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STUDY ON THE HOTSPOTS OF INTERACTIONS BETWEEN CETACEANS AND MARINE LITTER IN THE ACCOBAMS AREA – DRAFT REPORT

STUDY ON THE HOTSPOTS OF INTERACTIONS BETWEEN CETACEANS AND MARINE LITTER IN THE ACCOBAMS AREA - DRAFT REPORT

Presented by Cristina Fossi, Member of the Scientific Committee, Task Manager on Marine litter & chemical and biological pollution and Cristina Panti, Expert

Issue: identification of hotspots of interactions between cetaceans and marine litter

1. Action requested

The Scientific Committee is invited to:

a. **Review** the draft report of the Study on the hotspots of interactions between cetaceans and marine litter in the ACCOBAMS Area
b. Provide **advice** on its development.

2. Background

In 2019, the Italian Ministry of Environment provided a voluntary contribution to ACCCOBAMS in order to develop specific activities on marine litter and chemical pollution.

As part of the 2020-2022 ACCOBAMS Programme of Work, these activities aim:

- to identify potential hotspots areas of interactions between cetaceans and marine litter (ingested marine litter / microplastics / entanglements in ghost nets)
- to establish a state of the art on the impacts of chemical pollution on cetaceans and to develop guidelines on the best practices to assess the impact of chemical pollution on cetaceans with a focus on emerging contaminants.

The overall objective of these activities is to raise awareness of ACCOBAMS Parties on the impacts of marine litter and chemical pollution on cetaceans and to provide useful tools and guidelines to the scientists in the ACCOBAMS area to assess chemical contamination on cetaceans.

The following document is a first draft of the report of the Study on the hotspots of interactions between cetaceans and marine litter in the ACCOBAMS Area.

Once finalized the final draft will be circulated by email to the Scientific Committee Members before its presentation at the Eighth Meeting of the Parties to ACCOBAMS in November 2022.

UNIVERSITÀ DI SIENA 1240

(DRAFT)

STUDY ON THE HOTSPOTS OF INTERACTIONS BETWEEN CETACEANS AND MARINE LITTER IN THE ACCOBAMS AREA, TO BE PREPARED IN LIAISON WITH RELEVANT EXPERTS AND SCIENTISTS FROM THE ACCOBAMS AREA

By

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Draft version in preparation of the final document to be presented

2 months before MOP8 (planed in November 2022 - *tbc*)

RELEVANT EXPERTS

THIS DOCUMENT WILL BE PREPARED IN LIAISON WITH RELEVANT EXPERTS AND SCIENTISTS FROM THE ACCOBAMS AREA

FRANCOIS GALGANI (IFREMER), CARLO BRANDINI (LAMMA), MASSIMILIANO ROSSO (CIMA), MARK SIMMONDS (SCIENCEGYRE), SVITLANA LIUBARTSEVA (CMCC), CELINE MAHFOUZ

Executive Summary

(to be done once the document has been completed)

Objectives of the document

The main objectives of this document will be to describe the knowledge on the interactions between cetaceans and marine litter in the ACCOBAMS area considering both peer-reviewed papers, reports of project and grey literature.

1. Marine Litter at global scale

In this section the topic of Marine Litter contamination at global scale will be briefly described. Marine litter is defined as any persistent, manufactured or processed solid material discarded, disposed, or abandoned in the marine environment. It is globally acknowledged as a major societal challenge of our times due to its significant environmental, economic, social, political and cultural implications. The review will then focus on to the state of contamination of the Mediterranean and contiguous areas, being the Mediterranean Sea indicated as one of the most impacted areas in the world by Marine Litter.

(This chapter will be supported by info-graphic material obtained from the literature on the subject and tailor-made according to the data analyzed.)

The pollution of the oceans due to plastic waste generates great concern for both the scientific community and society as a whole. In recent years, both political (national and international) and scientific initiatives have been developed to mitigate the consequences of the massive use of plastics and its presence in the marine environment (see Maximenko et al. (2019) for a complete summary). The United Nations Environmental Program (UNEP) defines marine litter (ML) as any persistent, manufactured or processed solid material that is discarded, disposed of or abandoned in the marine or coastal environment (UNEP,2009). These materials accumulate in both shallow and deep waters, and especially in closed basins such as the Mediterranean Sea (Barneset al., 2009; Cózar et al., 2015). Between 4.8 and 12.7 million tons of plastic waste were dumped into the ocean in 2010, an amount that is expected to increase by one order of magnitude by 2025 if no measures are implemented to improve the waste management systems. In the case of the Mediterranean, it is estimated that around 100k tons of plastic waste enter each year (Jambeck et al., 2015). Despite legislative advances in prevention, illegal dumping as well as waste transportation to the open ocean from coastal areas and river mouths is a problem that is still far from being solved.

Nowadays, marine litter is commonly observed across all oceans and marine ecosystems. Mainly represented by plastic (up to 80%) and its fragmentation products, meso- (0.5–2.5 cm) and micro-particles (<5 mm), they can be transported over long distances (Lebreton et al., 2018). Microplastic presence has been detected on coastlines where it may accumulate due to current, wave and wind actions, river outflows and direct littering at the coast (GESAMP, 2019). Moreover, it occurs on the ocean surface, along the water column, on the seafloor and in association with biota, due to entanglement or ingestion (Fossi et al., 2012, 2017; Baini et al., 2018; GESAMP, 2019; Suaria et al., 2016). In the last 50 years, since the first record available in the scientific literature published by Kenyon and Kridler in 1969, the number of species affected by plastic litter has

increased steadily reaching 914 species (Kühn and van Franeker, 2020). Bearing this in mind, monitoring and assessment programs appear essential to address specific questions about the distribution of marine litter, including microplastics, and its potential impacts on marine biodiversity.

At the European level, the Marine Strategy Framework Directive (MSFD) (2008/56/EC) and at the Mediterranean level the indicators (UNEP/MAP IMAP), have been developed to protect the marine environment as well as to ensure its sustainable use. Based on several descriptors/Ecological Objecives the ultimate goal of these regulations is the achievement of Good Environmental Status (GES) for the marine waters by the EU Member States. In particular, the provisions of the MSFD Descriptor 10 and Ecological Indicator 10, respectively, aim to protect the marine ecosystems against harm caused by the emerging issue of plastic litter. As highlighted by several ocean circulation models (Fossi et al., 2017, 2018; Liubartseva et al., 2018; Mansui et al., 2015; Politikos et al., 2020), the Mediterranean Sea has been considered a sensitive plastic litter accumulation zone with an average concentration comparable to the great oceanic gyres (Cózar et al., 2015; Suaria et al., 2016; UNEP/MAP, 2015). Mainly due to the limited exchange of surface waters with the Atlantic Ocean, and intensive land- and marine-based sources of pollution significant amounts of marine litter enter and accumulate in this basin. Coastal areas and waters, in particular, face significant pressures from heavy population densities to maritime, touristic, and industrial activities leading to a decrease in the integrity of marine ecosystems (Coll et al., 2012, 2010; UNEP, 2016). While the identification of biodiversity hotspots and sensitive areas is a well-established procedure for these zones, usually resulting in the identification of Marine Protected Areas, the offshore waters are usually less investigated. Marine megafauna, such as cetaceans and marine turtles as an example, are often used as umbrella species, considering not only their ecological role but also their charismatic influence in driving conservation efforts (Germanov et al., 2018). The identification of particularly sensitive areas as well as biodiversity hotspots in the pelagic realm can be effectively run by focusing on these valuable species.

Studies evaluating the potential risk connected to the spatial distribution of plastic litter and the presence of organisms inhabiting the marine ecosystems were only recently published worldwide (Everaert et al., 2018; Jâms et al., 2020; Mazarrasa et al., 2019; Schuyler et al., 2016; Wilcox et al., 2018, 2015) and in the Mediterranean Sea (Compa et al., 2019a; Darmon et al., 2017; Fossi et al., 2017; Soto-Navarro et al., 2021). Although some risk evidence were highlighted for the most studies species, such as sea turtles and birds, there is still a lack of data regarding the simulation-based risk approach and the real threats that may affect the marine fauna (Soto-Navarro et al., 2021). Empirical data collection on the magnitude and typology of plastic litter, the spatial distribution of organisms and the potential impacts on them is needed to assess a more accurate and reliable risk scenario.

1.1 Marine litter in the Mediterranean Sea and contiguous areas

Studies on marine litter in the Mediterranean basin started in the 1990s, but more attention was given to the issue after 2010, when more data became available on the abundance and distribution of marine litter, and when the first attempts to assess trends were made, microplastics entered the agenda and the mapping of impacts became a priority. There is no comprehensive assessment of the economic impacts of marine litter in the Mediterranean Sea, apart from an assessment of the economic impacts of marine litter in the Adriatic and Ionian Seas within the framework of the EU funded DeFishGear project (Vlachogianni, 2017), as well as limited information deriving from beach clean-up activities, the fishing industry, and research reports.

The Mediterranean Sea is a closed basin, with a coastal population of about 210 million inhabitants. Mediterranean countries are the number one tourist destination in the world, with around 360 million visitors every year, and receives waste from coastal zones, as well as from many large rivers flowing through largely urbanized cities such as the Nile River that transports more than 200 tonnes of plastic into the

Mediterranean Sea per year (Lebreton et al. 2017). In addition, more than 20% of global maritime traffic passes through the Mediterranean Sea. Consequently, the basin has become one of the most marine litter-affected areas in the world (UNEP/MAP, 2015). Plastics are the prevailing type, accounting for up to 95-100% of total floating marine litter, due also to the high floatability of plastics, and more than 50% of seabed marine litter. The analysis of 80 beaches conducted in 2016 (Addamo, Laroche & Hanke, 2017) indicated that only 10 types of debris, mostly single-use plastics (cutlery/trays/straws, cigarette butts, caps/lids, plastic bottles, shopping bags) represent more than 60% of the total recorded marine litter on beaches. No change was observed in the percentage of the dominant marine litter categories between 2013 and 2018 on the beaches of 8 Mediterranean countries (Ocean Conservancy, 2018). Typically, most of the litter on beaches originates from beach/recreational activities. Glass bottles and metal beverage cans disappeared from the top ten lists in non-tourist areas in recent years because of behavioural changes.

On the sea floor of the north-western basin, plastics and fishing-related items (some of which are also made of plastic) have represented the same percentage of litter for more than 20 years (UNEP/MAP, 2017a), but information still remains scarce, especially on the specific issue of abandoned, lost or otherwise discarded fishing gear (ALDFG), which may account for a large or even the largest part of marine litter items in many areas. Particular importance is currently being paid to the emerging issues of micro- and nanoplastics and the possible release of associated Persistent Organic Pollutants (POPs) and Endocrine Disrupting Chemicals (EDCs). Concentrations of microplastics at the surface of the Mediterranean Sea are largely above 100,000 items per km2 (UNEP/MAP, 2015) and, reach maximums of more than 64 million floating particles per km2 (Van Der Hal, Ariel & Angel, 2017).

Data on contiguous areas must be integrated

1.2 Sources and driving forces of Marine Litter

In most Mediterranean countries, the root causes of plastic pollution are found in the increase of plastic use, unsustainable consumption patterns, ineffective/inefficient waste management and loopholes in plastic waste management. Plastic ranges from 5% (Morocco), to 14% (Israel) of the total waste generated (World Bank in UNEP/MAP, 2015). Inputs of plastics into the sea, as estimated in 2015, are at the level of over 260,000 tonnes per year or 730 tonnes per day, depending on the coastal population, which may vary depending on the country, representing more than 2% of the total inputs in the world's oceans.
At the level of Mediterranean watersheds, another study (Weiss et al. 2019) modelled plastic flows into the Mediterranean Sea, as shown in Figure 1, and the Marine litter in relation to the economic sectors in the Mediterranean Sea. Sources, amounts and impacts are report in Figure 2 (According to UNEP/MAP, 2015 & UN Environment, 2018a).
In some areas, up to 58% of the municipal solid waste collected is still disposed of in open dump sites. Of the millions of tonnes of plastic waste produced every year in Mediterranean countries, less than one third is recycled and plastics recycling is less than 6% (WWF, 2018). Bearing in mind the importance of wastewater as a pathway for waste leaking into the sea, a key challenge is that in the Mediterranean region, 21% of wastewater (25% in Southern Countries) undergoes only basic treatment, and less than 8% (1% in southern countries) undergoes tertiary treatment (UNEP/MAP, 2017a).
Key economic sectors in the Mediterranean, such as professional and recreational fisheries, aquaculture, tourism and shipping, also generate large amounts of litter that end up as marine litter.

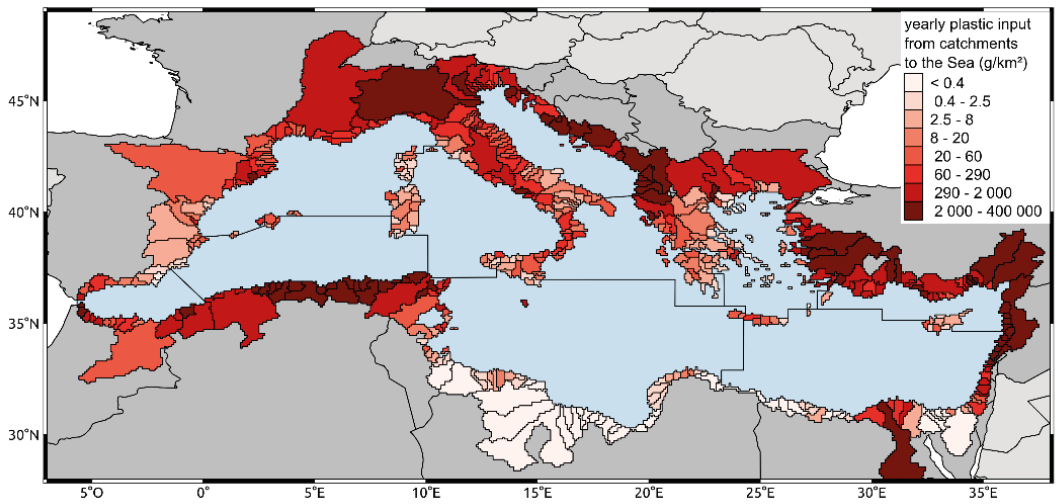

***Figure 1**. Estimate of annual specific plastic flows (kg/m3) discharged by watersheds into the Mediterranean Sea. Flows calculated based on Lebreton et al. 2017 (Unep/map 2021).*

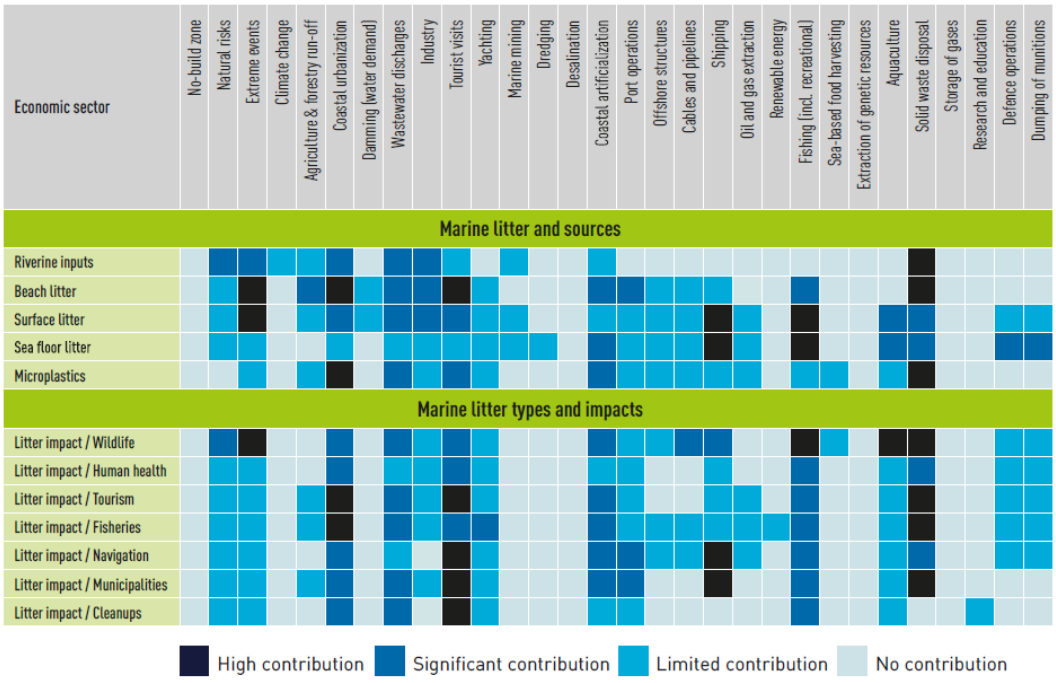

***Figure 2.** Marine litter in relation to the economic sectors in the Mediterranean Sea. Sources, amounts and impacts (According to UNEP/MAP, 2015 & UN Environment, 2018a) (According to UNEP/MAP, 2015 & UN Environment, 2018a)*

1.3 Definitions and policy context

Marine litter can be classified in size classes as follows: macrolitter referring to items above 25mm in the longest dimension; mesolitter from 5mm to 25 mm; and microlitter from 1µm to 5mm. Sometimes the later size class is further broken down to large microplastics from 1mm to 5 mm and small microplastics from 1µm to 1mm. The main legislative frameworks related to marine litter monitoring are the EU Marine Strategy

Framework Directive (2008/56/EC, 2010/477/EC, 2017/848/EC) and the Barcelona Convention Ecosystem Approach (COP19 IMAP Decision IG.22/7) (see Box 1.1 and Box 1.2).

Box. 1. *The Marine Litter Descriptor, criteria, and respective Indicators within the framework of the EU MSFD. Marine Litter within the EU MSFD Properties and quantities of marine litter do not cause harm to the coastal and marine environment (Descriptor 10)*

Marine Litter within the EU MSFD

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

Criteria D10C1 - Primary: The composition, amount and spatial distribution of litter on the coastline, in the surface layer of the water column, and on the seabed, are at levels that do not cause harm to the coastal and marine environment.

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

Criteria D10C2 - Primary: The composition, amount and spatial distribution of micro-litter on the coastline, in the surface layer of the water column, and in seabed sediment, are at levels that do not cause harm to the coastal and marine environment.

- ✓ amount, distribution and, where possible, composition of microparticles (in particular microplastics) (10.1.3)

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

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

Criteria D10C4 - Secondary: The number of individuals of each species which are adversely affected due to litter, such as by entanglement, other types of injury or mortality, or health effects.

Box. 1.2. *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 23: 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.

2. Marine litter interaction with marine mammals

The effects of marine litter on marine wildlife have been documented since the 1960s. However, the production of plastics and associated pollution has subsequently increased greatly, and marine debris has now been recognised as a global problem (CBD, 2016), with more than 800 species known to have been adversely affected (Fossi et al., 2018d; Kuhn and van Franeker, 2020).

For cetaceans, impacts from entanglement or ingestion can be acute or chronic. Almost two-thirds of cetacean species have been found to have ingested plastic macro-litter (2.5 cm+) and this affects species across many different habitats which exhibit different feeding techniques. This section focuses both on entanglement and ingestion.

Impacts of debris on marine fauna occur throughout the marine ecosystems (Gall and Thompson, 2015; Kühn et al., 2015). For marine mammals, impacts can be divided into those arising from entanglement, which can result in injury, drowning or strangulation, and those from ingestion, with pathology ranging from no discernible impact through to blockage of the digestive tract, suffocation and starvation (Sheavly and Register, 2007). Sub-lethal effects may compromise feeding and associated malnutrition, disease and reduced reproduction, growth and longevity (Moore et al., 2013). New data suggests when the dimension of the items ingested by marine fauna range from millimeter to nanometer in size (i.e., micro- debris 1 µm-5 mm and nano-plastics <1µm, GESAMP, 2016), this can lead to inflammation, damage of the tissues at the cellular level, or altered molecular pathways (Mattsson et al., 2015, 2017; Pedà et al., 2016). Baulch and Perry (2014) and Kühn et al. (2020) reviewed the data on plastic ingestion and entanglement rates available for cetaceans, showing an increase in the number of cases being reported over the last five decades. A total of 130 papers/documents were published from 1965 to January 2018 (*to be updated in due course till June 2022*), 44 on entanglement and 86 on ingestion of debris by cetaceans. Only 2 out of the 13 cetacean families analyzed have not interacted with debris, and ingestion appears to be the most common, occurring in over 58% of all cetacean species, including species employing a variety of feeding techniques throughout the water column (Fossi et al., 2018a; Figure 3). In contrast, entanglement events have only been documented in ∼30% of cetacean species (Figure 3). The majority of entanglements for cetaceans are in ghost or active fishing gear (Baulch and Perry, 2014). Cetaceans tend be entangled around their neck, flippers and flukes (Moore et al., 2013; van der Hoop et al., 2014). However, for the ingestion of debris, the number of records does not reflect the magnitude of the issue, due to low detection rate and difficulty in retrieving and analyzing specimens. Sixty three percent of the 89 species of cetaceans (excluding *Lipotes vexillifer* which is listed as "possibly extinct" by the Society for Marine Mammalogy in 2018)) have been reported to be affected by debris.

Items ingested are most commonly plastic (46% of all items ingested) and range in size from small fragments (<5 mm, Besseling et al., 2015; Lusher et al., 2018) to large sheets of plastic and netting over one meter long (Jacobsen et al., 2010; de Stephanis et al., 2013). However, globally, the paucity and homogeneity of data prevented a robust identification of whether, at a species level, there are certain cetacean species particularly prone to ingesting debris. This is mainly due to the difficulties in performing such analysis in these species and the lack of harmonized and standard protocols (e.g., many entanglement events or cases of debris ingestion are not reported). Seventy per cent of the documents analyzed were published after 2000, although only in the last few years were standardized protocols applied, and this can affect the reliability of the results reported.

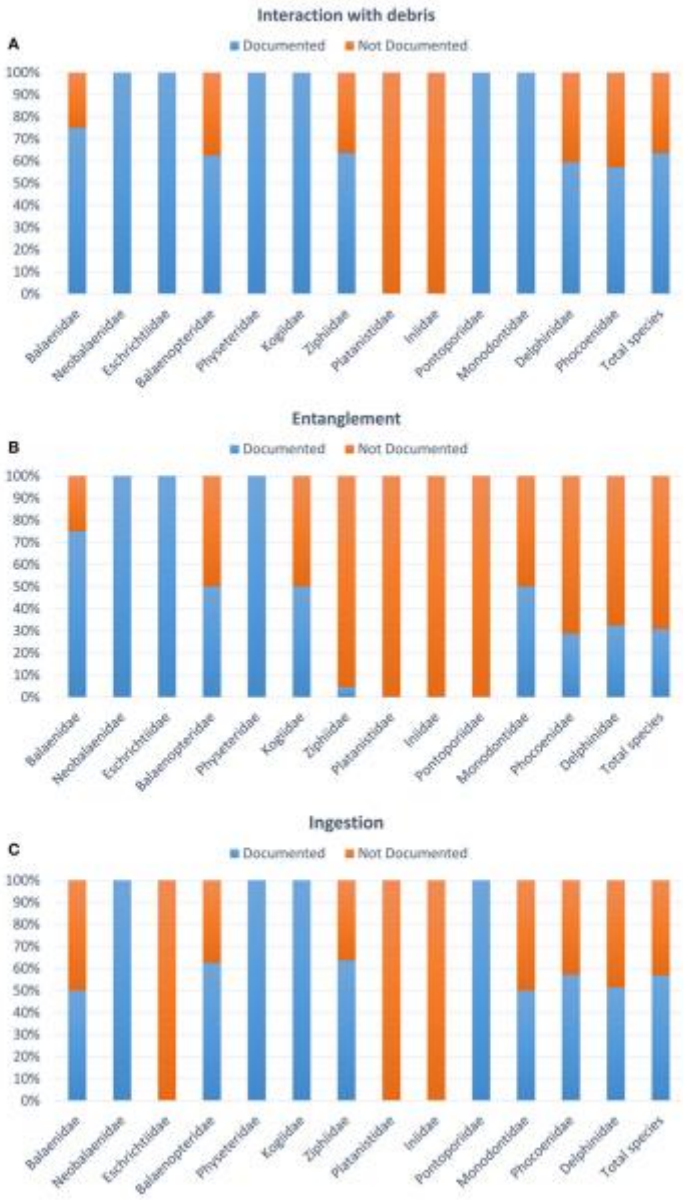

Figure 3. Percentage of studied species for debris in relation to the total number of species per family in the order Cetaceans. (A) Interaction with debris including both **entanglement and ingestion**; (B) percentage of species with documented/not documented entanglement; (C) percentage of species with documented/not documented ingestion (Fossi et al. 2018)

2.1 Ingestion of Microplastics by Cetaceans

The study of microplastic ingestion by cetaceans is a challenging task, due to the difficulty in obtaining accurate samples during necropsies and analyzing large volumes (e.g., from large cetaceans). Few studies have directly identified microplastics in the digestive tracts of stranded cetaceans. Applying standard protocols for the detection and identification of microplastics in the digestive tract (Lusher et al., 2015, Panti et al., 2019), microplastics were found throughout the stomach/intestine of seven odotontocetes species: *Ziphius cavirostris, Delphinus delphis, Stenella coeruleaolba, Phocoena phocoena, Orcinus orca, and Tursiops truncatus* (Lusher et al., 2018; van Franeker et al., 2018). Only one study on Mysticetes, a stranded humpback whale (*Megaptera novaeangliae*), recorded the presence of microplastic in its intestines, including fragments, and threads (Besseling et al., 2015). There are multiple possible routes of microplastic uptake,

including direct ingestion from the water column while feeding, inhalation at the air-water interface, or via trophic transfer from prey items (IWC, 2013). Uptake of microplastics has been demonstrated in zooplankton species such as copepods and euphasiids (Kühn et al., 2015; Fossi et al., 2018b), which are some of the main prey of baleen whales and may thus be a source of secondary transfer of debris to cetaceans.

Data on this topic must be integrated and updated up to June 2022.

3. Main results of the bibliographic research on Marine Litter models distribution in the ACCOBAMS area

In this paragraph we report the results of the bibliographic research on Marine Litter distribution models in the ACCOBAMS area with a particular focus on the most studied area: the Mediterranean sea. ***25 papers*** *report studies (September 2021, to be further implemented till June 2022) on plastic distribution prediction by oceanographic models in the Mediterranean area; the main results of the various modeling models are shown below.*

3.1 Bibliographic research

The first methodological step of this project consists in carrying out an accurate bibliographic research on the selected topic (hotspots of interactions between cetaceans and marine litter in the ACCOBAMS area) using the main research platform used for scientific publications (Scopus, PubMed, Google Scholar, etc.) and also grey literature (e.g. project's reports). This chapter will be supported by info-graphic material obtained from the data elaboration at the end of the bibliographic research set at June 2022.

The summary of each study has been reported under the title of the paper and the list of authors.

Combining Litter Observations with a Regional Ocean Model to Identify Sources and Sinks of Floating Debris in a Semi-enclosed Basin: The Adriatic Sea (Daniel F. Carlson, Giuseppe Suaria, Stefano Aliani, Erick Fredj, Tomaso Fortibuoni, Annalisa Griffa, Aniello Russo and Valentina Melli)

Visual ship transect surveys provide crucial information about the density, and spatial distribution of floating anthropogenic litter in a basin. However, such observations provide a 'snapshot' of local conditions at a given time and cannot be used to deduce the provenance of the litter or to predict its fate, crucial information for management and mitigation policies. Particle tracking techniques have seen extensive use in these roles, however, most previous studies have used simplistic initial conditions based on bulk average inputs of debris to the system. Here, observations of floating anthropogenic macro debris in the Adriatic Sea are used to define initial conditions (number of particles, location, and time) in a Lagrangian particle tracking model. Particles are advected backward and forward in time for 60 days (120 days total) using surface velocities froman operational regional ocean model. Sources and sinks for debris observed in the central and southern Adriatic in May 2013 and March 2015 included the Italian coastline from Pescara to Brindisi, the Croatian island of Mljet, and the coastline from Dubrovnik through Montenegro to Albania. Debris observed in the northern Adriatic originated from the Istrian peninsula to the Italian city of Termoli, as well as the Croatian island of Cres and the Kornati archipelago. Particles spent a total of roughly 47 days afloat. Coastal currents, notably the eastern and western Adriatic currents, resulted in large alongshore displacements. Our results indicate that anthropogenic macro debris originates largely from coastal sources near population centers and is advected by the cyclonic surface circulation until it strands on the southwest (Italian) coast, exits the Adriatic, or recirculates in the southern gyre.

Plastic Debris Occurrence, Convergence Areas and Fin Whales Feeding Ground in the Mediterranean Marine Protected Area Pelagos Sanctuary: A Modeling Approach (Maria Cristina Fossi, Teresa Romeo, Matteo Baini, Cristina

Panti, Letizia Marsili, Tommaso Campani, Simonepietro Canese, François Galgani, Jean-Noël Druon, Sabina Airoldi, Stefano Taddei, Maria Fattorini, Carlo Brandini and Chiara Lapucci)

The Mediterranean Sea is greatly affected by marine litter. In this area, research on the impact of plastic debris (including microplastics) on biota, particularly large filter-feeding species such as the fin whale (*Balaenoptera physalus*), is still in its infancy. We investigated the possible overlap between microplastic, mesoplastic and macrolitter accumulation areas and the fin whale feeding grounds in in a pelagic Specially Protected Area of Mediterranean Importance (SPAMI): the Pelagos Sanctuary. Models of ocean circulation and fin whale potential habitat were merged to compare marine litter accumulation with the presence of whales. Additionally, field data on microplastics, mesoplastics, and macrolitter abundance and cetacean presence were simultaneously collected. The resulting data were compared, as a multi-layer, with the simulated distribution of plastic concentration and the whale habitat model. These data showed a high occurrence of microplastics (mean: 0.082 items/m2, STD ± 0.079 items/m2) spatial distribution agreed with our modeling results. Areas with high microplastic density significantly overlapped with areas of high macroplastic density. The most abundant polymer detected in all the sampling sites was polyethylene (PE), suggesting fragmentation of larger packaging items as the primary source. To our knowledge, this is the first study in the Pelagos Sanctuary in which the simulated microplastic distribution has been confirmed by field observations. The overlap between the fin whale feeding habitat and the microplastic hot spots is an important contribution for risk assessment of fin whale exposure to microplastics.

Modeling transport of microplastics in enclosed coastal waters: A case study in the Fethiye Inner Bay (Asli Numanoglu Genc, Nilufer Vural, Lale Balas)

In this study, transport and possible accumulation of microplastic marine litter in enclosed coastal waters are modeled numerically. The model is applied to the Fethiye Inner Bay, located in Fethiye-Gocek Specially Protected Area. In modeling studies, three dimensional coastal hydrodynamics, transport and water quality numerical model HYDROTAM-3D was used. The current climate was prepared by modeling long-term circulation patterns due to wind, wave and density stratifications. Following the hydrodynamic studies, the advection and diffusion of 3 mm size polystyrene particles by the coastal currents in the surface waters of Fethiye Inner Bay were simulated. The coastal regions where the microplastic pollution will be concentrated and transported were determined by the modeling scenarios. It has been found that microplastic accumulation is expected in the southwest and east coastal waters of the Fethiye Inner Bay. The results of the model will contribute to the databases for sustainable protection of the marine environments.

Selective transport of microplastics and mesoplastics by drifting in coastal waters (Atsuhiko Isobe, Kenta Kubo, Yuka Tamura, Shinichio Kako, Etsuko Nakashima, Naoki Fujii)

The quantity and size distributions of small plastic fragments in the Seto Inland Sea, Japan were investigated using field surveys and a numerical particle-tracking model. The model was used to interpret the distributions of small plastic fragments and the possible transport processes in coastal waters. Of note, the size and quantity of mesoplastics (approximately >5 mm) gradually increased close to the coast irrespective of the existence of river mouths, which probably act as a major source of anthropogenic marine debris. Additionally, microplastics were more dominant as we moved further offshore. The numerical model reproduced the near-shore trapping of mesoplastics, suggesting that mesoplastics are selectively conveyed onshore by a combination of Stokes drift and terminal velocity, dependent on fragment sizes. It is suggested that mesoplastics washed ashore on beaches degrade into microplastics, and that the microplastics, which are free from near-shore trapping, are thereafter spread offshore in coastal waters.

Regional approach to modeling the transport of floating plastic debris in the Adriatic Sea (S. Liubartseva, G. Coppini, R. Lecci, S. Creti)

Sea surface concentrations of plastics and their fluxes onto coastlines are simulated over 2009–2015. Calculations incorporate combinations of terrestrial and maritime litter inputs, the Lagrangian model MEDSLIK-II forced by AFS ocean current simulations, and ECMWF wind analyses. With a relatively short particle half-life of 43.7 days, the Adriatic Sea is defined as a highly dissipative basin where the shoreline is, by construction, the main sink of floating debris. Our model results show that the coastline of the Po Delta receives a plastic flux of approximately 70 kg(km day)-1. The most polluted sea surface area (N10 g km-2 floating debris) is represented by an elongated band shifted to the Italian coastline and narrowed from northwest to southeast. Evident seasonality is found in the calculated plastic concentration fields and the coastline fluxes. Complex source–receptor relationships among the basin's subregions are quantified in impact matrices.

Modelling the transport and accumulation of floating marine debris in the Mediterranean basin (J. Mansui, A. Molcard, Y. Ourmieres)

In the era of plastic and global environmental issues, when large garbage patches have been observed in the main oceanic basins, this work is the first attempt to explore the possibility that similar permanent accumulation structures may exist in the Mediterranean Sea. The questions addressed in this work are: can the general circulation, with its sub-basins scale gyres and mesoscale instabilities, foster the concentration of floating items in some regions? Where are the more likely coastal zones impacted from open ocean sources? Multi-annual simulations of advected surface passive debris depict the Tyrrhenian Sea, the north-western Mediterranean sub-basin and the Gulf of Sirte as possible retention areas. The western Mediterranean coasts present very low coastal impact, while the coastal strip from Tunisia to Syria appears as the favourite destination. No permanent structure able to retain floating items in the long-term were found, as the basin circulation variability brings sufficient anomalies.

Pathways of marine debris derived from trajectories of Lagrangian drifters (Nikolai Maximenko, Jan Hafner, Peter Niiler)
Global set of trajectories of satellite-tracked Lagrangian drifters is used to study the dynamics of marine debris. A probabilistic model is developed to eliminate the bias in spatial distribution of drifter data due to heterogeneous deployments. Model experiments, simulating long-term evolution of initially homogeneous drifter array, reveal five main sites of drifter aggregation, located in the subtropics and maintained by converging Ekman currents. The paper characterizes the geography and structure of the collection regions and discusses factors that determine their dynamics. A new scale Rc = (4k/|D|)1/2 is introduced to characterize tracer distribution under competing effects of horizontal divergence D and diffusion k. Existence and locations of all five accumulation zones have been recently confirmed by direct measurements of microplastic at the sea surface.

Identifying distribution and accumulation patterns of floating marine debris in the Black Sea (S. Miladinova**,** D. Macias, A. Stips, E. Garcia-Gorriz)
The distribution and accumulation of floating marine debris in the Black Sea during the last few decades are analysed by the help of numerical modelling. An approach based on a mesoscale circulation model combined with a particle tracking model is applied. It is established that the litter distribution is nearly independent of the source location and is mainly controlled by the basin circulation system. The western gyre predominantly accumulates floating debris in summer. After the integration of the main cyclonic current in winter, the debris in the inner basin moves east. Retention zones along the south-western coast persist in time. The mean particle stranding time is estimated at about 200 days. Accumulation zones along the south-eastern and eastern coast are abundant in summer, and then move further northeast and north. Simulations demonstrate an increasing litter accumulation in summer on the North Western Shelf and shelf break.

The boundary current role on the transport and stranding of floating marine litter: The French Riviera case (Yann Ourmieres, Jérémy Mansui, Anne Molcard, François Galgani, Isabelle Poitou)
The aim of the present study is to evidence the role of a boundary current and meteorological conditions in the transport and stranding of floating marine debris. The used data are from a beach survey and an inter-annual unique effort of marine debris sightings along the French Riviera in the North-Western Mediterranean region. Offshore data have been collected during oceanic cruises while beach surveys were performed around Antibes city. Debris were found on 97% of the ocean transects, with a large spatial and temporal variability, showing contrasted areas of low (~ 1 item/km2) and of high (> 10 items/km2) debris densities. Results suggest that the debris spatio-temporal distribution is related to the Northern current (NC) dynamics, the regional boundary current, with accumulation patterns in its core and external edge. By playing a role in the alongshore transport, such a boundary current can form a cross-shore transport barrier. Stranding events can then occur after strong on-shore wind bursts modifying the sea surface dynamics and breaking this transport barrier. It is also shown that episodic enhancement of the stranding rate can be explained by combining the NC dynamics with the wind forcing and the rainfall effect via the local river run-off. Conversely, off-shore wind bursts could also free the marine litter from the boundary current and export them towards the open sea.

Modeling the Fate and Distribution of Floating Litter Particles in the Aegean Sea (E. Mediterranean) (Dimitrios V. Politikos, Christos Ioakeimidis, George Papatheodorou and Kostas Tsiaras)
A circulation model is coupled to a Lagrangian particle-tracking model to simulate the transport floating litter particles in the Aegean Sea, Greece (Eastern Mediterranean). Considering different source regions and release dates, simulations were carried out to explore the fate and distribution of floating litter over 1990–2009, taking into account the seasonal and interannual variability of surface circulation. Model results depicted recurrently high concentrations of floating litter particles in the North Aegean plateau, the Saronikos Gulf, and along Evia and Crete islands. Modeled transport pathways of floating litter demonstrated that source regions are interconnected, with Saronikos Gulf being a main receptor of litter from other sources. Notably higher percent of litter exit (∼35%) than enter the model domain (∼7%) signified that

Aegean Sea seems to act as a source rather than receptor of floating litter pollution in the Eastern Mediterranean Sea. Beached litter was found around 10%, mostly located in the western part of the Aegean Sea. This is the first modeling study to explore the transport of floating marine litter in Greek waters.

A global inventory of small floating plastic debris (Erik van Sebille, Chris Wilcox, Laurent Lebreton, Nikolai Maximenko, Britta Denise Hardesty, JanAvan Franeker, Marcus Eriksen, David Siegel, Francois Galgani and Kara Lavender Law)

Microplastic debris floating at the ocean surface can harm marine life. Understanding the severity of this harm requires knowledge of plastic abundance and distributions. Dozens of expeditions measuring microplastics have been carried out since the 1970s, but they have primarily focused on the North Atlantic and North Pacific accumulation zones, with much sparser coverage elsewhere. Here, we use the largest dataset of microplastic measurements assembled to date to assess the confidence we can have in global estimates of microplastic abundance and mass. Weuse a rigorous statistical framework to standardize a global dataset of plastic marine debris measured using surface-trawling plankton nets and coupled this with three different ocean circulation models to spatially interpolate the observations. Our estimates show that the accumulated number of microplastic particles in 2014 ranges from 15 to 51 trillion particles, weighing between 93 and 236 thousand metric tons, which is only approximately1%of global plastic waste estimated to enter the ocean in the year 2010. These estimates are larger than previous global estimates, but vary widely because the scarcity of data in most of the world ocean, differences in model formulations, and fundamental knowledge gaps in the sources, transformations and fates of microplastics in the ocean.

Marine litter in the Mediterranean Sea: an oceanographic perspective (Enrico Zambianchi, Ilaria Iermano, Giuseppe Suaria and Stefano Aliani)
Floating debris is ubiquitous in the world ocean, and its presence is very widespread also in the Mediterranean Sea. The conservative nature of an important fraction of marine litter allows it to travel for distances up to the basin scale, causing local accumulation, posing a serious environmental threat, offering a rafting opportunity to marine organisms. In this paper we briefly review the main oceanographic processes responsible for marine debris transport at the surface and at depth. We also briefly review the main studies carried out on the oceanographic forcing on marine litter in the world ocean and we interpret the most recent findings on floating debris in the Mediterranean region in the light of the oceanographic knowledge of the basin.

Lagrangian Transport of Marine Litter in the Mediterranean Sea (Enrico Zambianchi, MarilisaTrani and Pierpaolo Falco)
Concern about marine litter has been rising in the last decades, triggered by the discovery of the great mid-ocean garbage patches. The Mediterranean Sea is strongly affected by the presence of floating litter, as it has a very high amount of waste generated annually per person that eventually ends up in its waters, with plastic objects accounting for a large percentage of all manmade debris. In principle, the basin looks very vulnerable to possible accumulation of floating debris, since its dynamics is characterized by an inward surface flow of water from the Atlantic hampering surface floating items from being flushed out. Yet, no evidence of permanent litter accumulation areas has been reported so far in the Mediterranean. In this paper we utilized the largest available set of historical Lagrangian data gathered in the Mediterranean Sea to estimate the probability of debris particles to reach different subareas of the basin, with the main objective of singling out possible retention areas. Climatological reconstructions of the time evolution of litter distribution in the basin carried out on the basis of observed Lagrangian displacements suggest a general tendency of floating matter to collect in the southern portion of the basin, and in particular a long term accumulation in the southern and southeastern Levantine basin, areas not yet sampled by marine litter observation campaigns, whose targeted organization we strongly recommend at the end of this paper.

The dynamics of microplastics and associated contaminants: Data-driven Lagrangian and Eulerian modelling approaches in the Mediterranean Sea (Federica Guerrini, Lorenzo Mari, Renato Casagrandi)

Plastic pollution is widespread in the global oceans, but at the same time several other types of hydrophobic pollutants contaminate the marine environment. As more and more evidence highlights, microplastics and polluting chemicals are intertwined via adsorption/desorption processes. A thorough assessment of their total impact on marine ecosystems thus requires that these two kinds of pollution are not considered separately. Here we compare the outcomes of two complementary, data-driven modelling approaches for microplastic dispersal and for Plastic-Related Organic Pollutants (PROPs) in the marine environment. Focusing on the Mediterranean Sea, we simulate two years of Lagrangian particle tracking to map microplastic dispersion from the most impacting sources of pollution (i.e. coastal areas, the watersheds of major rivers, and fishing activities). Our particle sources are data-informed by national census data, hydrological regimes, and vessel tracking data to account for spatial and temporal variability of mismanaged plastic waste generation. These particle-based simulations are complemented with a simulation of the dynamics of primary pollutants in the sea, obtained via an advection- diffusion Eulerian model. While providing further understanding of the

spatiotemporal distribution of microplastics and the dynamics of PROPs at a Mediterranean-wide scale, our results call for the development of novel integrated modelling approaches aimed at coupling the dynamics of microplastics with the chemical ex- changes occurring through them, thus promoting a holistic description of marine plastic pollution.

Predicting marine litter accumulation patterns in the Mediterranean basin: Spatio-temporal variability and comparison with empirical data (J. Mansui, G. Darmona, T. Ballerini, O. van Canneyt, Y. Ourmieres, C. Miaud)

The Mediterranean Sea is now acknowledged to be a hot spot for marine litter. However, little is known about Floating Macro Litter (FML) concentration at the scale of the entire basin; predictions regarding this would greatly help guide policymaking to fight this scourge. While previous studies have shown high spatio-temporal variability in FML distribution, the aim of this study was to accurately identify seasonal debris accumulation patterns on regional and local spatial scales across the Mediterranean basin. The objective was then to quantitatively compare this distribution model to other simulations and empirical data. We first studied FML distribution with a 2-D Lagrangian model coupled to an oceanic general circulation model (OGCM) at a horizontal resolution of 1/12°. From an initial homogeneous deployment, we deployed a set of >108 virtual particles across the whole basin and tracked each particle during 3-month journeys. Then we described the FML distribution model outputs and compared them both to empirical observations at the scale of the whole basin (gathered from a review of scientific papers on surface debris distribution), and to other numerical FML simulations from previous studies. The results of our offshore modeled distribution of FML fully agreed with characteristic debris accumulation patterns analyzed in our review of other studies. This indicates that our model could allow the prediction of monthly litter accumulation patterns at the scale of the entire Mediterranean Sea.

Surface water circulation develops seasonally changing patterns of floating litter accumulation in the Mediterranean Sea. A modelling approach D. (Macias, A. Cózar, E. Garcia-Gorriz, D. González-Fernánde , A. Stips)

Marine litter and, particularly, plastics are a growing concern at global scale. The Mediterranean Sea is among the zones in the world with the highest concentration of floating plastic debris. However, our knowledge remains limited on the spatial distribution of litter across this basin. Here, a set of different numerical model simulations were conducted to examine the dynamic conditions of the surface layer of the Mediterranean and how this drives the circulation and accumulation of floating litter. Seasonal dynamics of surface water circulation led to contrasting distribution patterns of floating litter along the year. Multiple hot spots of litter zones appeared across the basin in summer, while litter disperses and moves towards the Eastern Mediterranean and nearshore waters in winter. Taking into account such seasonal variability in the spatial patterns of litter in the Mediterranean seems to be key in the design of further sampling surveys and management strategies.

Quarterly variability of floating plastic debris in the marine protected area of the Menorca Channel (Spain). (Luis F. Ruiz-Orejon, Baptiste Mourre, Rafael Sarda, Joaquín Tintore, Juan Ramis-Pujol)

Plastic pollution is widespread in all the oceans and seas, representing a significant threat to most of their ecosystems even in marine protected areas (MPAs). This study determines the floating plastic distribution in four different periods between 2014 and 2015 in the recently approved Menorca Channel MPA (Balearic Islands). Plastic debris were persistent during all sampling periods on the surface of the Channel, composed mainly by the microplastic sizes. Average particle abundances ranged from 138,293 items/km2 in autumn to 347,793 items/km2 during the spring, while weight densities varied from 458.15 items/km2 in winter to 2016.67 items/km2 in summer. Rigid plastics were the most frequent particles in all the periods analysed (from 89.40%-winter to 94.54%-spring). The high-resolution and particle distribution models corroborated that the oceanographic variability shapes different patterns of presence of plastics, and in particular the existence of areas with almost no plastics.

Sea Waves Transport of Inertial Micro-Plastics: Mathematical Model and Applications (Alessandro Stocchino, Francesco De Leo and Giovanni Besio)

Plastic pollution in seas and oceans has recently been recognized as one of the most impacting threats for the environment, and the increasing number of scientific studies proves that this is an issue of primary concern. Being able to predict plastic paths and concentrations within the sea is therefore fundamental to properly face this challenge. In the present work, we evaluated the effects of sea waves on inertial micro-plastics dynamics. We hypothesized a stationary input number of particles in a given control volume below the sea surface, solving their trajectories and distributions under a second-order regular wave. We developed an exhaustive group of datasets, spanning the most plausible values for particles densities and diameters and wave characteristics, with a specific focus on the Mediterranean Sea. Results show how the particles inertia significantly affects the total transport of such debris by waves.

Rummaging through the bin: Modelling marine litter distribution using Artificial Neural Network. (S. Franceschini, F. Matteia, L. D'Andrea, A. Di Nardia, F. Fiorentino, G. Garofalo, M. Scardia, S. Cataudella, T. Russo)

Marine litter has significant ecological, social and economic impacts, ultimately raising welfare and conservation concerns. Assessing marine litter hotspots or inferring potential areas of accumulation are challenging topics of marine research. Nevertheless, models able to predict the distribution of marine litter on the seabed are still limited. In this work, a set of Artificial Neural Networks were trained to both model the effect of environmental descriptors on litter distribution and estimate the amount of marine litter in the Central Mediterranean Sea. The first goal involved the use of self-organizing maps in order to highlight the importance of environmental descriptors in affecting marine litter density. The second goal was achieved by developing a multilayer perceptron model, which proved to be an efficient method to estimate the regional quantity of seabed marine litter. Results demonstrated that machine learning could be a suitable approach in the assessment of the marine litter issues

Microplastics in surface waters of the Gulf of Gabes, southern Mediterranean Sea: Distribution, composition and influence of hydrodynamics (Amal Zayen, Sami Sayadi, Cristele Chevalier, Moncef Boukthir, Sana Ben Ismail, Marc Tedetti)

The Mediterranean Sea has been described as one of the most affected areas by marine litter in the world. Although microplastics and their effects have been investigated in this area, most of the currently available studies have been limited to the northwestern part of the basin. This study constitutes a first attempt to determine the abundance, characteristics and composition of microplastics in near surface waters of the Gulf of Gabes (southern Mediterranean Sea, Tunisia). Samples were collected using a 200 µm-mesh size trawl net along two transects. The study revealed an average concentration of 63,739 items/km2 where fragments and films were the most frequent microplastics. Polyethylene, reformulated polyethylene and polypropylene were the most abundant plastics identified among the samples (86–100%). The influence of hydrodynamics on microplastics in the Gulf of Gabes was investigated through the use of a Lagrangian tracking model to simulate the dispersion of particles in water. Modelling results seem to be in agreement with the reported distribution and characteristics of microplastics in this area.

Modeling plastic waste flows in the Mediterranean Sea environment: from rivers to the sea (Lisa Weiss, Wolfgang Ludwig , Claude Estournel and Mahrez Sadaoui)

The plastic issue in the Mediterranean environment represents a major concern but the quantification of sources and the particles distribution at Sea are still poorly known. Our modeling approach consists, first, in developing a statistical model to quantify the rivers emissions of plastic particles to the Sea. It is based on the delineation of the Mediterranean watersheds, plastic measurements in world rivers and geospatial data as population densities, waste management, river runoff. Then, this model of plastic inputs is used to initiate numerical simulations of ocean circulation to analyze the plastics dispersion through the currents coupling with waves.

Are Mediterranean Marine Protected Areas sheltered from plastic pollution? (S. Liubartseva, G. Coppini, R. Lecci)

Comparisons of six selected Mediterranean MPAs were conducted to find similarities and site-specific differences in coastline fluxes and sources of plastic marine litter. Output from the recently developed 2D Lagrangian model for the Mediterranean was post-processed to study (1) the National Park of ses Salines d'Eivissa i Formentera, (2) Nature Reserve of Bouches de Bonifacio, (3) North-East Malta MPA, (4) Specially Protected Area of Porto Cesareo, (5) Community Importance Site of Torre Guaceto, and (6) Ethniko Thalassio Parko Alonnisou Voreion Sporadon. Model coastline fluxes of plastic ranged from 0.4 to3.6 kg (km day)−1, which is relatively low compared to the average flux of 6.2 ± 0.8 kg (km day)−1 calculated over the Mediterranean 2013–2017. Shipping was identified as a major source of plastic litter in all MPAs studied, contributing 55%–88% of total plastic. Sitespecific rankings of the top 5 land-based plastic sources revealed that sea surface kinematics control plastic drift.

Modeling of floating marine litter originated from the Eastern Ionian Sea: Transport, residence time and connectivity (D.V. Politikos, K. Tsiaras, G. Papatheodorou, A. Anastasopoulou)

A Lagrangian particle tracking model coupled to a circulation was used to explore the transport, residence time and connectivity of floating litter that originated from the Eastern Ionian Sea during 2011–2014. At the end of simulations, on average 26% of litter was retained within the coastal waters of the Eastern Ionian Sea, whereas 58% was washed into offshore waters without formulating permanent accumulation areas, as the basin-wide surface circulation was characterized by considerable interannual variability. The inflow of litter into the Adriatic and Eastern Mediterranean Seas was moderate, ranging between 9% and 20%, and the beached litter was on average 9.2%, mostly located in the northern subregions. The average residence time of litter particles ranged between 20 and 80 days, implying their temporary retention before drifting offshore. Connectivity patterns depicted an exchange of litter mainly between adjacent subareas and with a northward direction.

3D hotspots of marine litter in the Mediterranean: A modeling study (Javier Soto-Navarro, Gabriel Jorda , Salud Deudero, Carme Alomar , Ángel Amores, Montserrat Compa)

The 3D dispersion of marine litter (ML) over the Mediterranean basin has been simulated using the velocity fields from a high resolution circulation model as base to run a 3D Lagrangian model. Three simulations have been performed to mimic the evolution of ML with density lower, similar, or higher than seawater. In all cases a realistic distribution of ML sources was used. Our results show that the accumulation/dispersion areas of the floating and buoyancy neutral particles are practically the same, although the latter are distributed in the water column, 80% of them found in the photic layer (average depth of 35m). Regarding to the densest particles, they rapidly sink and reach the seafloor close to their source. The regions of higher temporal variability mostly coincide with the ML accumulation regions. Weak seasonal variability occurs at a sub-basin scale as a result of the particles redistribution induced by the seasonal variability of the current field.

Modelling the Marine Microplastic Distribution from Municipal Wastewater in Saronikos Gulf (E. Mediterranean) (Kalaroni S, Hatzonikolakis Y, Tsiaras K, Gkanasos A and Triantafyllou G)

A three-dimensional hydrodynamic model is coupled with a Lagrangian-Individual Based Model to simulate the floating microplastics (A three-dimensional hydrodynamic model is coupled with a Lagrangian-Individual Based Model to simulate the floating microplastics (<300μm) dispersal and transport in the Saronikos Gulf. Considering municipal wastewaters as their main source, simulations were carried out over 2011–2012. A comparison with hydrodynamic observational data has shown that the model qualitatively reproduces the main circulation structure and hydrodynamic features. To explore the fate and distribution of microplastics, model results were analyzed taking into account the seasonal variability of near-surface circulation. Simulation results gave a qualitative description of affected areas from microplastics pollution, suggesting that the most affected part of Saronikos Gulf is the coastal area that extends from Psitallia Waste water treatment plant to the east. Despite some limitations, this is a first model attempt to explore the dispersal and distribution of microplastics in the Saronikos Gulf.

3.2 Main Conclusion on Marine Litter Models distribution in the Mediterranean area and Hot Spot Identification

The results show from several paper, and particularly the Javier Soto-Navarro et al 2020, thet the highest concentrations of neutral particles are found in the **Catalan continental shelf, the proximities of the Strait of Sicily and the Gulf of Gabes, the Adriatic Sea and the easternmost slope of the Levantine basin.** For the floating particles large concentrations are also found in the Balearic Sea. On the other hand, the particles with negative buoyancy rapidly sink and reach the seafloor close to their sources, with no time to disperse. The comparison among different studies suggests that the main limitation of the modelling studies is linked to the lack of accurate in-formation about the amount of ML released into the sea from different sources. Additionally, there are several issues that could be explored in the future. One of them would be to include the effects of population fluctuation in the coastal areas due to, for instance, the touristic seasonality, as well as the seasonal variability of the river discharge. The regions of higher temporal variability mostly coincide with the ML accumulation regions (Fig 4).

Considerations to be further developed when the bibliographic research will be concluded.

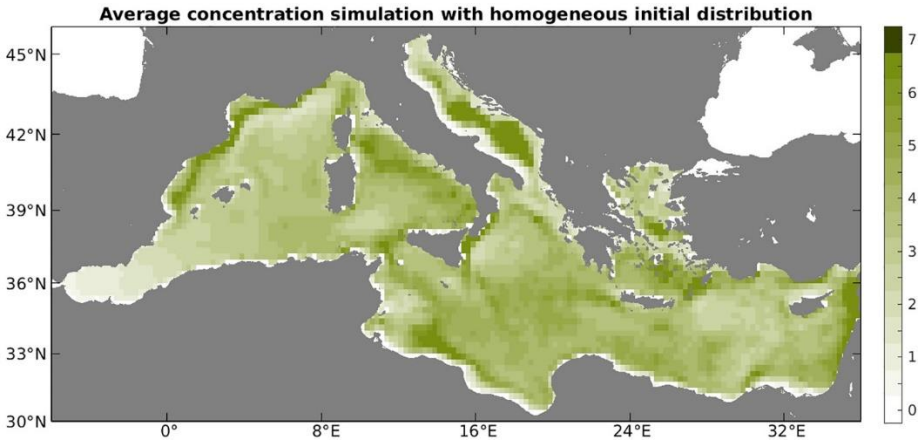

Figure 4. Average concentration for the simulation starting from a homogeneous particle distribution over the whole basin. Units are kg/km^2(From: 3D hotspots of marine litter in the Mediterranean: A modeling study (Soto-Navarro,et al. 2020).

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4. Main results of the bibliographic research on the impact of Marine Litter in Cetaceans in ACCOBAMS area

This paragraph will cover in detail the bibliographic research on impact of Marine Litter interaction with Cetaceans in the ACCOBAMS area with a particular focus on the most studied area: the Mediterranean Sea. ***10 papers*** *(up to September 2021, to be further implemented till June 2022) report studies on plastic impact and interaction with cetacean species in the Mediterranean area; the main results of the papers are reported below.*

Are baleen whales exposed to the threat of microplastics? A case study of the Mediterranean fin whale (Balaenoptera physalus) (Maria Cristina Fossi, Cristina Panti, Cristiana Guerranti, Daniele Coppola, Matteo Giannetti, Letizia Marsili, Roberta Minutoli)

Baleen whales are potentially exposed to micro-litter ingestion as a result of their filter-feeding activity. However, the impacts of microplastics on baleen whales are largely unknown. In this case study of the Mediterranean fin whale (Balaenoptera physalus), we explore the toxicological effects of microplastics on mysticetes. The study included the following three steps: (1) the collection/count of microplastics in the Pelagos Sanctuary (Mediterranean Sea), (2) the detection of phthalates in surface neustonic/planktonic samples, and (3) the detection of phthalates in stranded fin whales. A total of 56% of the surface neustonic/planktonic samples contained microplastic particles. The highest abundance of microplastics (9.63 items/m3) was found in the Portofino MPA (Ligurian Sea). High concentrations of phthalates (DEHP and MEHP) were detected in the neustonic/planktonic samples. The concentrations of MEHP found in the blubber of stranded fin whales suggested that phthalates could serve as a tracer of the intake of microplastics. The results of this study represent the first warning of this emerging threat to baleen whales.

Fin whales and microplastics: The Mediterranean Sea and the Sea of Cortez scenarios (Maria Cristina Fossi, Letizia Marsili, Matteo Baini, Matteo Giannetti, Daniele Coppola, Cristiana Guerranti, Ilaria Caliani, Roberta Minutoli, Giancarlo Lauriano, Maria Grazia Finoia, Fabrizio Rubegni, Simone Panigada, Martine Berube, Jorge Urban Ramírez, Cristina Panti)

The impact that microplastics have on baleen whales is a question that remains largely unexplored. This study examined the interaction between free-ranging fin whales (Balaenoptera physalus) and microplastics by comparing populations living in two semi-enclosed basins, the Mediterranean Sea and the Sea of Cortez (Gulf of California, Mexico). The results indicate that a considerable abundance of microplastics and plastic additives exists in the neustonic samples from Pelagos Sanctuary of the Mediterranean Sea, and that pelagic areas containing high densities of microplastics overlap with whale feeding grounds, suggesting that whales are exposed to microplastics during foraging; this was confirmed by the observation of a temporal increase in toxicological stress in whales. Given the abundance of microplastics in the Mediterranean environment, along with the high concentrations of Persistent Bioaccumulative and Toxic (PBT) chemicals, plastic additives and biomarker responses detected in the biopsies of Mediterranean whales as compared to those in whales inhabiting the Sea of Cortez, we believe that exposure to microplastics because of direct ingestion and consumption of contaminated prey poses a major threat to the health of fin whales in the Mediterranean Sea

Cetacean mortality due to interactions with fisheries and marine litter ingestion in the Croatian part of the Adriatic Sea from 1990 to 2019. (Martina Đuras, Ana Galov, Kim Korpes, Magdalena Kolenc, Matea Baburić, Andrea Gudan Kurilj, and Tomislav Gomerčić)

Various anthropogenic threats negatively influence the survival of cetaceans in all world seas. Thanks to a long-running marine mammal surveillance program, we are able to report the results of a detailed analysis of the influence of cetacean-fisheries interactions and marine litter ingestion on cetacean mortality in the Croatian part of the Adriatic Sea over the last three decades. The total number of dead cetaceans was 459, and included 334 bottlenose dolphins (*Tursiops truncatus*), 40 striped dolphins (*Stenella coeruleoalba*), ten Risso's dolphins (*Grampus griseus*), six Cuvier's beaked whales (*Ziphius cavirostris*) and four fin whales (*Balaenoptera physalus*). Three hundred of them were examined postmortally. Cetacean-fisheries interaction occurred frequently in the Adriatic Sea, being detected in 96 (20.9%) of the recorded cases. Bycatch was the most abundant cetacean-fisheries interaction, with 66 (14.4%) cases recorded. Good nutritional condition and evidence of recent feeding were the most common findings recorded in bycatch cases,

followed by persistent froth in the airways, edematous lungs, bruises and an amputated fluke or tail. Cetacean-fisheries interactions other than bycatch affected 30 animals and included larynx strangulations, longterm tail entanglement and fishing gear in the stomach. Ingestion of marine litter that was not related to fisheries was recorded in four animals. This study reveals the considerable negative anthropogenic influence on cetaceans in the Adriatic Sea, especially the bottlenose dolphin that is considered to be the most numerous cetacean species therein, and demonstrates the need for the urgent development of a cetacean bycatch reduction program. Finally, it also shows the importance of sustaining national surveillance programs to gain scientifically based knowledge important for cetacean protection and prospects for their long-term survival.

Analysis of the Gastro-Intestinal Tract of Marine Mammals: A Multidisciplinary Approach with a New Multi-Sieves Tool (Giorgia Corazzola, Matteo Baini, Carla Grattarola, Cristina Panti, Federica Marcer, Fulvio Garibaldi, Enrica Berio, Cecilia Mancusi, Matteo Galli, Sandro Mazzariol , Maria Cristina Fossi, Cinzia Centelleghe, and Cristina Casalone)

Organs and content of the gastro-intestinal tract (GIT) of marine mammals are relevant for a variety of investigations and provide data to researchers from different fields. Currently used protocols applied to the GIT for specific analysis limit the possibility to execute other investigations and important information could be lost. To ensure a proper sample collection and a multidisciplinary investigation of the GIT of marine mammals, a new multi-sieves tool and a specific protocol have been developed. This new device and approach allowed the simultaneous sampling of the GIT and its content for the main investigations concerned. The samples collected during these preliminary trials were suitable to perform all the different research procedures considered in this work. The obtained results show that with a few and easy procedural adjustments, a multidisciplinary sampling and evaluation of the GIT of marine mammals is possible. This will reduce the risk of losing important data aimed at understanding the cause of death of the animal, but also biology and ecology of marine mammals, and other important data for their conservation and habitats management

As main meal for sperm whales: Plastics debris (Renaud de Stephanis, Joan Gimenez, Eva Carpinelli, Carlos Gutierrez-Exposito, Ana Canadas)

Marine debris has been found in marine animals since the early 20th century, but little is known about the impacts of the ingestion of debris in large marine mammals. In this study we describe a case of mortality of a sperm whale related to the ingestion of large amounts of marine debris in the Mediterranean Sea (4th published case worldwide to our knowledge), and discuss it within the context of the spatial distribution of the species and the presence of anthropogenic activities in the area that could be the source of the plastic debris found inside the sperm whale. The spatial distribution modelled for the species in the region shows that these animals can be seen in two distinct areas: near the waters of Almeria, Granada and Murcia and in waters near the Strait of Gibraltar. The results shows how these animals feed in waters near an area completely flooded by the greenhouse industry, making them vulnerable to its waste products if adequate treatment of this industry's debris is not in place. Most types of these plastic materials have been found in the individual examined and cause of death was presumed to be gastric rupture following impaction with debris, which added to a previous problem of starvation. The problem of plastics arising from greenhouse agriculture should have a relevant section in the conservation plans and should be a recommendation from ACCOBAMS due to these plastics' and sperm whales' high mobility in the Mediterranean Sea.

Ingestion of macroplastics by odontocetes of the Greek Seas, Eastern Mediterranean: Often deadly! (Paraskevi Alexiadou, Ilias Foskolos, Alexandros Frantzis)

Plastic pollution is an omnipresent problem that threatens marine animals through ingestion and entanglement. Marine mammals are no exception to this rule but their interaction with plastic remains understudied in the Mediterranean Sea. Here we highlight this problem by analyzing the stomach contents of 34 individuals from seven odontocete species stranded in Greece. Macroplastic (> 5 mm) was found in the stomachs of nine individuals from four species (harbour porpoise Phocoena phocoena, Risso's dolphin Grampus griseus, Cuvier's beaked whale Ziphius cavirostris and sperm whale Physeter macrocephalus) with the highest frequency of occurrence in sperm whales (60%). Gastric blockage from plastic was presumably lethal in three cases, with plastic bags being the most common finding (46%). Plastic ingestion is of particular conservation concern for the endangered Mediterranean sperm whales. A regular examination of stranded cetaceans with a standardised protocol is critical for allowing spatiotemporal comparisons within and across species.

Sometimes Sperm Whales (Physeter macrocephalus) Cannot Find Their Way Back to the High Seas: A Multidisciplinary Study on a Mass Stranding (Sandro Mazzariol, Giovanni Di Guardo, Antonio Petrella, Letizia Marsili, Cristina M. Fossi, Claudio Leonzio, Nicola Zizzo, Salvatrice Vizzini, Stefania Gaspari, Gianni Pavan, Michela Podesta, Fulvio Garibaldi, Margherita Ferrante, Chiara Copat, Donato Traversa, Federica Marcer, Sabina Airoldi, Alexandros Frantzis, Yara De Bernaldo Quiro´, Bruno Cozzi, Antonio Fernandez)

Background: Mass strandings of sperm whales (Physeter macrocephalus) remain peculiar and rather unexplained events, which rarely occur in the Mediterranean Sea. Solar cycles and related changes in the geomagnetic field, variations in water temperature and weather conditions, coast geographical features and human activities have been proposed as possible causes. In December 2009, a pod of seven male sperm whales stranded along the Adriatic coast of Southern Italy. This is the sixth instance from 1555 in this basin. Methodology/Principal Findings: Complete necropsies were performed on three whales whose bodies were in good condition, carrying out on sampled tissues histopathology, virology, bacteriology, parasitology, and screening of veins looking for gas emboli. Furthermore, samples for age determination, genetic studies, gastric content evaluation, stable isotopes and toxicology were taken from all the seven specimens. The animals were part of the same group and determined by genetic and photo-identification to be part of the Mediterranean population. Causes of death did not include biological agents, or the ''gas and fat embolic syndrome'', associated with direct sonar exposure. Environmental pollutant tissue concentrations were relatively high, in particular organochlorinated xenobiotics. Gastric content and morphologic tissue examinations showed a prolonged starvation, which likely caused, at its turn, the mobilization of lipophilic contaminants from the adipose tissue. Chemical compounds subsequently entered the blood circulation and may have impaired immune and nervous functions.
Conclusions/Significance: A multi-factorial cause underlying this sperm whales' mass stranding is proposed herein based upon the results of postmortem investigations as well as of the detailed analyses of the geographical and historical background. The seven sperm whales took the same ''wrong way'' into the Adriatic Sea, a potentially dangerous trap for Mediterranean sperm whales. Seismic surveys should be also regarded as potential co-factors, even if no evidence of direct impact has been detected.

Laryngeal Snaring by Ingested Fishing Net in a Common Bottlenose Dolphin (Tursiops truncatus) Off the Israeli Shoreline (Alon M. Levy, Ori Brenner, Aviad Scheinin, Dan Morick, Eliana Ratner, Oz Goffman and Dan Kerem)

We report an unusual snaring of the larynx in an adult, female common bottlenose dolphin (Tursiops truncatus). The dolphin was observed swimming and diving in Haifa Port, Israel, but was found dead the next day, 60 km south, on the coast. Postmortem examination revealed stranded-cordage, nylon filaments wrapped around the larynx, cutting through the soft tissue, and extending down into the forestomach, where a large mass of netting was found. The cachectic state of the dolphin and the subacute to chronic, hyperplastic response of soft tissue surrounding the filaments lodged around the larynx, suggest a prolonged period of starvation, which led to the final weakness and wasting of the dolphin.

Stomach content of Harbour porpoise (Phocoena phocoena) from the Turkish western black sea in spring and early summer (Arda M. Tonay, Ayhan Dede , Ayaka A. Ozturk and Bayram Ozturk)

The study was based on stomach content from 42 harbour porpoises bycaught or stranded between April to June in 2002 and 2003, on the Turkish western Black Sea coast. Seven fish species were identified. Sprat and whiting were the most important fish species in the diet by frequency of occurrence (64.1% and 23.6%, respectively). Besides fishes, crustaceans, pieces of algae, molluscs, bivalves, sand and plastic debris were also recorded

Evaluating the presence of microplastics in striped dolphins (Stenella coeruleoalba) stranded in the Western Mediterranean Sea (O. Novillo, J.A. Raga, J. Tomás)

Litter is a well-known problem for marine species; however, we still know little about the extent to which they're affected by microplastics. In this study, we analyse the presence of this type of debris in Western Mediterranean striped dolphins' intestinal contents over three decades. Results indicated that frequency was high, as 90.5% of dolphins contained microplastics. Of these microplastics, 73.6% were fibres, 23.87% were fragments and 2.53% were primary pellets. In spite of the high frequency of occurrence, microplastic amount per dolphin was relatively low and highly variable (mean ± SD = 14.9 ± 22.3; 95% CI: 9.58–23.4). Through FT-IR spectrometry, we found that polyacrylamide, typically found in synthetic clothes, was the most common plastic polymer. Here, we establish a starting point for further research on how microplastics affect this species' health and discuss the use of striped dolphins as indicators of microplastics at sea.

5. Main Conclusion of the bibliographic research on Marine Litter models distribution and impact on Cetaceans in the ACCOBAMS area

In this paragraph we report the main results and the conclusion obtained from the bibliographic research and from the re-elaboration of the main outcomes produced by research projects conducted on a Mediterranean scale on the same topic will be elaborated in this session.

To be done once the literature review has been completed.

This paragraph will be implemented by adding info graphics, tables and figures.

6.Risk Analysis

In this section will present the methodologies used and the main results obtained from the application of risk analyses carried out in the study area by two important projects and divided into the following sub-sections: **ASI and PB-MPAs Sinergy, Plastic Busters MPAs Methodology and results**

6. 1. Risk analysis approach: ASI and PB-MPAs Synergy

An important section of this report concerns the synergy between the ASI initiative and the Med-Interreg project Plastic Busters MPAs. A risk assessment methodology will be used to define the Cetaceans risk assessment, related to hot spot areas of ML (in the Pelagos Sanctuary as a key study area) using ASI data (provided by ACCOBAMS SC to the PB-MPAs Consortium for the area concerned to the project) in a collaborative effort between UNISI, IFREMER and LaMMA Consortium.

Debris impact on marine wildlife has become a major issue of concern. Many species have been identified as being threatened by collision, entanglement or ingestion of debris, generally plastics, which constitute the predominant part of the recorded marine debris. Assessing sensitive areas, where exposure to debris are high, is thus crucial, in particular for cetacean and sea turtles which have been proposed as sentinels of debris levels for the Marine Strategy Framework Directive and for the UNEP-IMAP programmes.

In this section we propose the application of the methodology previously used by Darmon et al 2016 for sea turtle Risk assessment.

(https://www.sciencedirect.com/science/article/abs/pii/S0967064516301886?via%3Dihub)

In this previous paper the objective was to assess sea turtle exposure to marine debris in the 3 metropolitan French fronts. Using aerial surveys performed in the Channel, the Atlantic and the Mediterranean regions in winter and summer 2011–2012, Darmon and collaborator evaluated exposure areas and magnitude in terms of spatial overlap, encounter probability and density of surrounding debris at various spatial scales. Major overlapping areas appeared in the Atlantic and Mediterranean fronts, concerning mostly the leatherback and the loggerhead turtles respectively. The probability for individuals to be in contact with debris (around 90% of individuals within a radius of 2 km) and the density of debris surrounding individuals (up to 16 items with a radius of 2 km, 88 items within a radius of 10 km) were very high, whatever the considered spatial scale, especially in the Mediterranean region and during the summer season. The comparison of the observed mean debris density with random distribution suggested that turtles selected debris areas. This may occur if both debris and turtles drift to the same areas due to currents, if turtles meet debris accidentally by selecting

high food concentration areas, and/or if turtles actively seek debris out, confounding them with their preys. The authors concluded that empirical data on sea turtles and debris distributions, such as those collected aerially, are essential to better identify the location and the factors determining risks.

In this section we briefly describe the methodology used to define the Cetaceans risk assessment (in the Pelagos Sanctuary as a key study area) using ASI data in the PB-MPAs Consortium as previously explained.

Several steps are identified for the data processing according to the strategy previously proposed by Darmon et al 2016:

1: to define square unit (5-10 -nautical miles) for the whole Pelagos Sancturay;

2: to calculate the amount of each variable (litter/Cetacean/ turtles/sharks, etc.) in each square;

3: to define the sampling effort in each square (hours of flight/ square, probability of sampling effort): maximum is maximum effort or number of hours of flight (1), zero is no effort;

4: to relate the amounts of each variable/ sampling effort in each square (probability of presence) maximum (1) is maximum amount of each variable (litter/ species), zero is absence

5: map the distribution (pondered by sampling effort) (each square as 0 to 1 value)

6: cross map data on litter + each variable (Cetacean/ turtles/sharks, etc.). This may be through multiplying the probability from points 3 and 4

7: analyse the distribution of cross probability (6) through various algorithms such as kernel, kriging, minimum distance. etc.

Since data on litter will come from the counts of large debris only (>20cm), a refined analysis could come from the modelling of distribution litter / microplastics in the area for the time of surveys and then cross map probabilities.

These analyzes are currently in progress and the results will be announced in the final version of this report.

6. 2. The Plastic Busters MPAs Methodology and preliminary results

Plastic Busters MPAs is a 4-year-long InterregMed-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.

Plastic Busters MPAs consolidates Mediterranean efforts against marine litter by:

- Assessing the impacts of marine litter on biodiversity in MPAs and identifying marine litter 'hotspot' areas;
- Defining and testing tailor-made marine litter surveillance, prevention and mitigation measures in MPAs;
- Developing a common framework of marine litter actions for Interreg Mediterranean regions towards the conservation of biodiversity in Med MPAs.

The Plastic Busters MPAs project deploys the multidisciplinary strategy and common framework of actions developed within the Plastic Busters initiative led by the University of Siena and the Sustainable Development Solutions Network Mediterranean (SDSN Med). This initiative frames the priority actions needed to tackle marine litter in the Mediterranean basin and was labelled under the Union for the Mediterranean (UfM) in 2016, gathering the political support of 43 Euro-Mediterranean countries.

In this section we describe the methodological approach end the preliminary results obtained in the Plastic Busters MPAs Interreg project for the Risk assessment of marine litter and marine megafauna for the Pelagos Sanctuary (UNISI and CIMA unpublished data)

Home range analysis for marine megafauna distribution

Kernel density estimation was used to obtain marine megafauna distribution. However, considering that some transects were made in the same area (e.g. around the harbours), it was necessary to weight the effort: to do so, the Encounter Rate was chosen as the best method.

The species considered were divided in different categories:

- *Cetaceans*: striped dolphin (sc), fin whale (bp), bottlenose dolphin (tt), deep divers (deepd) which include sperm whales, risso's dolphin and cuvier's beaked whale.
- *Associated species* (birds, fish, …): jellyfish (jellyf), sun fish (mm) and giant devil ray (mb).
- *Seabirds:* different species regrouped in one group, such as Scopoli's shearwater, yelkouan shearwater, common tern, European shag (seab). Three species were then investigated due to their importance in the PNAT area: Scopoli's shearwater (cd), Yelkouan shearwater (py), Audouin's gull (ia). This last species, ia, was sighted only in PNAT.

The 1 km European Environmental Agency's (EEA) INSPIRE compliant reference grid was used as the grid for the analysis. For each cell, the total number of individuals of the same species sighted during the whole campaign was obtained (Table 1), together with the kilometres surveyed in the whole campaign were calculated.

The Encounter Rate was calculated for each cell *i,* dividing the total number of individuals of the species *j* in the cell *i* (N_{ij}), by the kilometres surveyed in the cell *i* (L_i), and normalized by the highest value after the outliers:

$$ER_{ij} = \frac{\frac{N_{ij}}{L_i}}{ER_{\max(j)}}$$

***Table 1** : Summary of the species dataset*

Species	**No individuals**	**No sightings**	**Cells with ER_{ij} > 0**
Fin whale (bp)	30	18	14
Deep divers (deepd)	27	15	14
Striped dolphin (sc)	829	56	50
Bottlenose dolphin (tt)	77	15	15
Jellyfish (jellyf)	1360	51	43
Seabirds (seab)	657	332	257
Giant devil ray (mb)	22	22	17
Sunfish (mm)	47	42	33
Scopoli's shearwater (cd)	471	258	204

Yelkouan shearwater (py)	169	65	57
Audouin's gull (ia)	48	34	27

Kernel density estimation (KDE) was applied using centroids of cells as a reference, with a radius of 20 km and weighted considering the ER. The radius was considered suitable considering the distribution of animals and the dispersion of the plastic litter.

The KDE was done separately, for each species (sc, bp, tt, mm, mb, cd, py, ia) or group of species (deepd, seab, jellyf). The 50% contour was then used to identify core area (HR50) of species/group_species distribution and the 90% contour to identify general distribution (HR90).

In order to assess marine litter hazard for the two considered HRs, floating litter and microplastic density was associated to the HR50 and HR90 of each species/group of species.

Regarding the cetacean distribution, it is evident the importance of the continental slope and submarine canyons for the majority of species, except bottlenose dolphins which prefer the continental shelf. For this reason, the distribution of the first three groups is concentrated in the northern western part of Pelagos, while the tt are indeed more present near the coast of Tuscany.

For the associated species the distribution seems to concentrate near the coast, especially for the seabirds which are more present along the Tuscany islands. It is interesting the overlap of the jellyfish and sunfish distributions.

These analyzes are currently in progress and the results will be announced in the final version of this report.

7. Main Conclusion

In this session we will briefly summarize the main conclusions obtained from the elaboration of the previous data in order to obtain a synthetic picture on identification of hotspots areas and potential interactions between cetaceans and marine litter in the ACCOBAMS area. (In progress)

8. Main Recommendation for Future Work

In this last session, potential future research, mitigation actions and governance interactions, to be implemented in the future in the ACCOBAMS area will be suggested. (In progress)

Siena, October 2021

ANNEX 1

Inventory of marine litter related projects and their respective outputs

An overview of the relevant projects and initiatives that dealing with ML contamination in the Mediterranean area are listed in Annex 1. The list includes a core set of 15 projects, implemented at Mediterranean and European level, that focused on different aspects of the marine litter issue such as: monitoring & assessment, prevention & mitigation or the entire management cycle of marine litter pollution. The knowledge outputs of the projects that have been taken into consideration within the Plastic Busters MPAs activities are depicted in Boxes. (to be further updated)

Table Annex 1. An overview of the relevant projects and initiatives that dealing with ML contamination in the Mediterranean area

ACRONYM	FULL TITLE	FUNDING SOURCE	THEMATIC FOCUS	WEBSITE
PLASTIC Busters MPAs		Interreg Med	monitoring & assessment - entire management cycle	
ACT4LITTER	Joint measures to preserve natural ecosystem from marine litter in Mediterranean Marine Protected Areas	Interreg Med	entire management cycle	link
AMARE	Safeguarding the Marine Environment Together - Bridging Conservation and Stakeholder Uses in the NE Marine Protected Area	Interreg Med	monitoring & assessment	link
BASEMAN	Microplastics Analysis in European Waters	JPI Oceans	monitoring & assessment	link
COMMON	Coastal Management and Monitoring Network for tackling marine litter in Mediterranean Sea	CBC Med	entire management cycle	link
DEFISHGEAR	Derelict Fishing Gear Management System in the Adriatic Region	IPA Adriatic	entire management cycle	link
INDICIT I & II	Implementation of Indicators of Marine Litter on Sea Turtles and Biota in Regional Sea Conventions and Marine Strategy Framework Directive Areas	EU	monitoring & assessment	link
MARELITT	Reducing the impact of marine litter in the form of derelict fishing gear in the Baltic sea	Interreg Baltic	prevention & mitigation	link
MARINE LITTER MED	Marine Litter MED project	EU	prevention & mitigation	link
MARLISCO	Marine Litter in European Seas - Social Awareness and Co-Responsibility	FP7	prevention & mitigation	link
MEDSEALITTER	Developing Mediterranean-specific protocols to protect biodiversity from litter impact at basin and local MPAs scales	Interreg Med	monitoring & assessment	link
SWIM-H2020 SM	Sustainable Water Integrated Management and Horizon 2020 Support Mechanism	EU	entire management cycle	link
WES	Water and Environment Support in the ENI Southern Neighbourhood Region	EU	entire management cycle	link

ANNEX 2

Excel file of Bibliographic research on impact of Marine Litter in Cetaceans in ACCOBAMS area

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