Plastic Busters MPAs marine litter monitoring and assessment output and results in Med MPAs

Plastic Busters MPAs Capitalization Event | 12 October 2021

Presented by M. Cristina Fossi, University of Siena, Italy

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Project co-financed by the European Regional Development Fund

Why Plastic Busters initiative?

Plastic Busters on basin scale

A crucial aspect of the marine litter issue, underlined by the **Barcelona Convention within the Regional Plan for Marine Litter** (Istanbul 2013) is that: "Marine pollution knows no border, pollution in one country affects all other 21 countries, hence there is a need for a regional approach".

Plastic Busters is the first project at basin scale that binds the Southern and Northern Mediterranean countries on the issue of Marine Litter under the umbrella of UNEP/MAP and UfM, with 10 countries already involved in the project and 12 countries endorsing the project.

Diagnosis of the problem to identified specific solutions

- Impact on Biodiversity?
- Impact on Fisheries?
- Identification of Hot spot areas?
- Impact on Human?

Project coordinator
Maria Cristina Fossi
Biomarker Laboratory, University of Siena, Italy

SDSN-MED

Flagship project

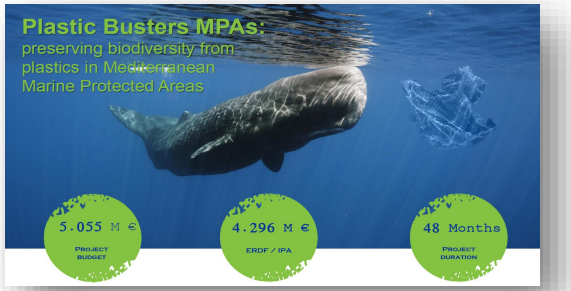
2013

UfM Labelling

Union for the Mediterranean
Union pour la Méditerranée
الإتحاد من أجل المتوسط

2016

MED-Interreg



2018

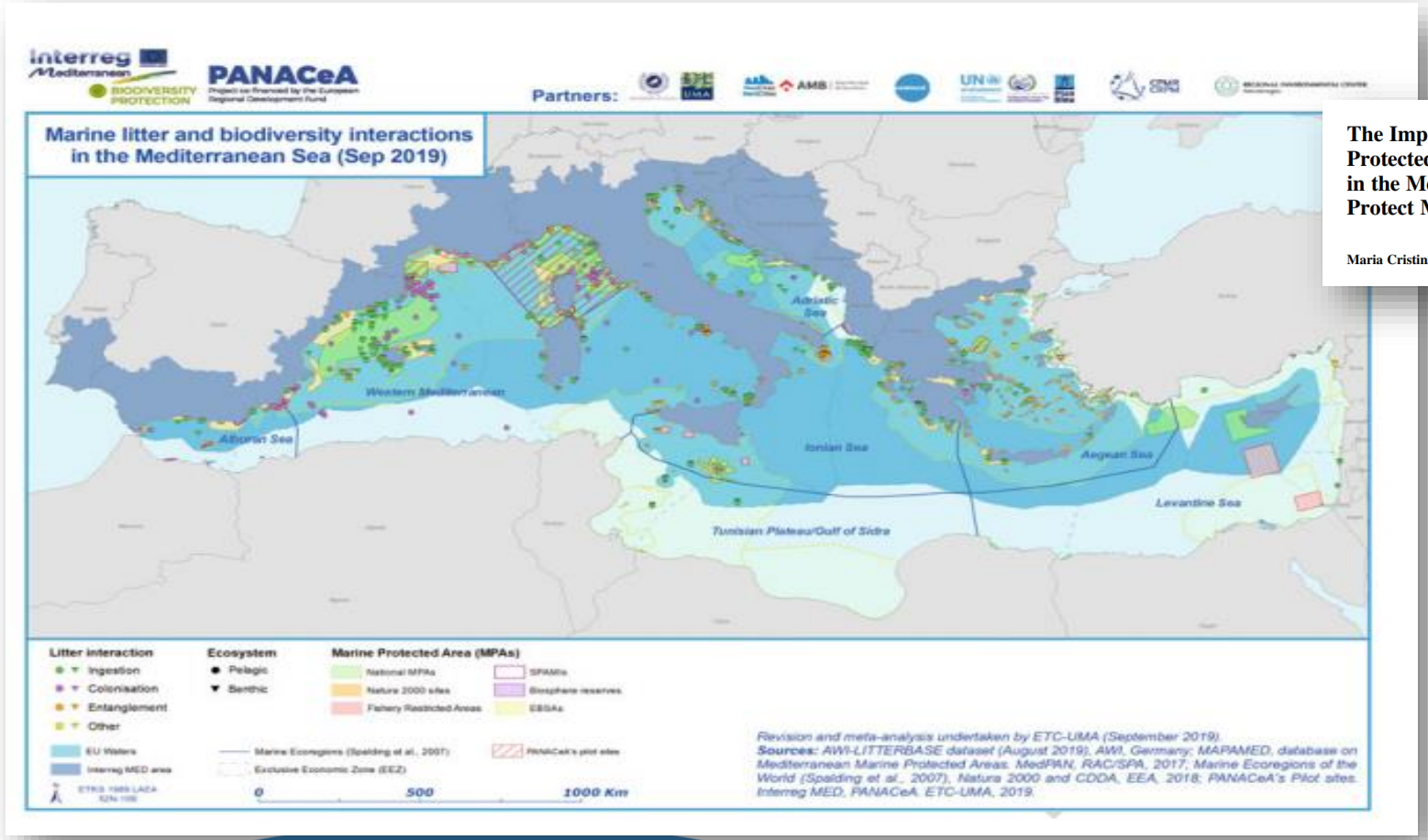
ENI -CBC

COMMON

AdriCleanFish

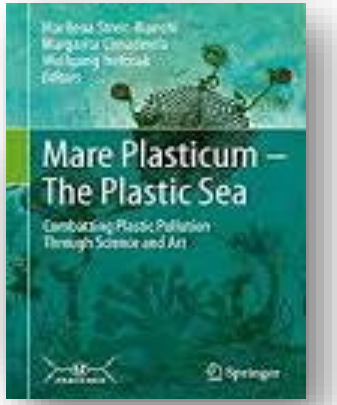
2019 - 20

The Impact of Marine Litter in Marine Protected Areas (MPAs) in the Mediterranean Sea



The Impact of Marine Litter in Marine Protected Areas (MPAs) in the Mediterranean Sea: How Can We Protect MPAs?

Maria Cristina Fossi and Cristina Panti



In the whole Mediterranean basis 1231 MPAs and OECMs (Other Effective area- based Conservation Measures) cover 179,798 km for a total surface of 7.14% under a legal designation. Many of these areas are heavily subjected to marine litter pressure.

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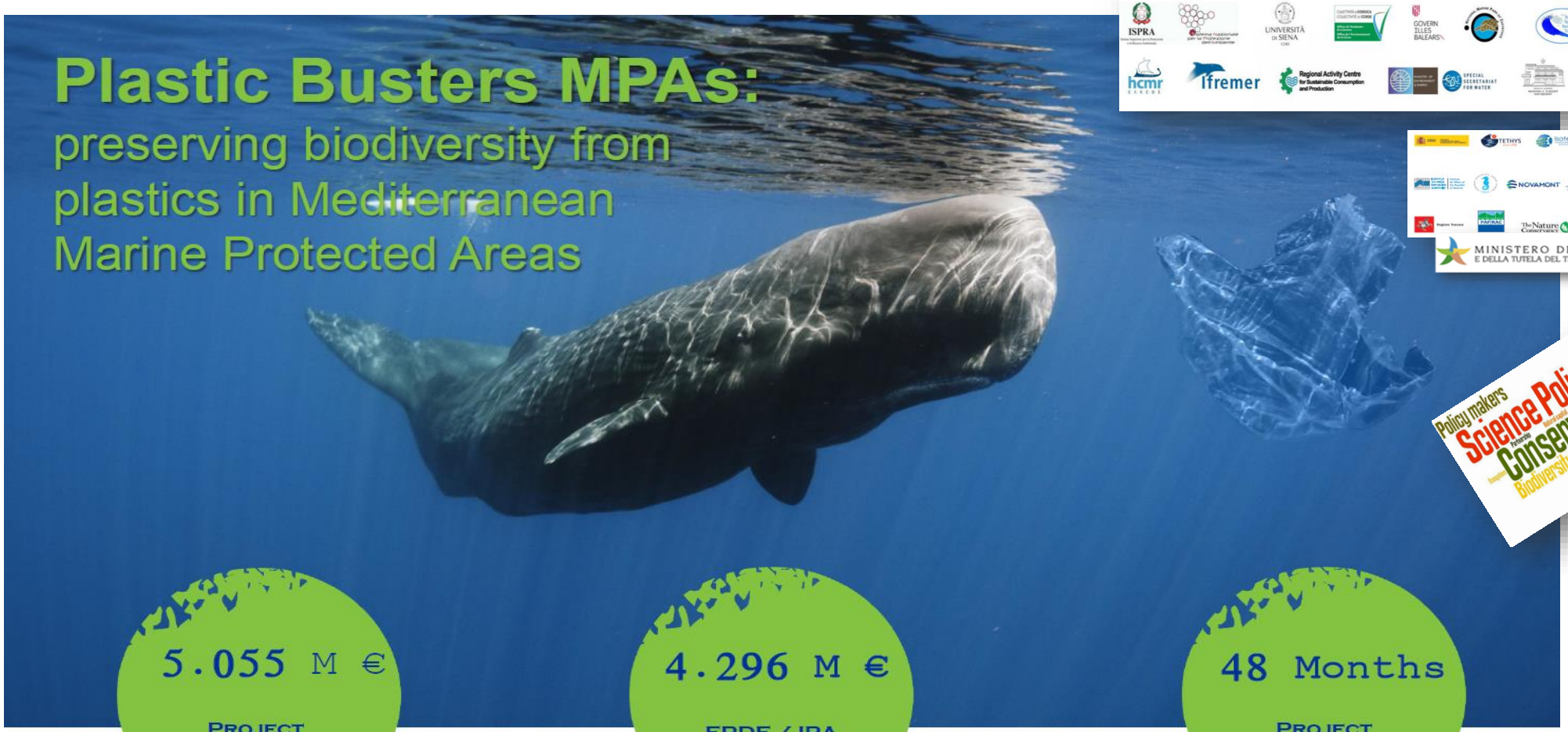
Plastic Busters MPAs:

preserving biodiversity from plastics in Mediterranean Marine Protected Areas



MINISTERO DELL'AMBIENTE E DELLA TUTELA DEL TERRITORIO E DEL MARE

5.055 M €
PROJECT BUDGET

4.296 M €
ERDF / IPA

48 Months
PROJECT DURATION

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EUROPEAN UNION

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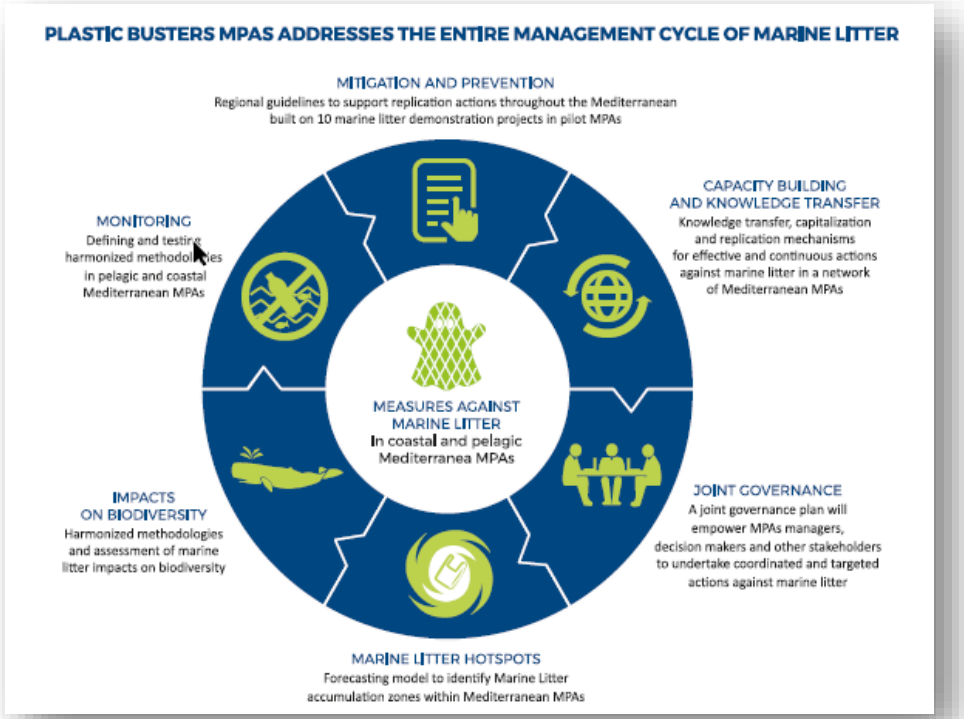
Plastic Busters MPAs general objectives

Novelty - Whole Management Cycle Of Marine Litter



- **PlasticBusters MPAs**, is a 4-year-long project Interreg Mediterranean funded project aiming to contribute to **maintaining biodiversity and preserving natural ecosystems** in pelagic and coastal **marine protected areas** (MPAs), by defining and implementing a **harmonized approach against marine litter**.
- The project entails actions that address the **WHOLE MANAGEMENT CYCLE OF MARINE LITTER**, from **monitoring and assessment** to **prevention and mitigation**, as well as actions to **strengthen networking** between and among pelagic and coastal MPAs located in Italy, France, Spain, Croatia, Albania and Greece.
- The project will support the **implementation** of the **MSFD** and the Barcelona Convention **Regional Plan on Marine Litter** Management in the Med.

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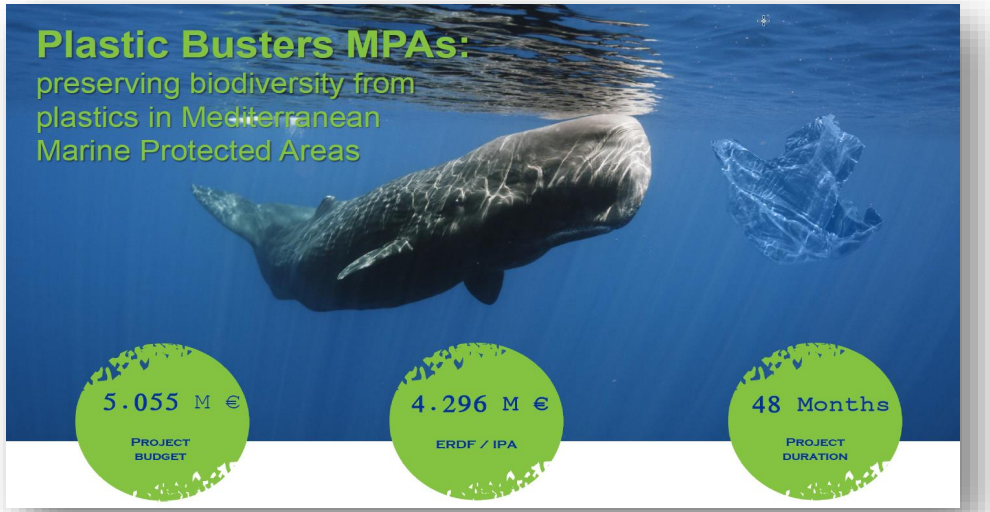

- **WP1** • PROJECT MANAGEMENT
- **WP2** • PROJECT COMMUNICATION
- **WP3** • STUDYING
- **WP4** • TESTING
- **WP5** • TRANSFERRING
- **WP6** • CAPITALISING

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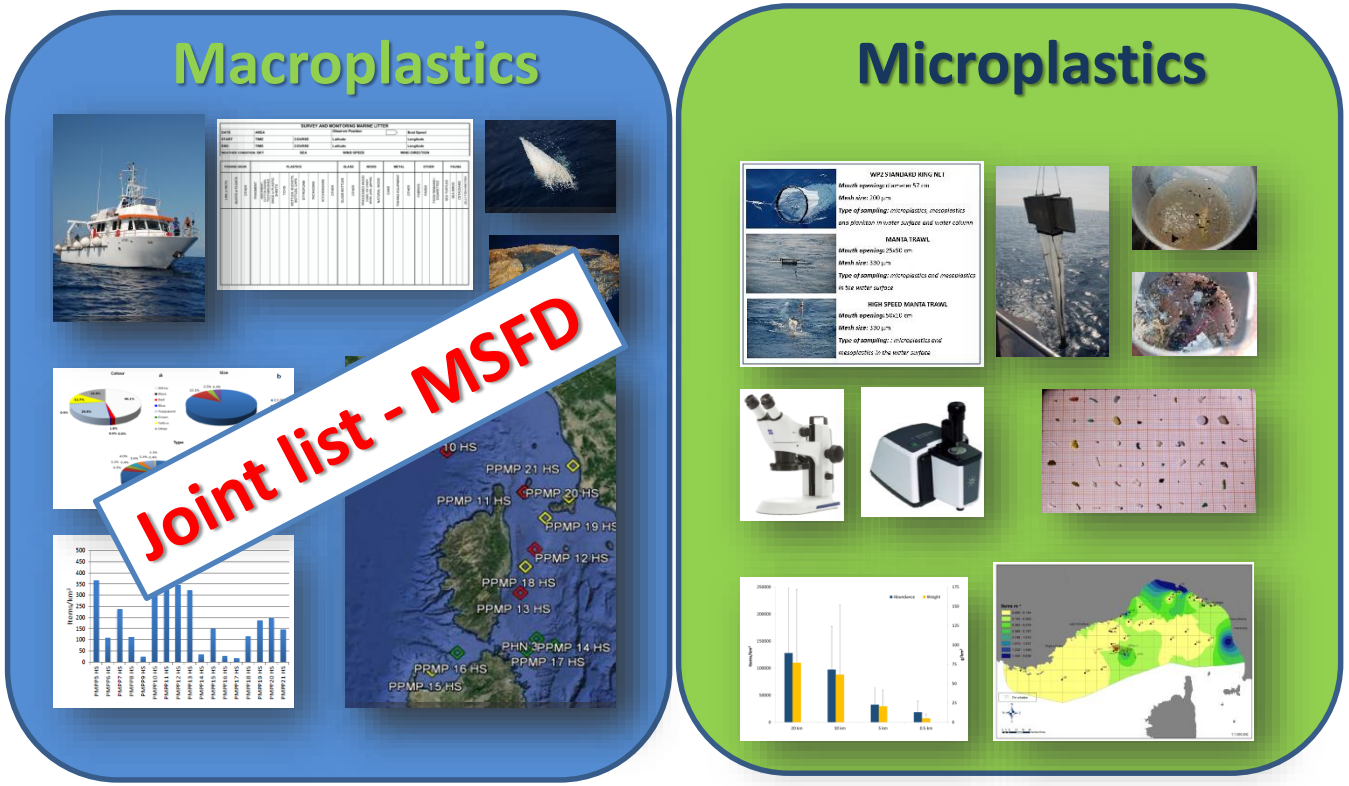
Plastic Busters MPAs WP4:

Novelty - Harmonized Diagnosis in the Environment

4.1 – Coordinating WP 4
4.2 Piloting harmonized ML monitoring in Med MPAs to assess ML (macro- and micro-plastics) in the coastal and pelagic environment
4.3 Piloting harmonized ML monitoring approaches in Med MPAs and hotspots to establish the impacts on biota, including endangered species and fishery resources
4.4 Testing the ML forecasting model
4.5 Preparation of the demo projects
4.6 Piloting ML prevention and mitigation measures



MARINE LITTER MONITORING

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Plastic Busters MPAs WP4:
Novelty - Harmonized Diagnosis in Biota

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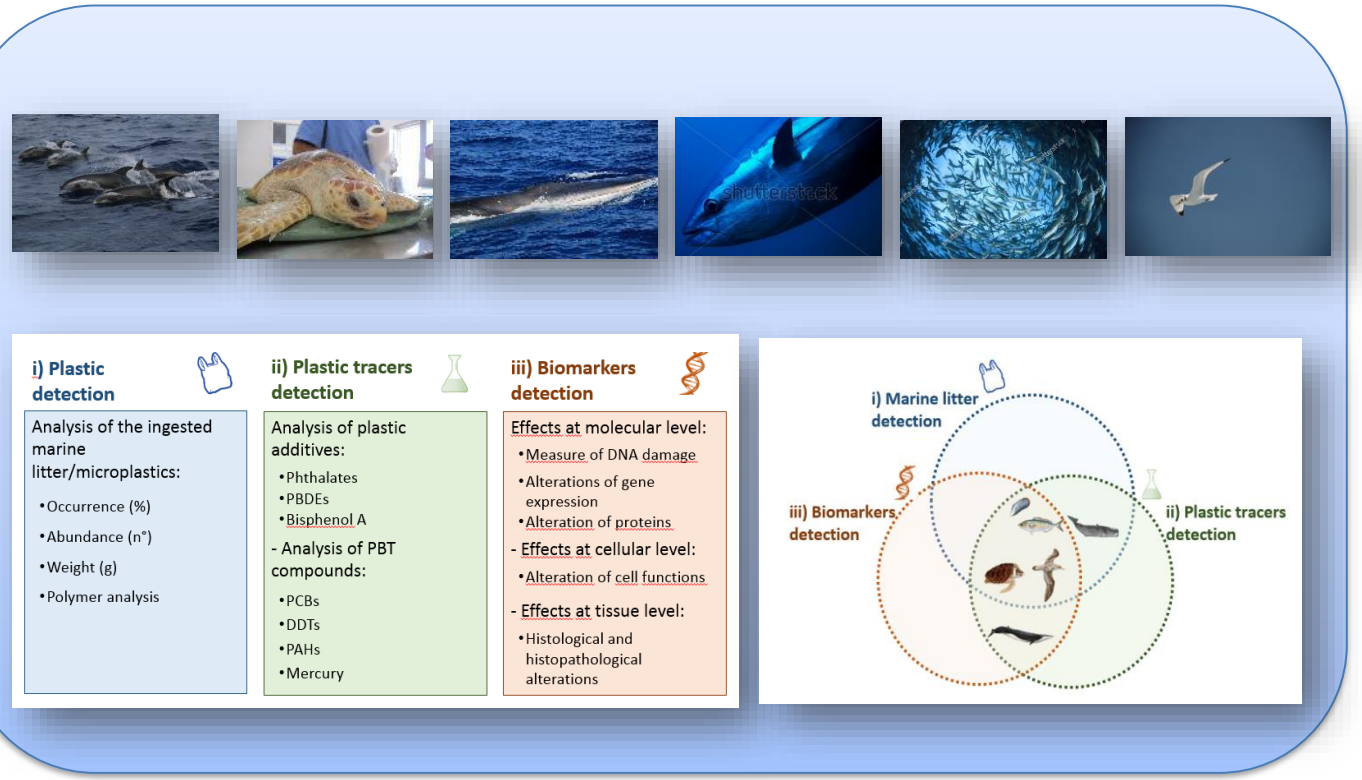

MARINE LITTER IMPACTS ON BIOTA

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1) Identification of marine litter bioindicators


Environmental Pollution

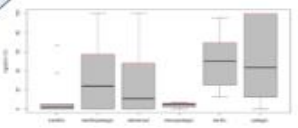
Bioindicators for monitoring marine litter ingestion and its impacts on Mediterranean biodiversity

Maria Cristina Fossi, Cristina Pedà, Montserrat Compa, Catherine Tsangaris, Carme Alomar, Francoise Claro, Christos Ioakeimidis, Francois Galgani, Tatjana Hema, Salud Deudero, Teresa Romeo, Pietro Battaglia, Franco Andaloro, Ilaria Caliani, Silvia Casini, Cristina Panti, Matteo Baini

BIBLIOGRAPHIC RESEARCH

1

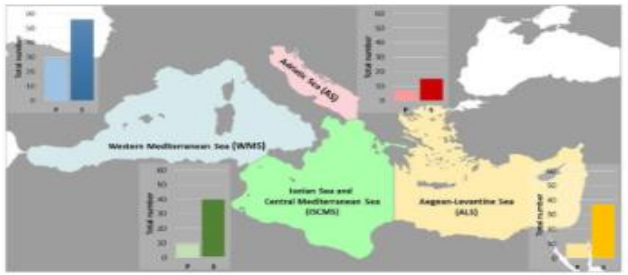
STATISTICAL ANALYSIS



3

DATASET

2



State the of art of marine litter ingestion in Mediterranean Sea

BIOINDICATOR SELECTION STRATEGY

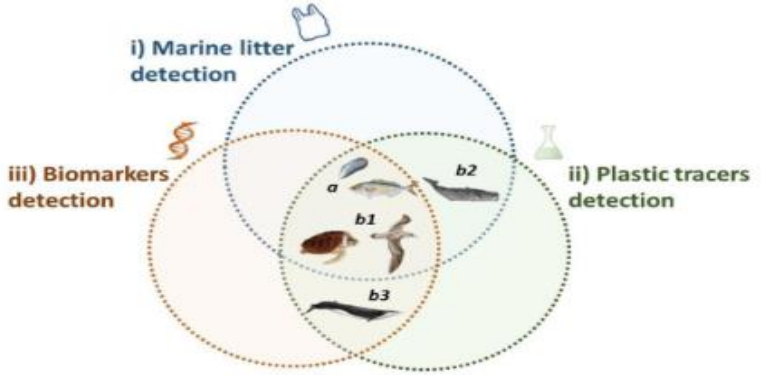
Ecological and biological selection criteria

Habitat and home range selection criteria

4

THE THREEFOLD MONITORING APPROACH

5



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

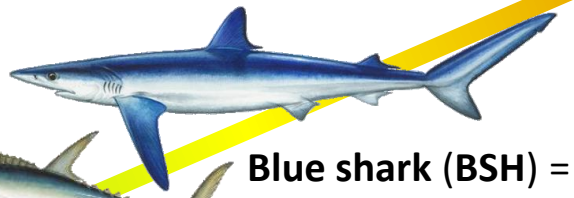
354 specimens were analyzed with the **same standardized protocol**

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.**

High

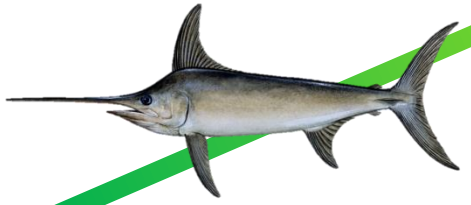
Sperm whale (**SW**) = 76.92% (10/13)

Loggerhead sea turtle (**LHT**)= 68.82% (53/77)



Blue shark (**BSH**) = 25.26 (24/95)

Bluefin tuna (**BFT**) = 21.18% (18/85)



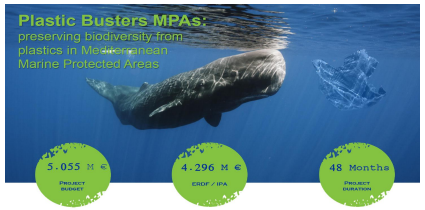
Low

Swordfish (**SWF**) = 10.71% (9/84)

Baini et al. (2018)

3) Bioindicator selection in relation to habitat and home range

Basin Scale



	SEA SURFACE	COASTAL WATERS	OPEN WATERS	SEAFLOOR	COAST LINE AND BEACH SEDIMENT
BASIN SCALE (Mediterranean Sea)	*Calonectris diomedea, Puffinus yelkouan*	*Calonectris diomedea, Puffinus yelkouan*	*Balaenoptera physalus; Cetorhinus maximus Xiphias gladius; Thunnus thynnus Xiphias gladius; Thunnus thynnus Caretta caretta Physeter macrocephalus*		
MEDIUM-SCALE (Mediterranean UN Environment/MAP sub-regions)			*Thunnus alalunga*		
SMALL-SCALE (FAO GSA)		*Boops boops Trachinotus ovatus*	*Maurolicus muelleri Engraulis encrasicolus Sardina pilchardus* Myctophids	*Galeus melastomus, Merluccius merluccius, Solea spp. Galeus melastomus, Scyliorhinus canicula*	
LOCAL SCALE				Holoturians	*Mytilus galloprovincialis Arenicola marina* Decapods *(e.g. Carcinus sp.)*

BIOINDICATOR SELECTION STRATEGY

Ecological and biological selection criteria

Habitat and home range selection criteria

BLUE: *biondicator for macrolitter*

RED: *bioindicator for microplastics*

Local Scale

017 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 toxicological effects

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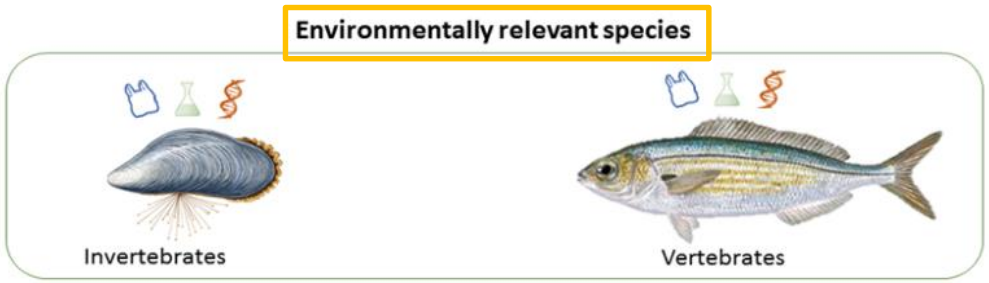
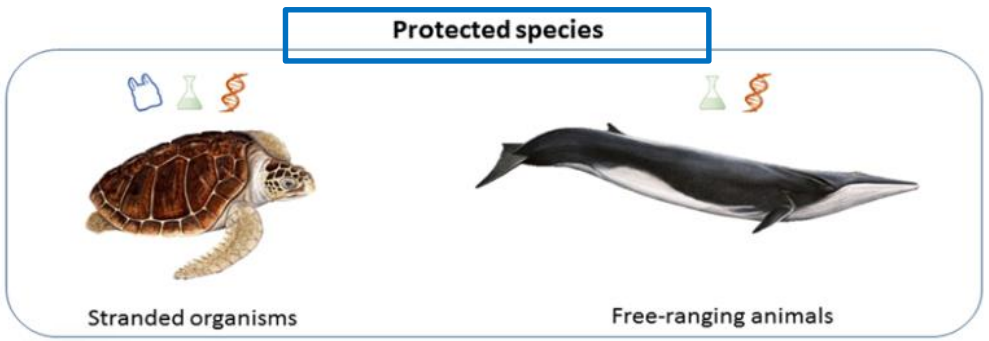
THE THREEFOLD MONITORING APPROACH





Plastic detections

- Analysis of the gastro intestinal (GI) contents:
  - Occurrence (%)
  - Abundance (n°)
  - Weight (g)
  - Polymer analysis

Plastic tracers detections

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

Biomarkers detections

- 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:
  - Hystological and hystopathological alterations

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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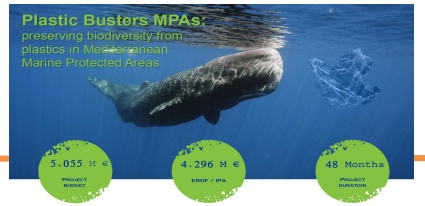

COastal Management and MOnitoring Network for tackling marine litter in Mediterranean sea

INDICIT II
INDICATOR • IMPACT • TAXA

Plastic Busters MPAs:

Main findings expected by the application of the PBMPAs approach are…

✓**DIAGNOSTIC PHASE**: development of effective methodologies to **diagnose the marine litter** (including microplastics) **presence and impacts on biodiversity** inhabiting Mediterranean MPAs (Deliv. 3.3.1), including the identification of Marine Litter hotspots (Deliv. 3.5.1).

✓**MITIGATION PHASE**: development of efficient tailor-made surveillance, **prevention and mitigation measures in Med MPAs** (Deliv.3.6.1) designed **according to the diagnostic actions** carried out during the monitoring phase. Identification of a series of measures to prevent and mitigate the impacts of marine litter in the hotspot areas, while **capitalizing on previous projects** results (e.g. Interreg MED ACT4LITTER, MEDSEALITTER, DG-ENV INDICIT, IPA-Adriatic DeFishGear, etc.).

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Plastic Busters MPAs: MPA scale

The monitoring methodologies have been developed to be tailor-made according to the **extension of the Marine Protected Areas to be monitored.** Whenever necessary, these methodologies have been described for each of the three types of protected areas completed in the project:

- ✓ **Small scale MPAs: Cabrera, Zakynthos**

- ✓ **Medium scale MPAs: Tuscan Archipelago**

- ✓ **Large pelagic (SPAMI, EBSA): SPAMI Pelagos Sanctuary**

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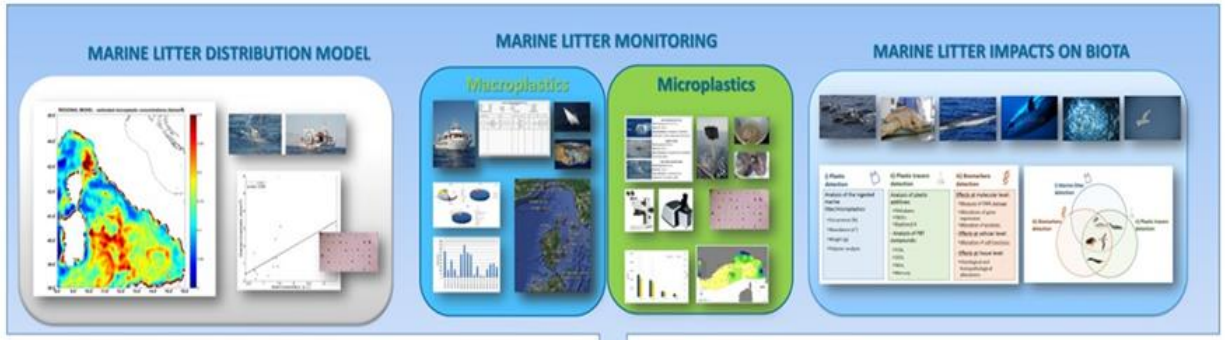
Plastic Busters MPAs activities in MPAs

Novelty – Risk Assessment - From Diagnosis to Mitigations

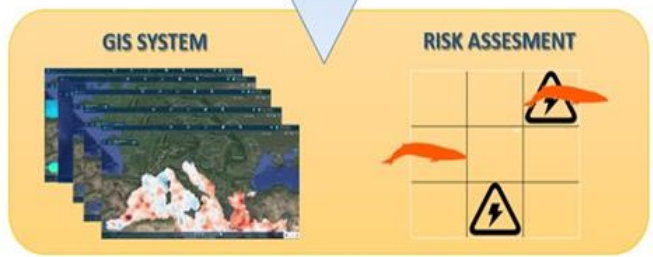


WP4 -Testing

- Pelagos Sanctuary (IT,FR,MC)
- Tuscan Archipelago (IT)
- Zakynthos National Marine Park (GR)
- Parque Nacional Del Archipiélago De Cabrera (SP)

WP5-Transferring

- Reserve Naturelle des Bouches de
- Bonifacio (FR)
- Parc National de Port-Cros (FR)
- Pelagie Islands MPA (IT)
- Res-Lošinj MPA (HR)
- Sazan-Karaburun (AL)



Diagnosis → **Mitigations**

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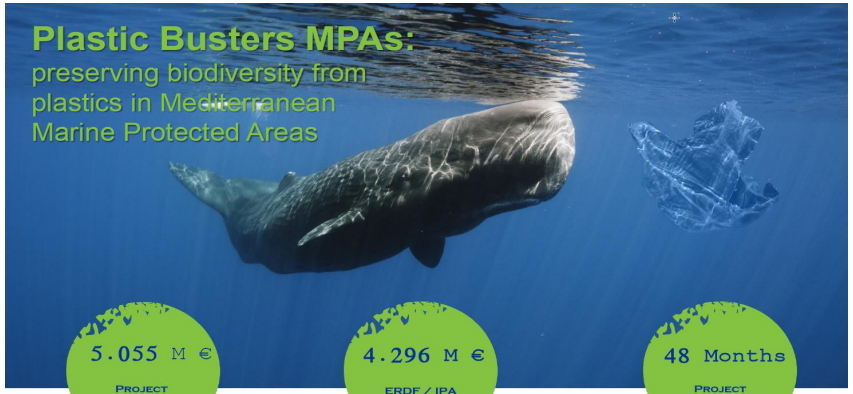

where we are now

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Monitoring activities in small scale MPAs: Zakynthos National Marine Park

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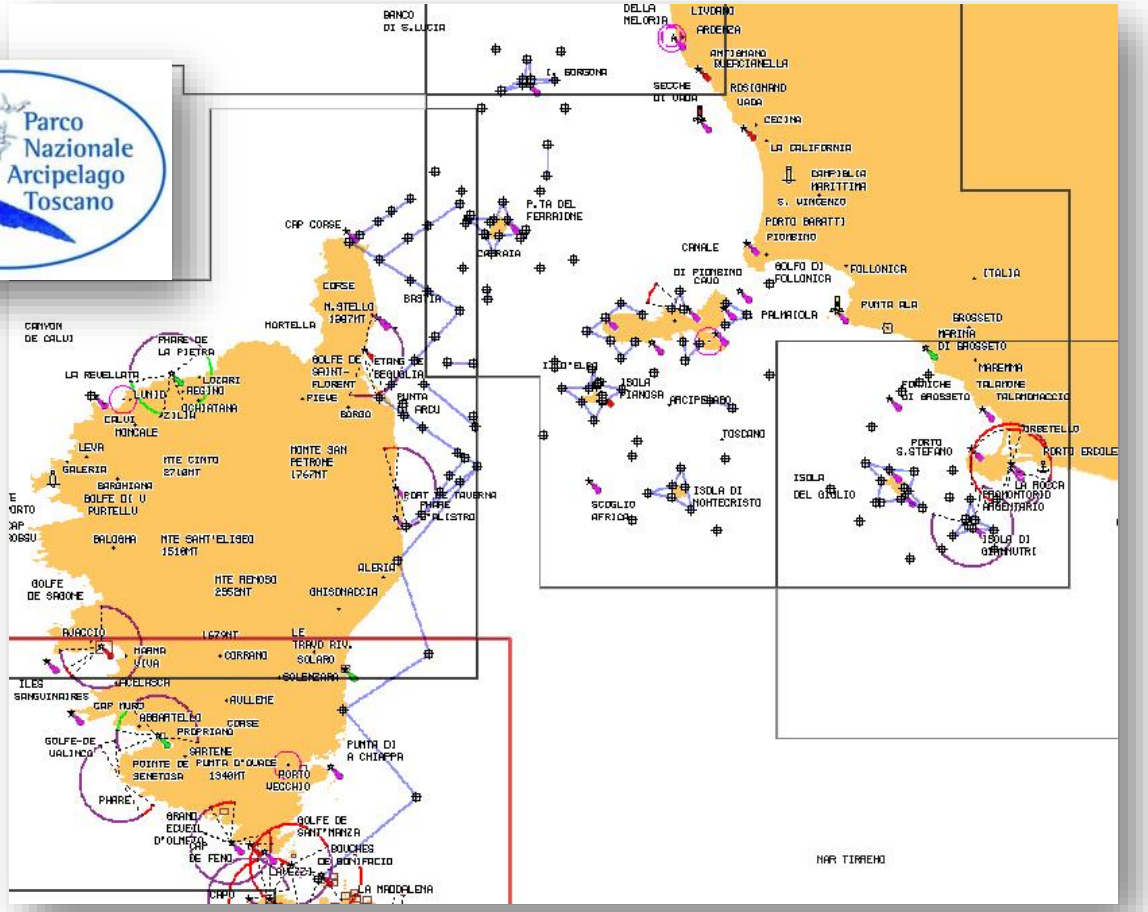
Monitoring activities in small scale MPAs: Cabrera National Park

Monitoring activities in Medium scale MPAs: Tuscan Archipelago National Park



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Monitoring activities in Large pelagic and coastal areas: SPAMI - *Pelagos Sanctuary*

Pelagos Sanctuary
protecting marine mammals in the Mediterranean Sea

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Plastic Busters MPAs:

Joint strategy for monitoring marine litter and its impact on biodiversity

SYNERGY BETWEEN MPAS MANAGER AND RESEARCHERS

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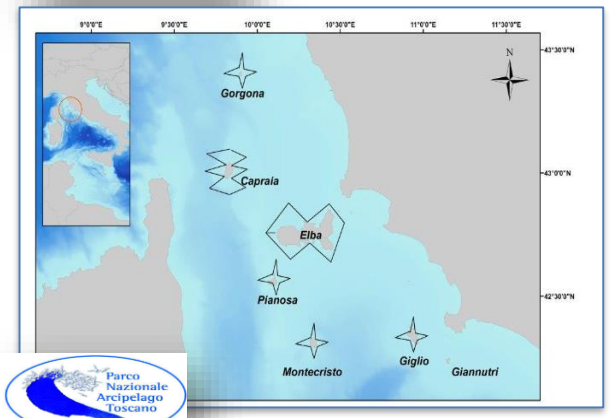
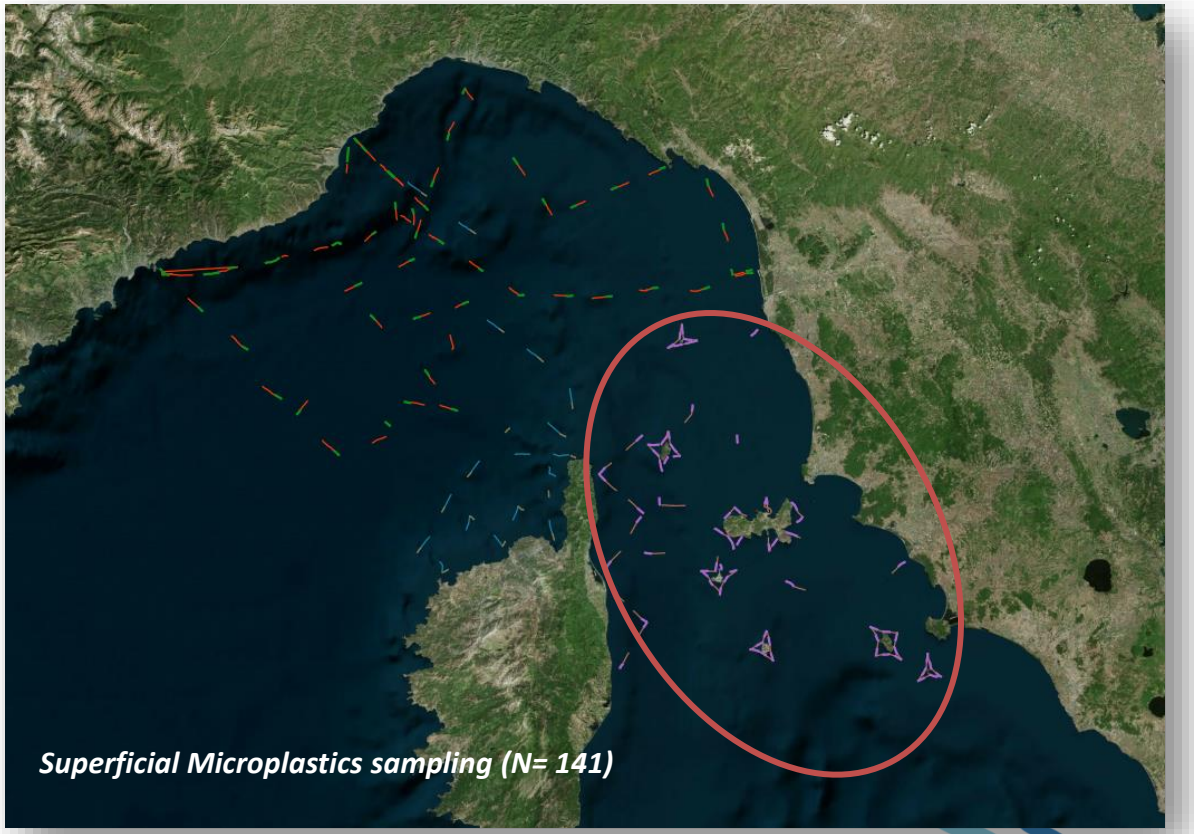
Plastic Busters MPAs:
Pelagos Sanctuary and PNAT Activities





May –June –July - September 2019

- ✓ 34 days of activity
- ✓ 2226 NM
- ✓ 34 Researchers
- ✓ 8 Institutions

(UNISI, ISPRA, IFREMER, EOC, PNAT,LAMMA, CIMA, Pelagos Secr.)

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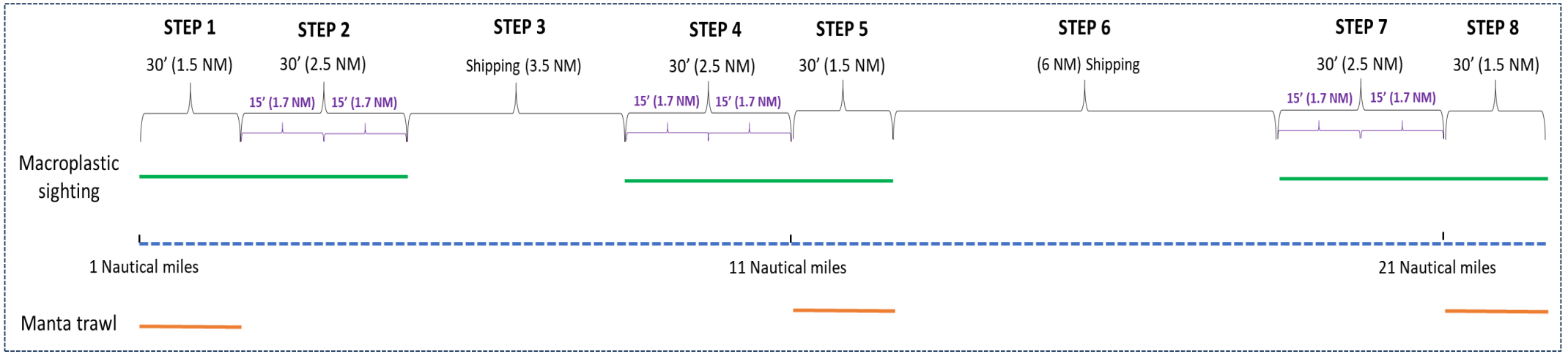
Simultaneous monitoring of FMML- MPs - Biota

NEW



1. **Microplastics and macroplastics simultaneous sampling/survey**. Transect of 30 minutes, starting 1 NM far away from the coast.
2. **Macroplastics (ML) survey**. Transect of **30 minutes** (record the GPS coordinates every 15 minutes).
3. Sailing up to 7.5 nautical miles far away from the coast.
4. **Macroplastics (ML) survey**. Transect of 30 minutes (record the GPS coordinates every 15 minutes).
5. **Microplastics and macroplastics simultaneous survey/sampling**. Transect of **30 minutes**, starting 1 NM far away from the coast.

   Sampling activities described in sections **3 – 4 – 5 repeated**, until reaching the daily total amount of nautical miles.

   - During the whole sampling campaign **megafauna observations** will be carried out.

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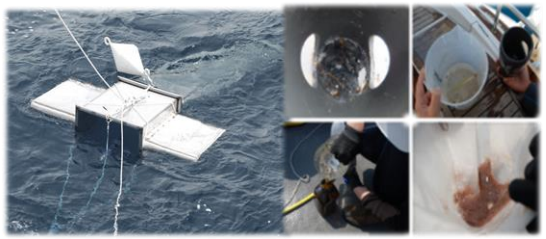
Experimental design: *Multiple sampling*

Superficial **Microplastics sampling (N= 141)**



Floating Macro Litter sighting (N=273)

Cetaceans Skin Biopsy sampling (N= 47)

Biota sighting
Cetaceans, Turtles, Birds and other species
(N= 300)

Neustonic Bioindicator species sampling (day time) **(N= 167 P.)**

Myctophidae Bioindicators sampling (night time)
(N=36P.)

Costal Bioindicators Mediterranean Mussel
(N= 120)

Commercial Fish Species
(N= 717)

Impact on Biodiversity
Impact on Fisheries

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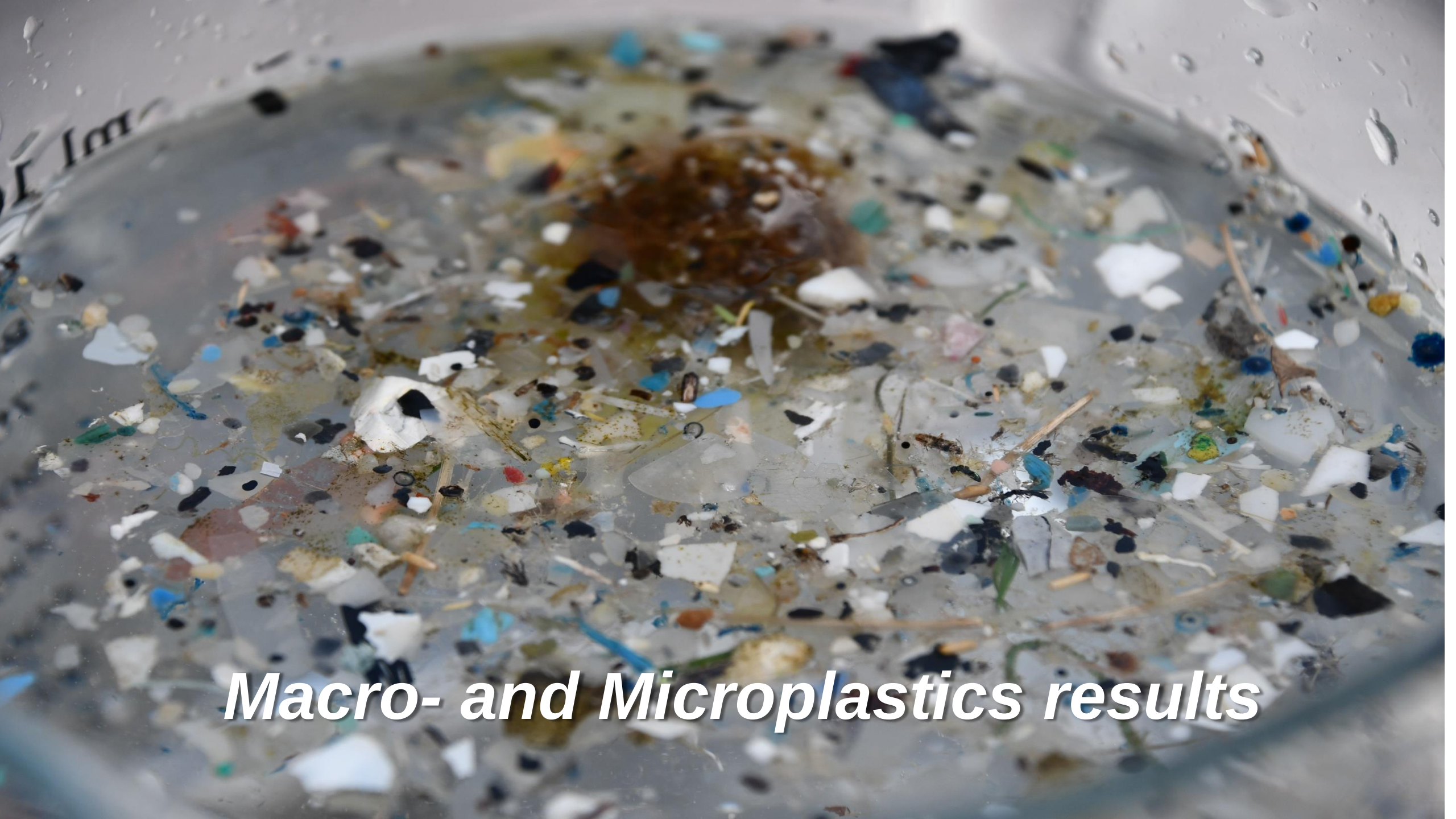


Macro- and Microplastics results

Monitoring Endangered Species

Monitoring marine litter impacts in Cetaceans

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

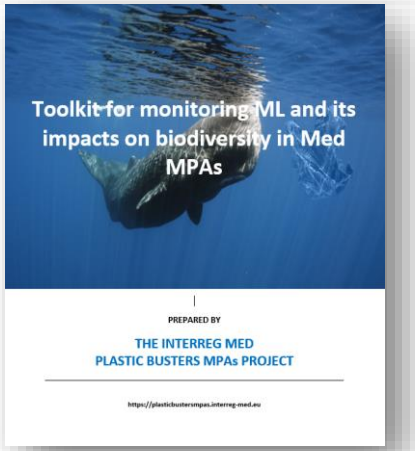
- Effects at cellular level:

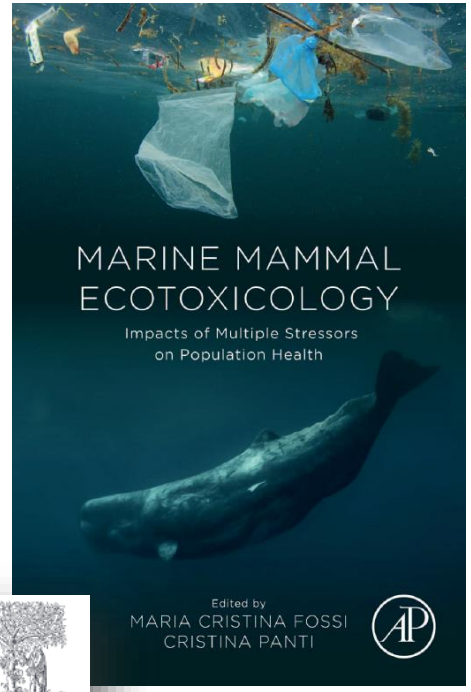
- Alteration of cell functions

- Effects at tissue level:

- Histological and histopathological alterations

FIGURE 6.3 The threefold monitoring approach to detect marine litter presence and impact in cetacean species (stranded and free-ranging organisms).





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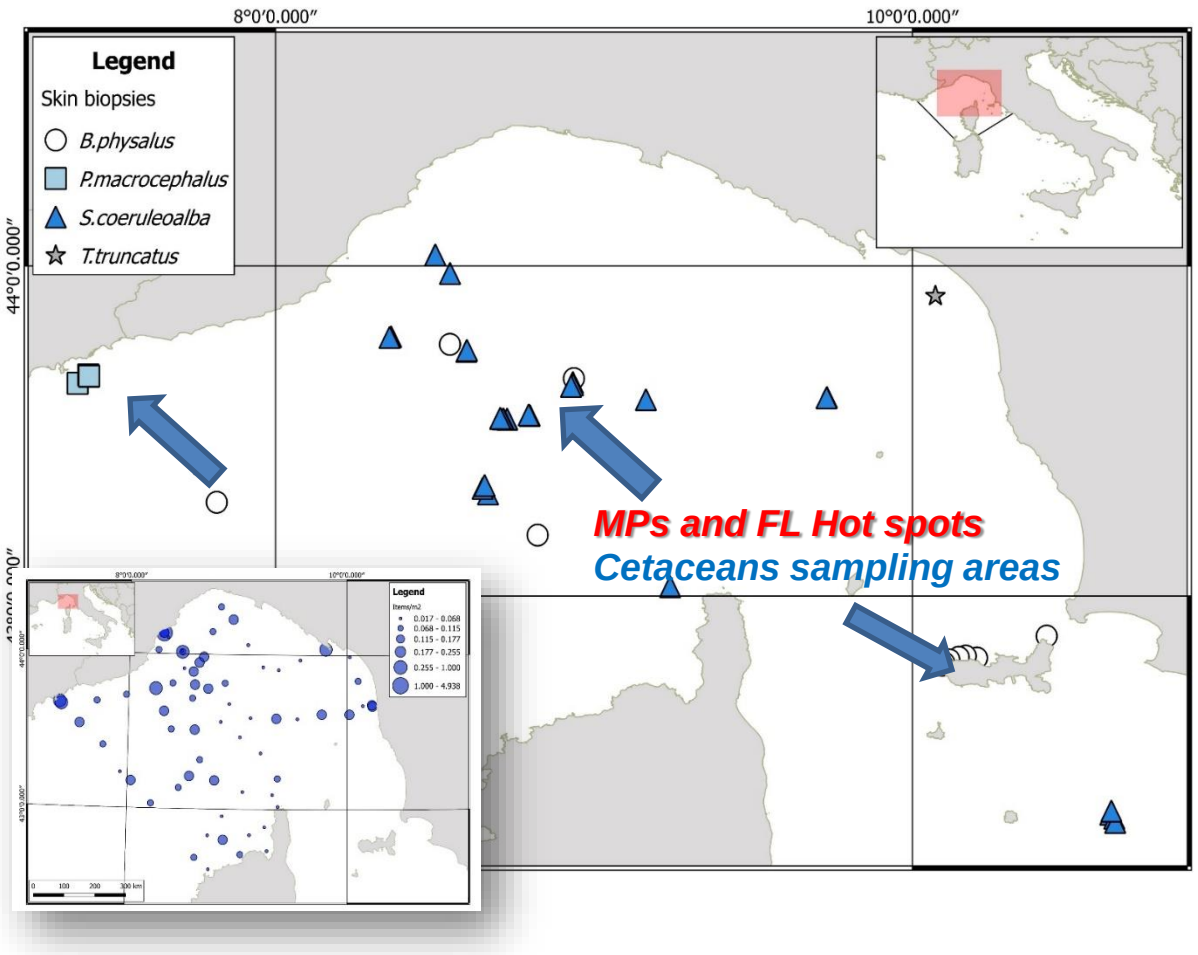
Impact on Cetacens ?



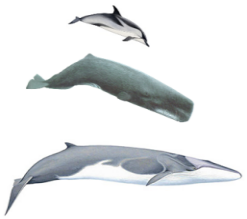
Plastic Tracers and Biomarkers in Endangered Species

NEW

DIAGNOSTIC MARKERS FOR CONTAMINANTS
- **Markers of exposure** (CYP1A, CYP2b, AhR)
- **Markers of general stress** (HSPs, Cortisol and other stress hormones)
- **Markers of reproductive alterations** (Ers, ARs, steroid sex hormones)
- **Markers of genotoxicity** (Lipid peroxidation, DNA Adducts, DNA strand break, Micronucleuous, apoptosis)
- **Markers of susceptibility** (AhR)

ANALYSIS OF ANTHROPOGENIC CONTAMINANTS
- OCs
- PAHs
- PBDEs and other HAHs
- Plastic additives

Skin biopsy
Epidermis-Dermis-Blubber
10-20 mm



DIAGNOSTIC MARKERS FOR FOOD DEPLETION
- **Markers nutritional status** (Fatty acids, isotopes)

DIAGNOSTIC MARKERS FOR CLIMATE CHANGE
- **Markers of stress** (Fatty acids, stress hormones)

DIAGNOSTIC MARKERS FOR IMMUNE SYSTEM ALTERATION
- **Markers of immunosuppression** (Cytokines, Immuno-related proteins and genes)

DIAGNOSTIC MARKERS FOR GENETIC EROSION
- **Markers for population stability** (nuclear microsatellites, mithocondrial DNA, genomics)

NEW FRONTIER METHODOLOGIES
- Toxicomics
- Cell cultures
- Organotypic culture

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Neustonic Bioindicators

Neustonic bioindicators

NEW

Isopod spp.

*

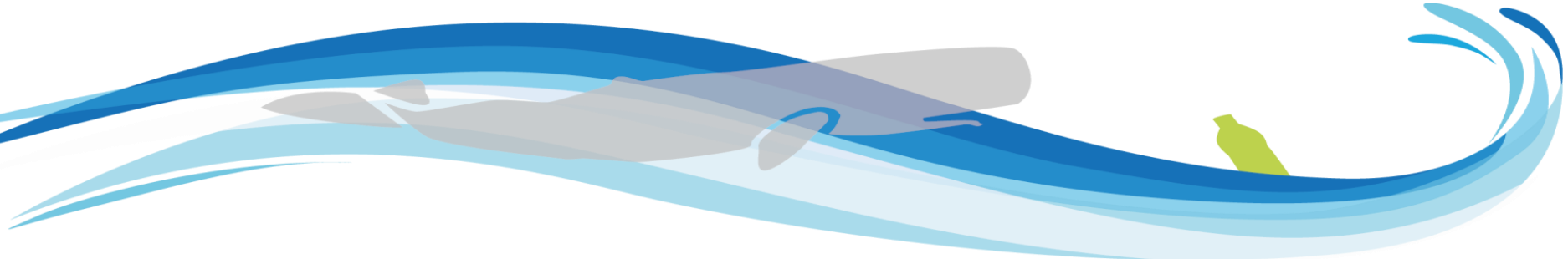
N° = 23 pool

Velella velella

*

N° = 120 pool

Sampled with manta net during daily surveys



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Commercial fish species

Commercial fish species and mussles

Three selected commercial harbour

European anchovy

N° = 156

Bogue

N° = 160

Striped red mullet

N° = 27

European pilchard

N° = 93

Red mullet

N° = 144

N° = 54 PNAT

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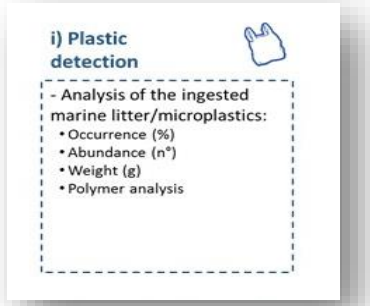
Laboratory analysis: *Microplastics ingestion*

INTERCALIBRATION EXERCISE Between PB-MPAs Labs

- Use of glass materials washed with micro-filtred water (0,4[illegible]
  - One procedural blanks every tw[illegible]

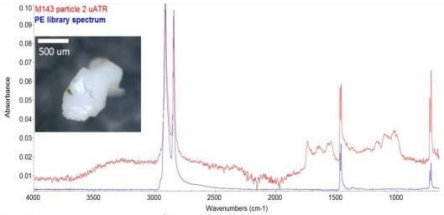
Digestion and filtration

- Digestion method: KOH 10% (1:5 w[illegible]
  (Rochman *et al* 2015, modified)
- Filtration with 1.6µ glass-fib[illegible]



Characterization of plastics

- Shape, c[illegible] of plastic particles
- Polym[illegible] IR) (10% total items)



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NEW

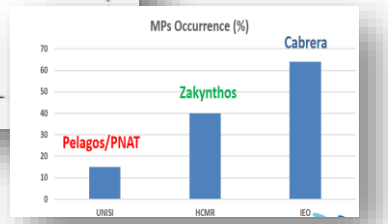
Three-Fold Monitoring Approach in Striped Red Mullet



Cabrera - IEO | **Zakynthos - HCMR** | **Pelagos/PNAT - UNISI**

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:
  - Hystological and hystopathological alterations

QX200™ Droplet Digital™ PCR System (Bio-Rad)

UNIVERSITÀ DI SIENA 1240

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…and more…..

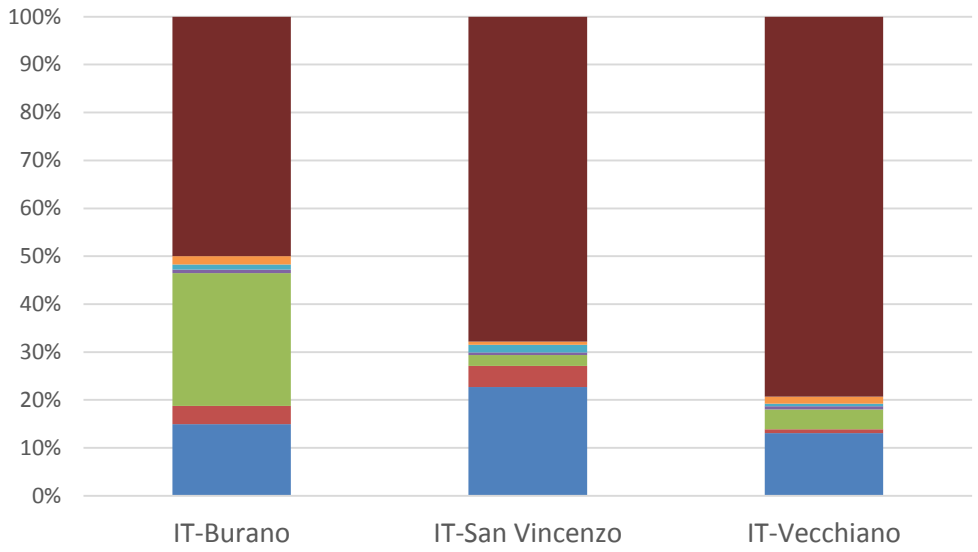
Monitoring Endangered Free-Ranging/Hospitalized Sea Turtles


Monitoring Endangered Free-Ranging/Hospitalized Sea-Birds

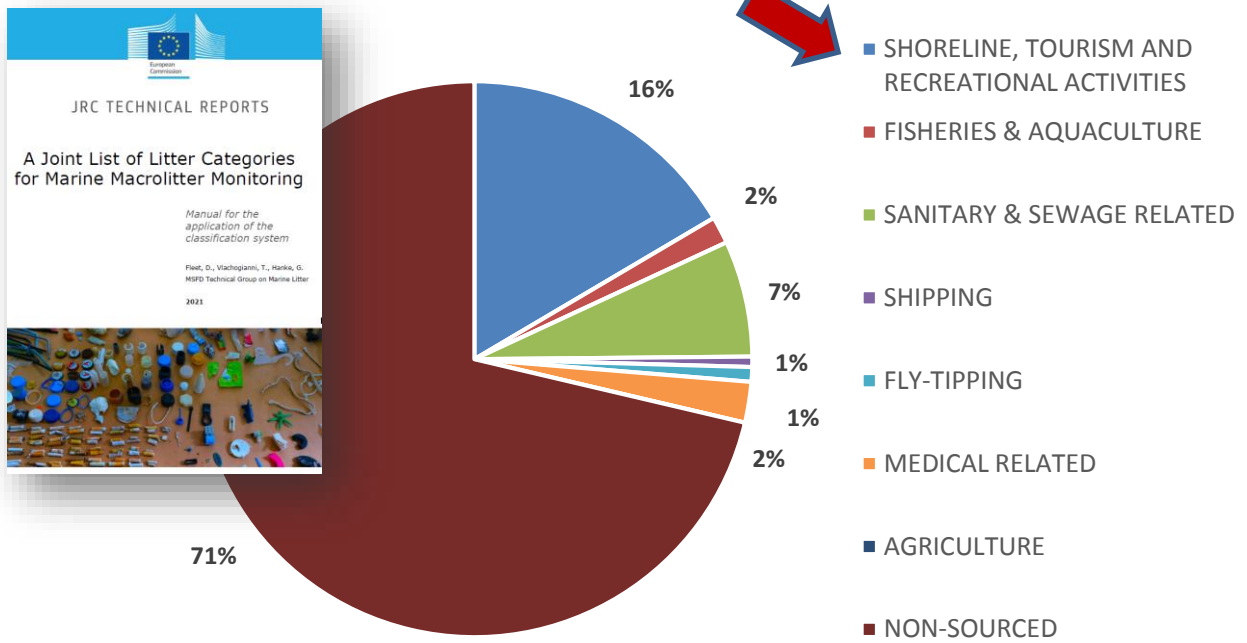
Monitoring Stranded Cetaceans Specimens

Monitoring Marine Litter in Beaches

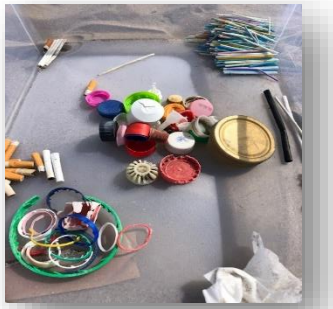
Monitoring Marine Litter in Beaches: Sources



> 50% of collected items unsourced



Shoreline, tourism and recreational activities and **Sanitary & sewage related** are the most abundant sources



26% of land-based sources items

3% of sea-based sources items

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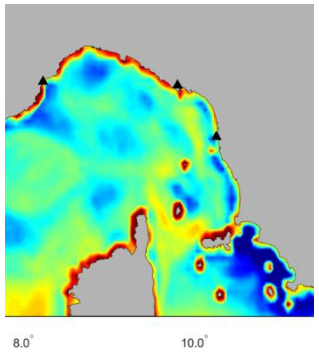
From the Diagnosis to the Mitigation

Monitoring Marine Litter HOTSPOTS in Beaches

- ✓ Data are obtained from **small boats** (5-6 m) operating at low speed and moving at a **distance of 20-100 m from the shore**.
- ✓ The position of accumulation areas are recorded using GPS for **low accumulation zones** (2-10 litter items/site, usually a 5-30 m stretch distance onshore) **and high accumulation zones** (> than 10 litter items/site).
- ✓ Maps are finally interpreted to support both the **identification of potential monitoring sites,** association with modelling predictions or identification of priority areas **for removal actions.**

Marine Litter Distribution Model



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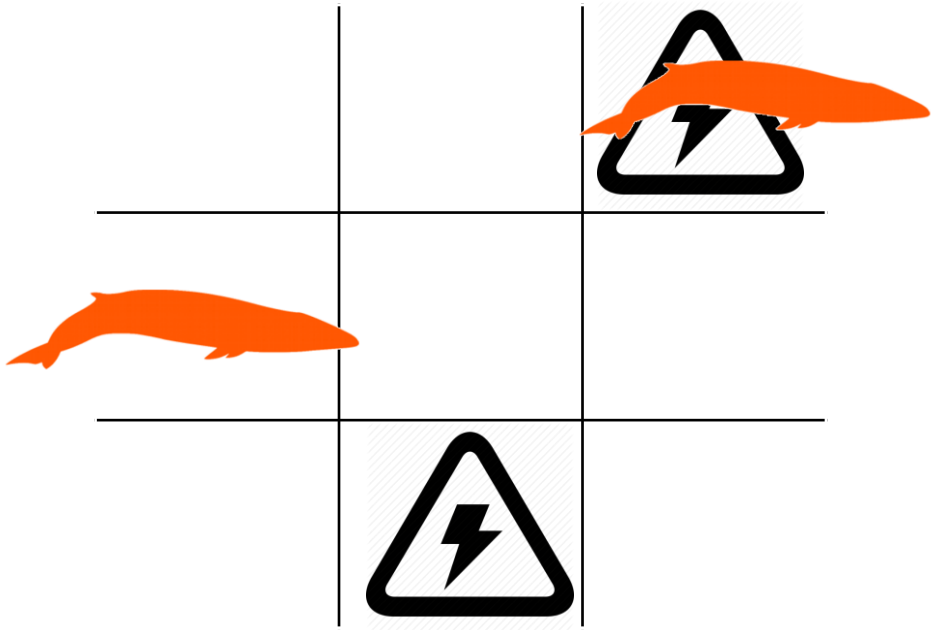
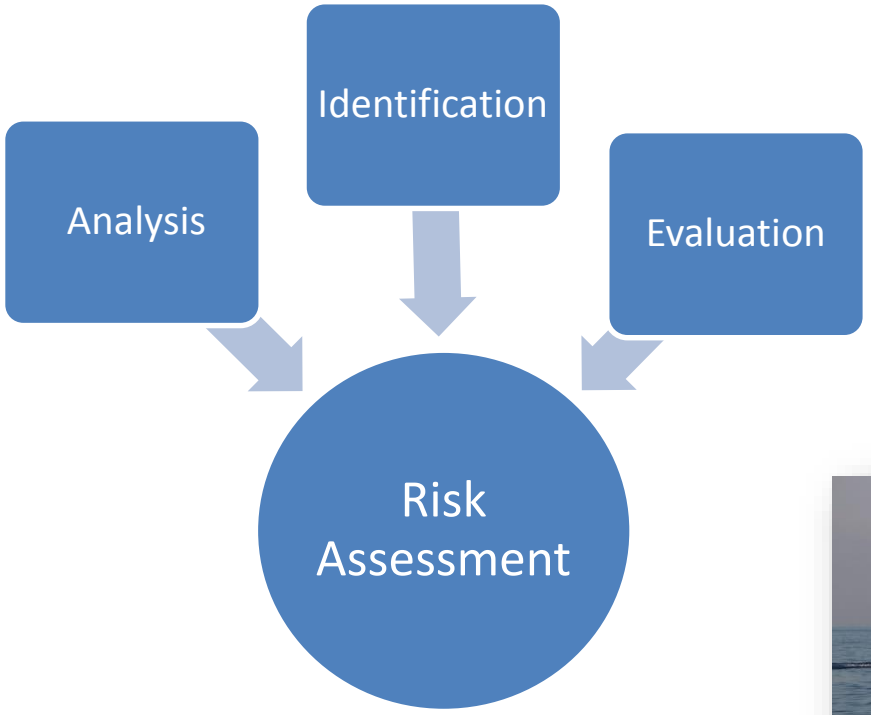
Risk prediction in the Pelagos Sanctuary

Risk MAP = Hazard MAP * Exposure MAP





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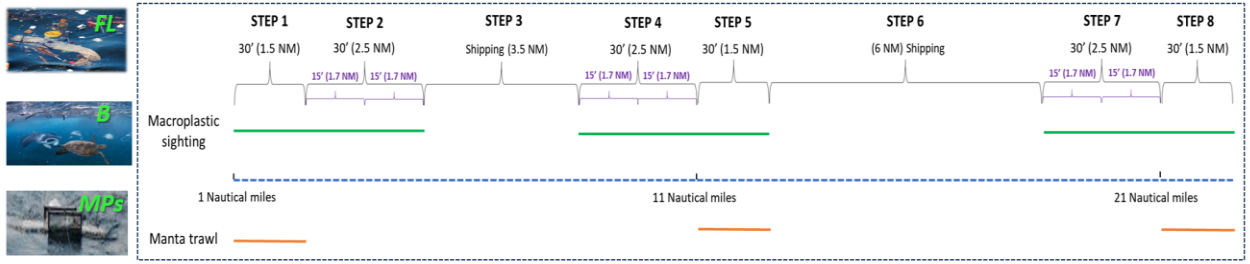
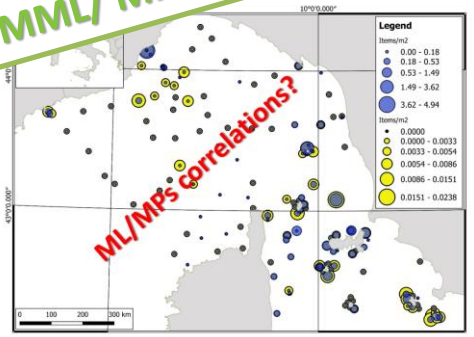
Lessons learned from the monitoring of Pelagos Sanctuary

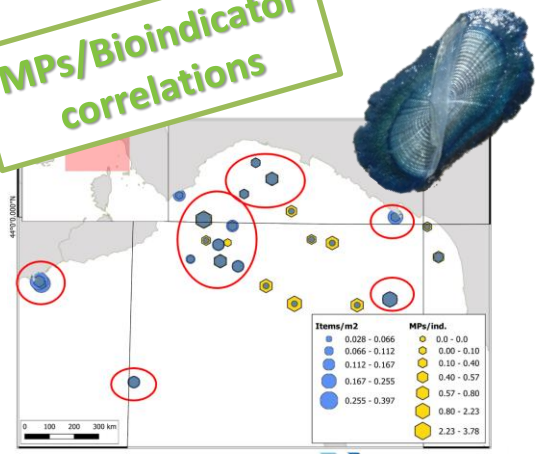
Simultaneous monitoring of FMML- MPs - Biota

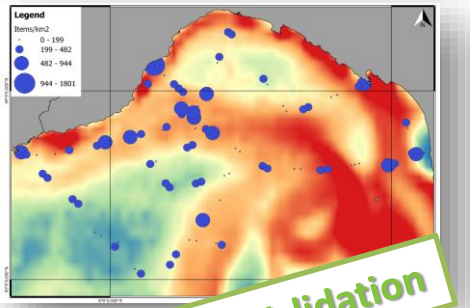


FMML/ MPs correlations



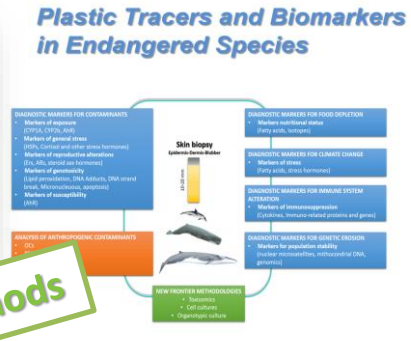
MPs/Bioindicator correlations



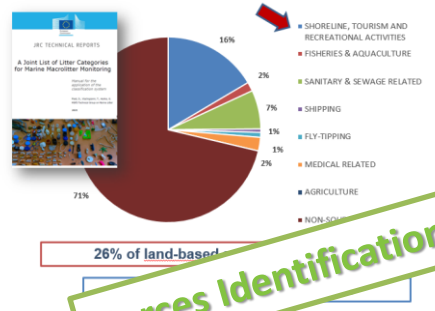


MPs Model Validation

new Methods



Risk Prediction



Sorces Identifications

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Plastic Busters MPAs WP5:
Novelty – Transferring in other MPAs

WP5 tackles one of the main challenges of our era and one of the main challenges of all science-policy-society projects which is to bridge the gap between science, policy and society and connect the information production and knowledge generation to its use in the decision making process at different levels.

- ✓ WP5 activities are important for the project success as these are expected to strengthen knowledge exploitation, **networking exchange, stakeholders' collaboration** and dialogue towards concrete, effective and continuous actions against marine litter in Med MPAs.
- ✓ The **transferring activities** will create the enabling environment for a truly transnational **Mediterranean common approach against marine litter in Med MPAs**.
- ✓ They will guarantee that the necessary tools and competences are inplace in order to promote the uptake of the project results **by additional Med MPAs** (see Act.6.3), **policy and decision makers** (see Act.6.4) and other **relevant stakeholder.**

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PB MPAs WP5: means of transferring

- On-Site **transferring activities** (Ongoing)
  - Goal is to transfer activities to 10 MPAs, also inviting representatives from other MPAs to allow for an exponential transferring of the project knowledge
  - As such, each project partner responsible for the transferring activities in the above 4 MPAs should ensure other MPAs representatives are invited thus triggering the transferring process.

Bonifacio - France (UNISI, OEC)

Capo Milazzo - Italy (ISPRA)

Brijuni - Croatia (UNIST-FGAG)

Karaburun-Sazan - Albania (MM)

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PB MPAs WP5: transferring in Capo Milazzo MPAs

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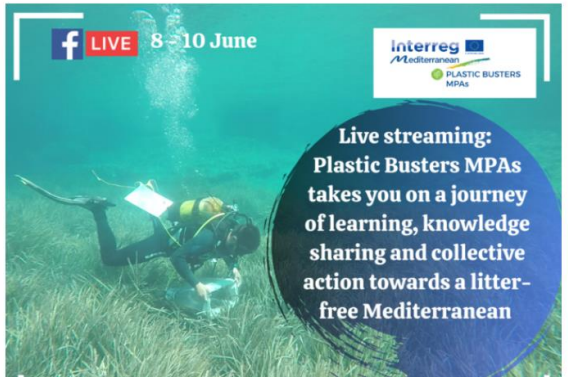
Home > News & Events > News > Live streaming: Plastic Busters MPAs takes you on a journey of learning, knowledge sharing and collective action towards a litter-free Mediterranean

LIVE STREAMING: PLASTIC BUSTERS MPAS TAKES YOU ON A JOURNEY OF LEARNING, KNOWLEDGE SHARING AND COLLECTIVE ACTION TOWARDS A LITTER-FREE MEDITERRANEAN

27/05/2021

- Join the first marine litter monitoring campaign streamed online and follow the team at sea, on the coast and in the laboratory.
- The 3-day-long activities will be conducted in the recently established MPA of Cape Milazzo in Sicily.
- The research activities, entail beach macrolitter surveys, surveys of floating macrolitter and microlitter, surveys on the presence of macrolitter on the seafloor. The impacts of marine litter on biota will be also investigated.
- This marine litter research expedition is a demonstration of the project's transferring phase aiming to pass on the knowledge and skills for harmonized marine litter monitoring to Mediterranean MPAs.



AMP AREA MARINA PROTETTA CAPO MILAZZO

2021

Interreg Mediterranean PLASTIC BUSTERS MPAs

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PB MPAs WP5: transferring in Bonifacio MPAs

2021

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MPAs

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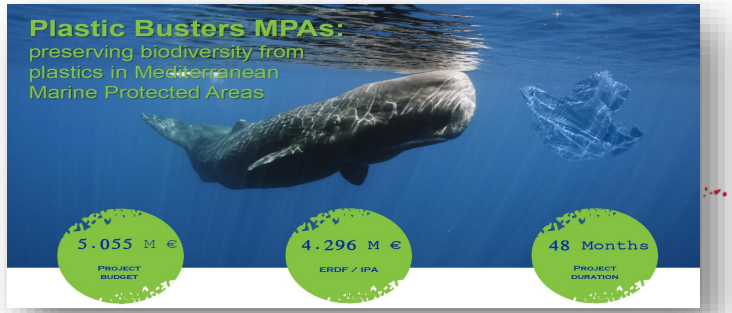
PLASTIC BUSTERS ON BASIN SCALE

TRANSFERING/CAPITALIZATION OF PLASTIC BUSTERS MPAs

Union for the Mediterranean
Union pour la Méditerranée
الإتحاد من أجل المتوسط

Interreg Mediterranean
EUROPEAN UNION

ENI CBCMED
Cooperating across borders in the Mediterranean



COMMON

NEW

Plastic Busters CAP

ENI CBCMED
Cooperating across borders in the Mediterranean

PLASTIC BUSTERS TEAM

Interreg Mediterranean
PLASTIC BUSTERS MPAs

Thanks !

Union for the Mediterranean
Union pour la Méditerranée
الإتحاد من أجل المتوسط