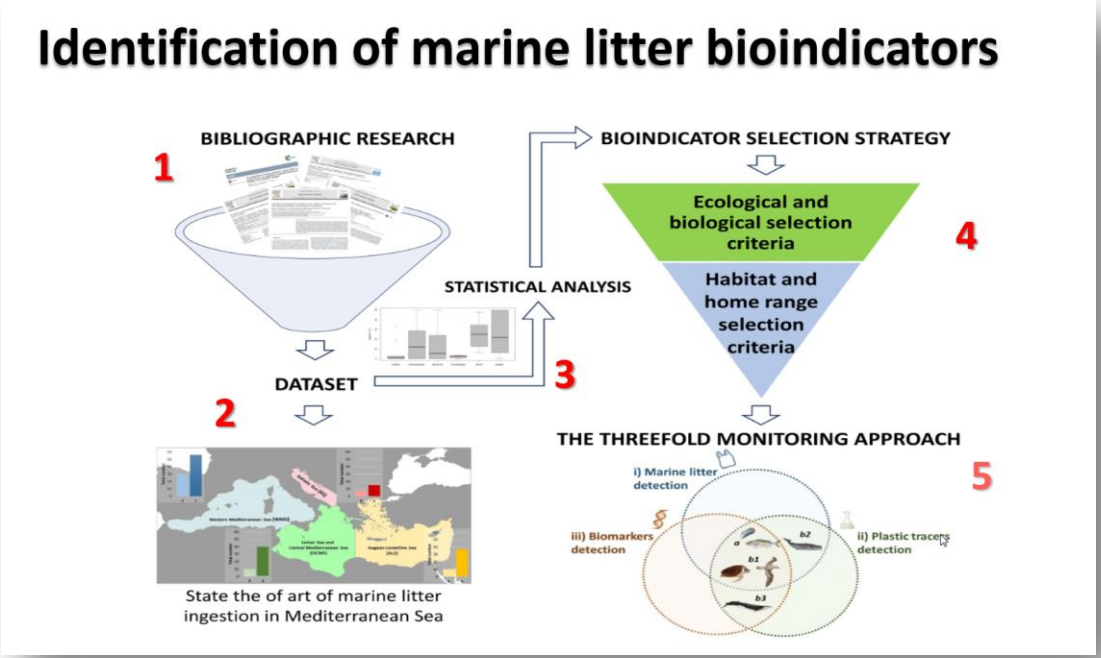


Environmental Pollution xxx (2017) 1–10

Contents lists available at ScienceDirect

Environmental Pollution

journal homepage: www.elsevier.com/locate/envpol

Bioindicators for monitoring marine litter ingestion and its impacts on Mediterranean biodiversity☆

Maria Cristina Fossi [a, b], Cristina Pedà [c], Montserrat Compa [d], Catherine Tsangaris [e], Carme Alomar [d], Francoise Claro [f], Christos Ioakeimidis [g], Francois Galgani [h], Tatjana Hema [g], Salud Deudero [d], Teresa Romeo [c], Pietro Battaglia [c], Franco Andaloro [c], Ilaria Caliani [a, b], Silvia Casini [a, b], Cristina Panti [a, b, *], Matteo Baini [a, b]

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Percentage and ranking of marine litter ingestion in the Med species calculated on the data present in literature

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% of ingestion

Species	% of ingestion
Balaenoptera physalus (Linnaeus, 1758)	100.00%
Calonectris diomedea (Scopoli, 1769)	95.92%
Siganus luridus (Rüppell, 1829)	86.67%
Cetorhinus maximus (Gunnerus, 1765)	83.33%
Pagrus pagrus (Linnaeus, 1758)	77.78%
Physeter macrocephalus Linnaeus, 1758	77.78%
Argyrosomus regius (Asso, 1801)	74.51%
Puffinus yelkouan (Acerbi, 1827)	70.97%
Mullus surmuletus Linnaeus, 1758	70.59%
Puffinus mauretanicus Lowe, 1921	69.57%
Diplodus annularis (Linnaeus, 1758)	68.75%
Boops boops (Linnaeus, 1758)	67.71%
Pagellus acarne (Risso, 1827)	67.31%
Serranus cabrilla (Linnaeus, 1758)	66.67%
Pelates quadrilineatus (Bloch, 1790)	65.19%
Trachurus mediterraneus (Steindachner, 1868)	62.13%
Saurida undosquamis (Richardson, 1848)	55.56%
Pomadasys incisus (Bowdich, 1825)	55.17%
Nemipterus randalli Russell, 1986	54.81%
Dermochelys coriacea (Vandelli, 1761)	50.00%
Scomber japonicus Houttuyn, 1782	47.73%
Upeneus moluccensis (Bleeker, 1855)	44.44%
Sparus aurata Linnaeus, 1758	43.64%
Liza aurata (Risso, 1810)	43.59%
Upeneus pori Ben-Tuvia & Golani, 1989	41.03%

Species	% of ingestion
Trigla lucerna Linnaeus, 1758	37.50%
Mullus barbatus Linnaeus, 1758	36.03%
Lithognathus mormyrus (Linnaeus, 1758)	34.78%
Larus michahellis J.F. Naumann, 1840	33.33%
Trachyrincus scabrus (Rafinesque, 1810)	33.33%
Polyprion americanus (Bloch & Schneider, 1801)	32.35%
Caretta caretta (Linnaeus, 1758)	31.10%
Dentex gibbosus (Rafinesque, 1810)	28.57%
Schedophilus ovalis (Cuvier, 1833)	28.57%
Trachinotus ovatus (Linnaeus, 1758)	24.35%
Trachurus trachurus (Linnaeus, 1758)	24.00%
Pagellus erythrinus (Linnaeus, 1758)	22.39%
Squalus acanthias Linnaeus, 1758	21.05%
Sardina pilchardus (Walbaum, 1792)	20.41%
Naucrates ductor (Linnaeus, 1758)	18.00%
Nettastoma melanurum Rafinesque, 1810	16.67%
Coryphaena hippurus Linnaeus, 1758	14.34%
Balistes capriscus Gmelin, 1789	14.00%
Larus audouinii Payraudeau, 1826	13.33%
Thunnus alalunga (Bonnaterre, 1788)	12.90%
Thunnus thynnus (Linnaeus, 1758)	12.67%
Morus bassanus (Linnaeus, 1758)	12.50%
Xiphias gladius Linnaeus, 1758	12.28%
Stenella coerulealba (Meyen, 1833)	11.67%
Tursiops truncatus (Montagu, 1821)	11.17%
Cataetyx laticeps Koefoed, 1927	10.00%

Species	% of ingestion
Mora moro (Risso, 1810)	9.09%
Etmopterus spinax (Linnaeus, 1758)	8.82%
Merluccius merluccius (Linnaeus, 1758)	7.69%
Galeus melastomus Rafinesque, 1810	7.11%
Hygophum benoiti (Cocco, 1838)	6.85%
Electrona risso (Cocco, 1829)	6.10%
Myctophum punctatum Rafinesque, 1810	4.23%
Centroscymnus coelolepis Barbosa 1864	2.99%
Solea solea (Linnaeus, 1758)	2.27%
Seriola dumerili (Risso, 1810)	2.00%
Citharus linguatula (Linnaeus, 1758)	1.92%
Pagellus bogaraveo (Brünnich, 1768)	1.67%
Squalus blainville (Risso, 1827)	1.33%
Trachurus picturatus (Bowdich, 1825)	1.00%
Helicolenus dactylopterus (Delaroche, 1809)	0.42%
Diaphus metopoclampus (Cocco, 1829)	0.34%
Alepocephalus rostratus Risso, 1820	0.00%
Brama brama (Bonnaterre, 1788)	0.00%
Conger conger (Linnaeus, 1758)	0.00%
Molva macrophthalma (Rafinesque, 1810)	0.00%
Phycis blennoides (Brünnich, 1768)	0.00%
Raja oxyrinchus Linnaeus, 1758	0.00%

Fossi et al., 2018

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Plastic Busters MPAs WP4: Biota Monitoring

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Target species – Secondary species

	SEA SURFACE	COASTAL WATERS	OPEN WATERS	SEAFLOOR	COAST LINE AND BEACH SEDIMENT
BASIN SCALE (Mediterranean Sea)	*Calonectris diomedea* *Puffinus yelkouan*	*Calonectris diomedea* *Puffinus yelkouan*	***Caretta caretta*** *Balaenoptera physalus* *Physeter macrocephalus* *Xiphias gladius* *Thunnus thynnus* *Chelonia mydas* *Dermocheyis coriacea*		
MEDIUM-SCALE (Mediterranean UN Environment/MAP sub-regions)			***Caretta caretta*** *Thunnus alalunga* *Coryphaena hippurus* *Euthynnus alletteratus* *Stenella striata* *Ziphius cavirostris*		
SMALL-SCALE (FAO GSA)	*Isopods* *Jellyfish (Pelagia)*	***Boops boops*** *Trachinotus ovatus*	***Engraulis encrasicolus*** ***Sardina pilchardus*** *Trachurus sp.* *Sardinella aurita* Myctophids	***Mullus surmuletus*** ***Diplodus sp.*** *Pagellus sp.* *Spondyliosoma* *Lithognathus mormyrus* *Galeus melastomus* *Merluccius merluccius*	
LOCAL SCALE				***Paracentrotus lividus*** Holothurians	***Decapods (Pachygrapsus marmoratus)*** *Mytilus galloprovincialis (cages?)*

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THE THREEFOLD MONITORING APPROACH

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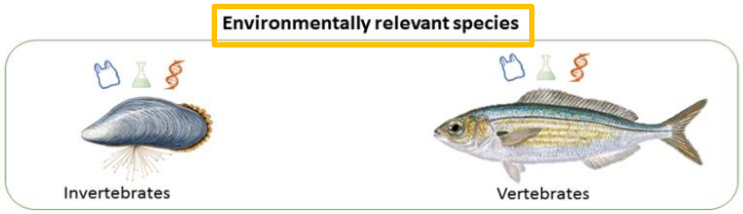

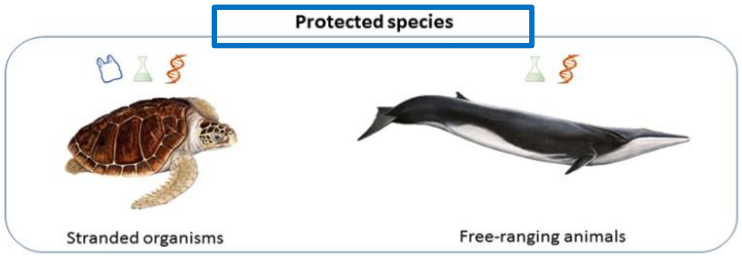

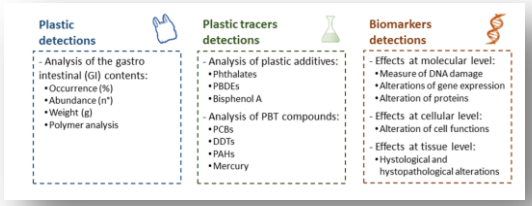

The simultaneous investigation in bioindicator species of:

A) the analysis of **gastro-intestinal content** to evaluate the **marine litter** ingested by the organisms;

B) the analysis of **plastic additives** and PBT compounds used as plastic tracers;

C) the analysis of the effects by **biomarkers responses** at different level of biological organization

… will allow a **more complete assessment of the real impact** related to plastic debris ingestion by marine organisms.


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Monitoring marine litter ingestion and impacts in commercially harvested species

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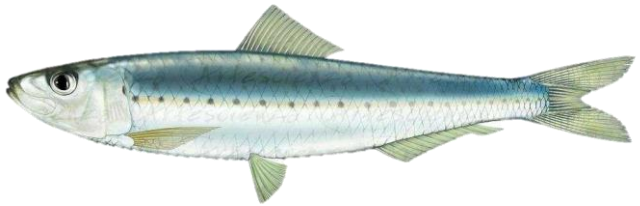

Ingestion

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Ingestion detection and effects in commercially harvested species

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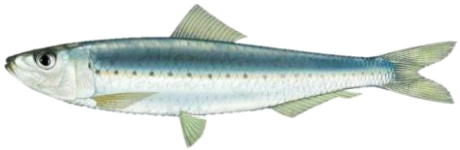

Several commercial fish and invertebrates comply to proposed criteria for selection of bioindicators

- sufficient background information for several species
- can be found in different habitats, known home ranges
- sufficient information on feeding behaviour
- wide spatial distribution for several species
- **commercial importance – link to human health**
- documented microplastic ingestion

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Fish species proposed as bioindicators for plastic ingestion

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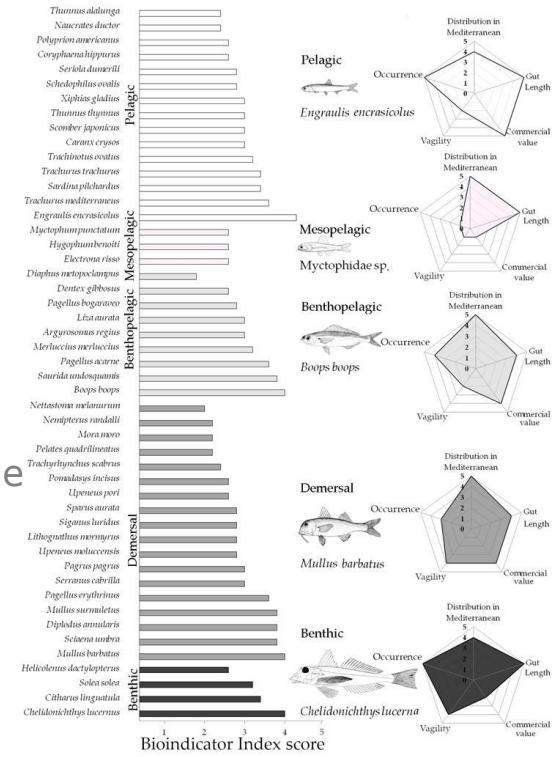
Trait	Scale	Description
Species Distribution	1	<10 % Coverage of Mediterranean
	2	11 - 30 % Coverage of Mediterranean
	3	31 – 60 % Coverage of Mediterranean
	4	61 - 70 Coverage of Mediterranean
	5	70 - 100 Coverage of Mediterranean
Gut length	1	> 100 cm
	2	31 - 100 cm
	3	21 - 30 cm
	4	11 - 20 cm
	5	< 10 cm
Commercial value	1	0 - 10,000 €/yr
	2	10,001 - 100,000 €/yr
	3	100,001 - 400,000 €/yr
	4	400,001 - 30,000,000 €/yr
Vagility	1	Migratory/ deep sea (MD)
	2	Oceanodromous (OC)
	3	Limited range (LR)
	4	Resident (RE)
Occurrence	1	0 - 10% Examined stomachs contain plastic
	2	11 - 30% Examined stomachs contain plastic
	3	31 - 40% Examined stomachs contain plastic
	4	41 - 60% Examined stomachs contain plastic
	5	61 - 100% Examined stomachs contain plastic

Small scale indicators



(Bray et al. 2018)

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Fish and invertebrate species proposed for monitoring ingestion of marine litter

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Taxon	Type of litter	Method	Infrastructure	Indicative Species	Priority	Remarks
Nektobenthic fishes	micro-plastics	Stomach contents	Coastal fishing and trawling	*Mullus sp., Boops sp.*	++	Wide distribution of species, easily caught
Demersal fishes	macro-litter	Stomach contents	Scientific and commercial trawling	*Scyliorhinus sp.*	+	Opportunistic collection possible
Pelagic fishes	micro-plastics	Stomach contents	Commercial fishing		+	Opportunistic collection possible
Molluscs	micro-plastics	Stomach contents / chemical	Collection, farming, chemical monitoring networks	*Mytilus sp.*	++	Existing collection networks, concerning public health
Crustacean	micro-plastics	Stomach contents / chemical	Collection		+	Work needed in the Mediterranean
Other invertebrates	micro-plastics	Stomach contents / chemical	Collection	Sea cucumbers	+	Work needed in the Mediterranean

Marine litter MED project

UNEP/MAP SPA/RAC, 2018

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Selection of species as bioindicators in coastal waters

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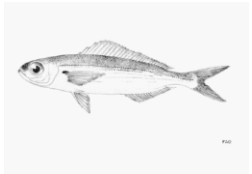
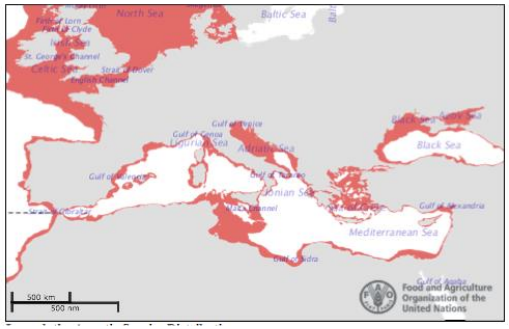
Boops boops





- Used as bioindicator for chemical contaminants monitoring in UNEP/MAP MED POL programme
- Used as bioindicator species for microplastic ingestion in MEDSEALITTER project

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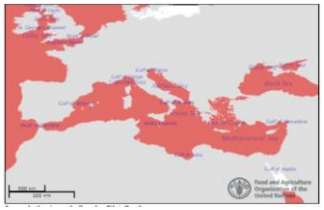
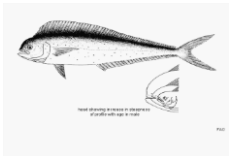
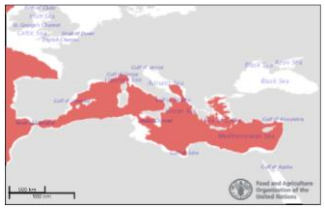
Selection of species as bioindicators in open waters

Xiphias gladius

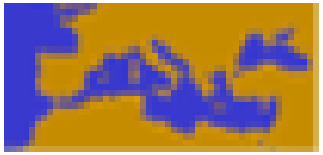


Coryphaena hippurus

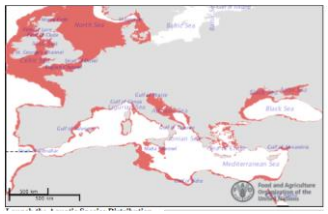




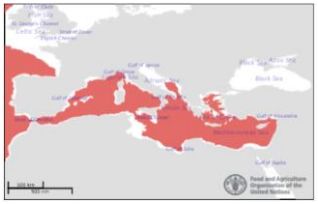
Thunnus thynnus



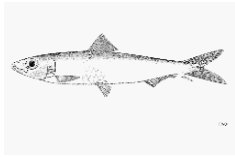
Engraulis encrasicolus

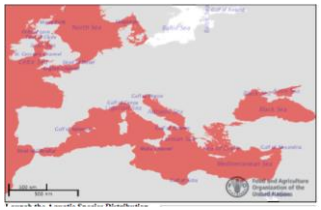


Thunnus allalunga



Sardina pilchardus





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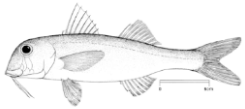
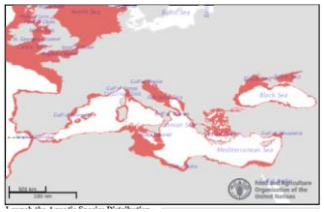
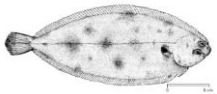
Selection of species as bioindicators on the seafloor

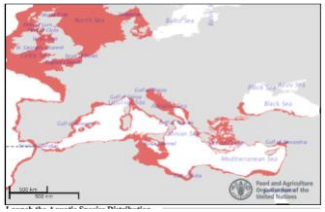
Mullus barbatus



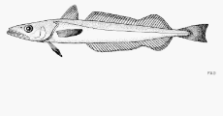


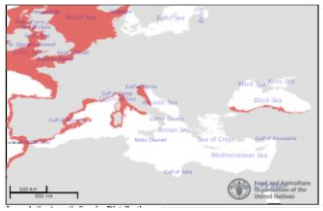
Solea solea





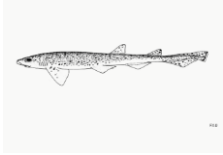
Merluccius merluccius



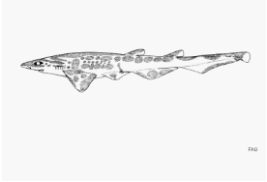


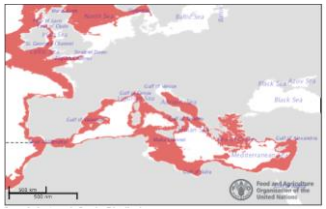
- Used as bioindicator species for monitoring chemical contaminants in UNEP/MAP MED POL programme
- Alternative species: *Mullus surmuletus*

Scyliorhinus canicula



Galeus melastomus





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Effects of microplastic ingestion in fish and invertebrate species

- Effects of microplastic ingestion mainly evaluated in laboratory exposed organisms
- Very few studies on effects of microplastic ingestion in field collected organisms
- Most field studies consider level of microplastic ingestion as indicative of impact
- Need to assess effects of microplastic ingestion in field collected organisms

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Monitoring marine litter ingestion and impacts in Endangered Species: Stranded organisms

MARINE MAMMALS

Some marine mammals were found to be affected by debris ingestion in published studies: *Physeter macrocephalus; Balaenoptera physalus; Tursiops truncatus; Grampus griseus; Stenella coerulealba.*

NO SPECIFIC PROTOCOL DEVELOPED

SEA TURTLES

All the species present in the Mediterranean Sea (*Caretta caretta; Chelonia mydas* and *Dermochelys coriacea*) were found to be affected by debris ingestion in published studies. *C. caretta is* already used as bioindicator for marine litter ingestion in MSFD, UNEP/MAP MED POL programme and INDICIT project.

SPECIFIC PROTOCOL DEVELOPED

SEABIRDS

Marine litter ingestion in seabirds is a well-documented phenomenon on a global scale, whereas only one study (Codina-García et al. 2013) investigated the presence of marine litter in 8 Mediterranean bird species: *Calonectris diomedea; Puffinus yelkouan; Puffinus mauretanicus; Morus bassanus; Ichthyaetus audouinii; Larus michahellis; Ichthyaetus melanocephalus; Rissa tridactyla; Stercorarius skua)*

SPECIFIC PROTOCOL DEVELOPED

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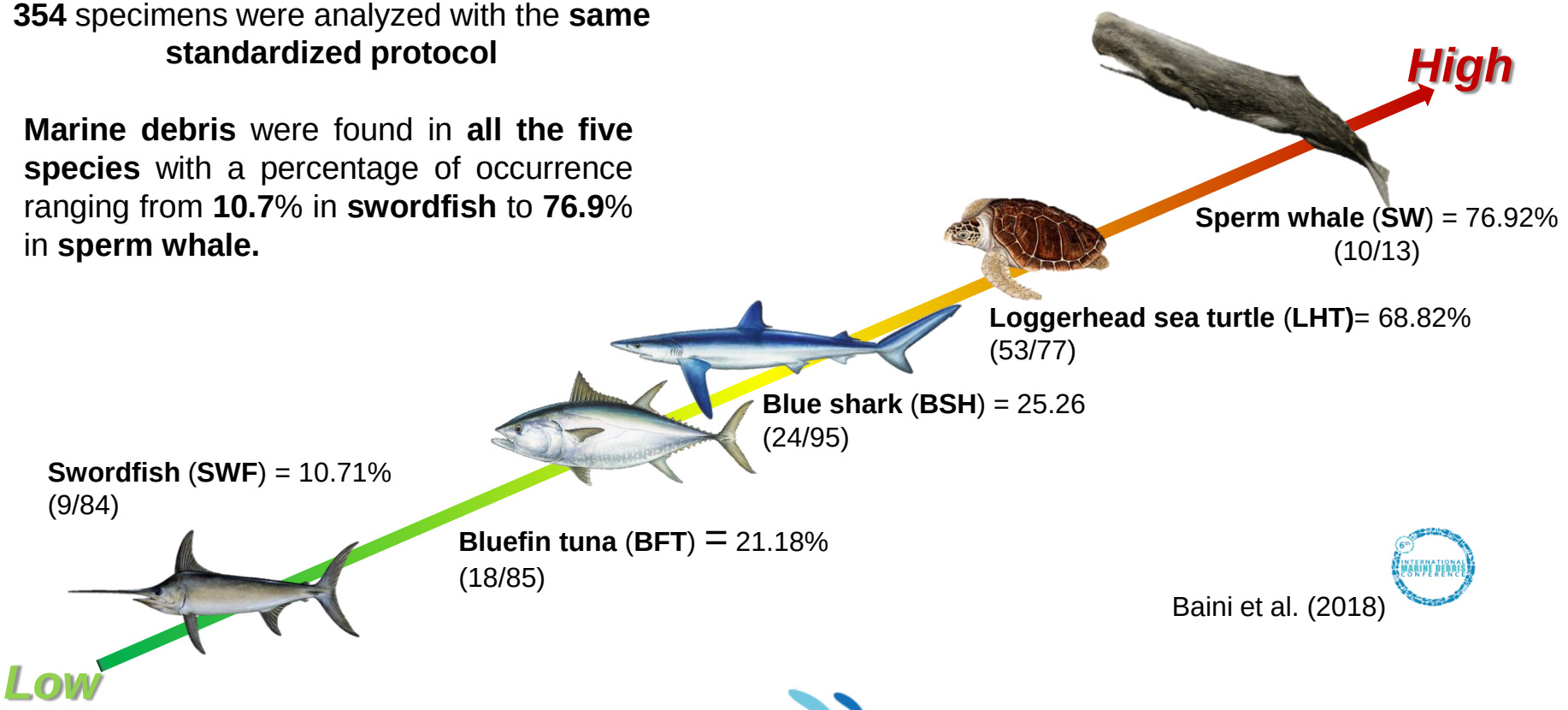
Percentage and ranking of marine litter ingestion in Med species calculated on the field data

354 specimens were analyzed with the **same standardized protocol**

Marine debris were found in **all the five species** with a percentage of occurrence ranging from **10.7**% in **swordfish** to **76.9**% in **sperm whale.**



Baini et al. (2018)

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Caretta caretta: hospitalized organisms

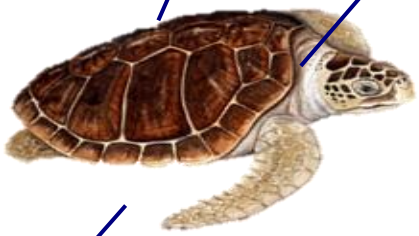
i) Plastic detection	ii) Plastic tracers detection	iii) Biomarkers detection
- Analysis of the ingested marine litter/microplastics: • Occurrence (%) • Abundance (n°) • Weight (g) • Polymer analysis	- Analysis of plastic additives: • Phthalates • PBDEs • Bisphenol A - Analysis of PBT compounds: • PCBs • DDTs • PAHs • Mercury	- Effects at molecular level: • Measure of DNA damage • Alterations of gene expression • Alteration of proteins - Effects at cellular level: • Alteration of cell functions - Effects at tissue level: • Histological and histopathological alterations

CARAPACE

Trace elements (Hg, Pb, Cd)
(Stoeppler & Backhaus, 1978)

WHOLE BLOOD

Comet assay (Frenzilli *et al.,* 1999)
ENA assay (Pacheco & Santos 1997)
Polycyclic aromatic hydrocarbons (Marsili *et al.,* 1997)
Organochlorines (Marsili & Focardi, 1996)
Respiratory burst (Caliani *et al.*, 2018 in press)
Differential WBC count (Casal & Oros, 2006)
H:L ratio



EXCRETA

Porphyrins (Grandchamp *et al.*, 1980)

PLASMA

LPO, Lipid peroxidation (Bird & Draper, 1984)
GGT, (commercial kits, Polymed)
VTG, Vitellogenin (Goksoyr *et al.,* 1991)
BChE, Butyrylcholinesterase (Ellman *et al.,* 1961)
Lysozyme activity (Caliani *et al.*, 2018 in press)
Total Antioxidant Assay (Caliani *et al*., 2018 in press)

SKIN BIOPSY

Protein expression of CYP1A (Fossi *et al.,* 2008, modified)

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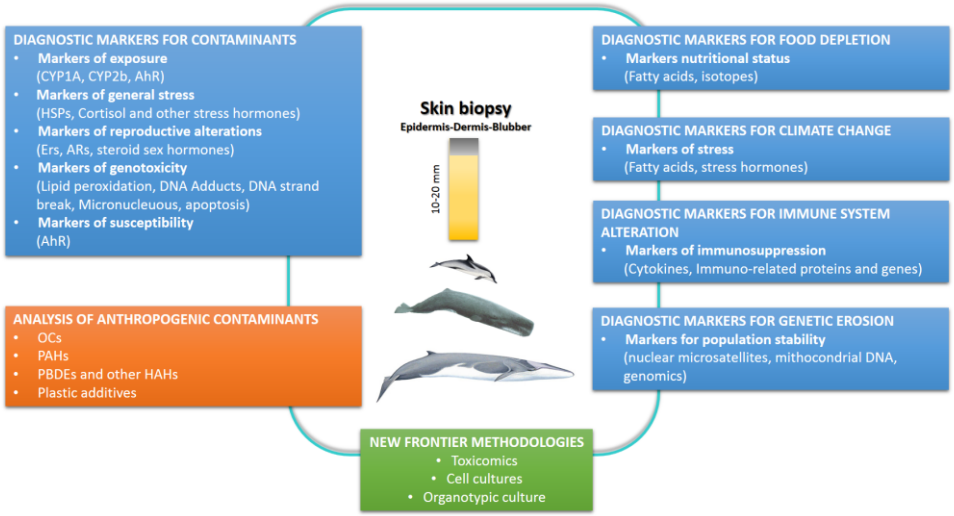
Monitoring marine litter impacts in Endangered Species: Free-ranging organisms

ii) Plastic tracers detection

- Analysis of plastic additives:
  - Phthalates
  - PBDEs
  - Bisphenol A
- Analysis of PBT compounds:
  - PCBs
  - DDTs
  - PAHs
  - Mercury

iii) Biomarkers detection

- Effects at molecular level:
  - Measure of DNA damage
  - Alterations of gene expression
  - Alteration of proteins
- Effects at cellular level:
  - Alteration of cell functions
- Effects at tissue level:
  - Histological and histopathological alterations



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Plastic Busters MPAs Monitoring Strategy:
Monitoring marine litter ingestion and impacts on Biota

i) Plastic detection

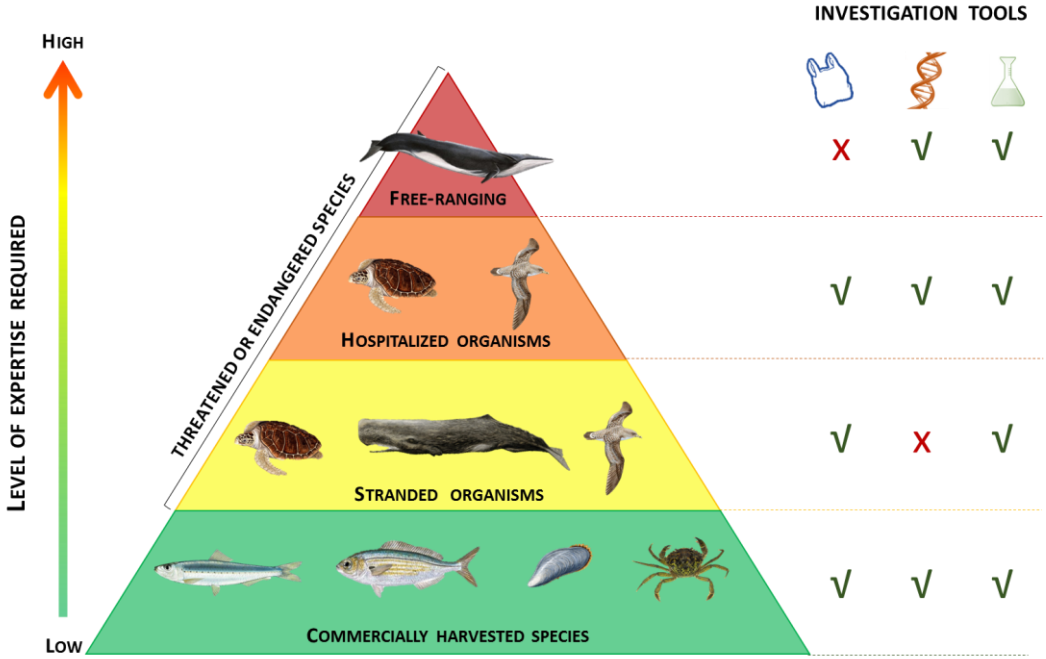
- Analysis of the ingested marine litter/microplastics:
  - Occurrence (%)
  - Abundance (n°)
  - Weight (g)
  - Polymer analysis

ii) Plastic tracers detection

- Analysis of plastic additives:
  - Phthalates
  - PBDEs
  - Bisphenol A
- Analysis of PBT compounds:
  - PCBs
  - DDTs
  - PAHs
  - Mercury

iii) Biomarkers detection

- Effects at molecular level:
  - Measure of DNA damage
  - Alterations of gene expression
  - Alteration of proteins
- Effects at cellular level:
  - Alteration of cell functions
- Effects at tissue level:
  - Histological and histopathological alterations



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Impact of marine litter in biota

Ingestion

Entanglement

Marine litter as transport vector and a habitat

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Entanglement-State of the art

Entanglement of marine species in marine debris causes the **most important harm** in the Marine Environment.

Entanglement rates **varied across different species/taxa**, but rates seemed to be **greater** in areas of overlap between **high population densities** and either human **fishing intensity** or areas of **high debris accumulation** (e.g., convergence zones).

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State of the art - Species

According to the UNEP (2016), entanglement incidents lead to wounds or death, with a declining order of species affected per taxon, for **192 species of invertebrates, 89 species of fish**, 83 species of birds, 38 species of mammals and all species of turtles (7).

Among the species stranded, **marine turtles** are the species on which the occurrence of impacts is the highest,

Derelict fishing Gear is a special concern for entanglement of fish and invertebrates

% of species affected

Turtles	100%
Fish	0.30%
Invertebrates	0.06%
Birds	24%
Whales	69%

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Entanglement - Methods of monitoring

1) Stranding/Observations (beaches, Nests)

2) ***Diving / Observations*** (**relevant for MPAs**)

3) ***Remote Operated Vehicles*** (ROVs)/ Imagery

Records:
Entangled animals /observed animals,Types of entanglement, types of interactions, injuries

Units
% of affected organisms/ Observed organisms (entanglement, types of interactions, injuries)
% of affected organisms / Per unit of observations (distance, surface, etc.)

ESPECES	TYPES OF LITTER	METHOD	EXISTING NETWORK	SPECIES	PRIORITY	REMARKS
Birds	Fishing gear, macro-litter	Observations , diagnosis	Strandings networks	All species	++	The monitoring must be organised per system with the following priorities: 1) Pilot study concerning opportunistic monitoring by strandings networks 2) Evaluation and tests of video/diving monitoring systems in protected areas 3) Surface observation test
Cetaceans	Lost nets, ghost nets	Observations , diagnosis	Strandings networks and at-sea observation	All species	++	
Turtles	Lost nets, ghost nets	Video monitoring (diving and ROVs)	Strandings networks and at-sea observation	All species	++	
Necto-benthic fishes	Fishing gear	Video monitoring (diving and ROVs)	Video monitoring (diving and ROVs)	All species	+	
Pelagic fishes	Lost nets, surface ghost nets	Observations , fishing	networks of sea observation	Big pelagic sharks	+	
Invertebrates	Lost nets, macro-litter	Video monitoring (diving and ROVs)	Protected area monitoring, scientific campaign	All species	+	
Birds	Meso-/macro-litter	Observation, litter in nests	Nesting monitoring networks	European Shag	++	Indicator of effect partially concerning strangling To be tested on a pilot scale

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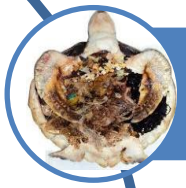
Impact of marine litter in biota



Ingestion

Entanglement

Marine litter as transport vector and a habitat

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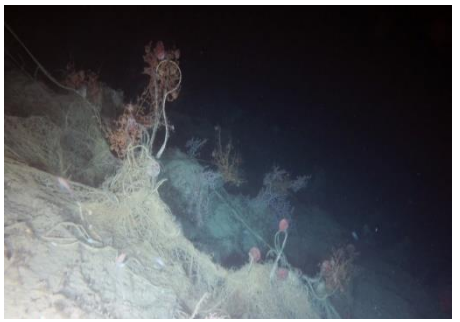
Marine litter as transport vector and habitat

Marine litter (macro- and micro-plastic) can represent a transport vector or a habitat for marine organisms found on the sea surface or on the seafloor.

Plastic when in seawater rapidly develops a biofilm that includes primary producers, consumers, predators and decomposers that encourages the attachment of larger organisms that use chemical and/or physical characteristics as a cue to settle.

Recently, the development and increasing utilization of Remotely Operated Vehicles (ROVs) has allowed investigating the coverage and colonization of different species on **seafloor litter**.

Derelict fishing gears often form an artificial substrate which is preferentially colonized by the serpulid policheate, ramified hydroids (Sertulariidae), encrusting sponges, colonial tunicate, bryozoans and corals.



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Worflow of the Plastic Busters MPAs Project activities

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Thank you!

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