MARLICE 2019

International Forum on Marine Litter and Circular Economy

Enhancing knowledge on marine litter distribution, patterns, trends and implications for biota in Mediterranean Marine Protected Areas MPAs

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MARLICE Seville, 10-11-12 April, 2019 Spanish Info Day

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Plastics at sea: an emerging threat

Protecting habitats of special interest

Maintaining the functionality and biodiversity in marine

An estimated 8 millions tonnes enter the marine environment annually

Without intervention, this will increase to 100-250 Mt in 2025

Sustainable use and management of marine ecosystems and resources

Marine debris is found in all of the deep

Modelling and predictions

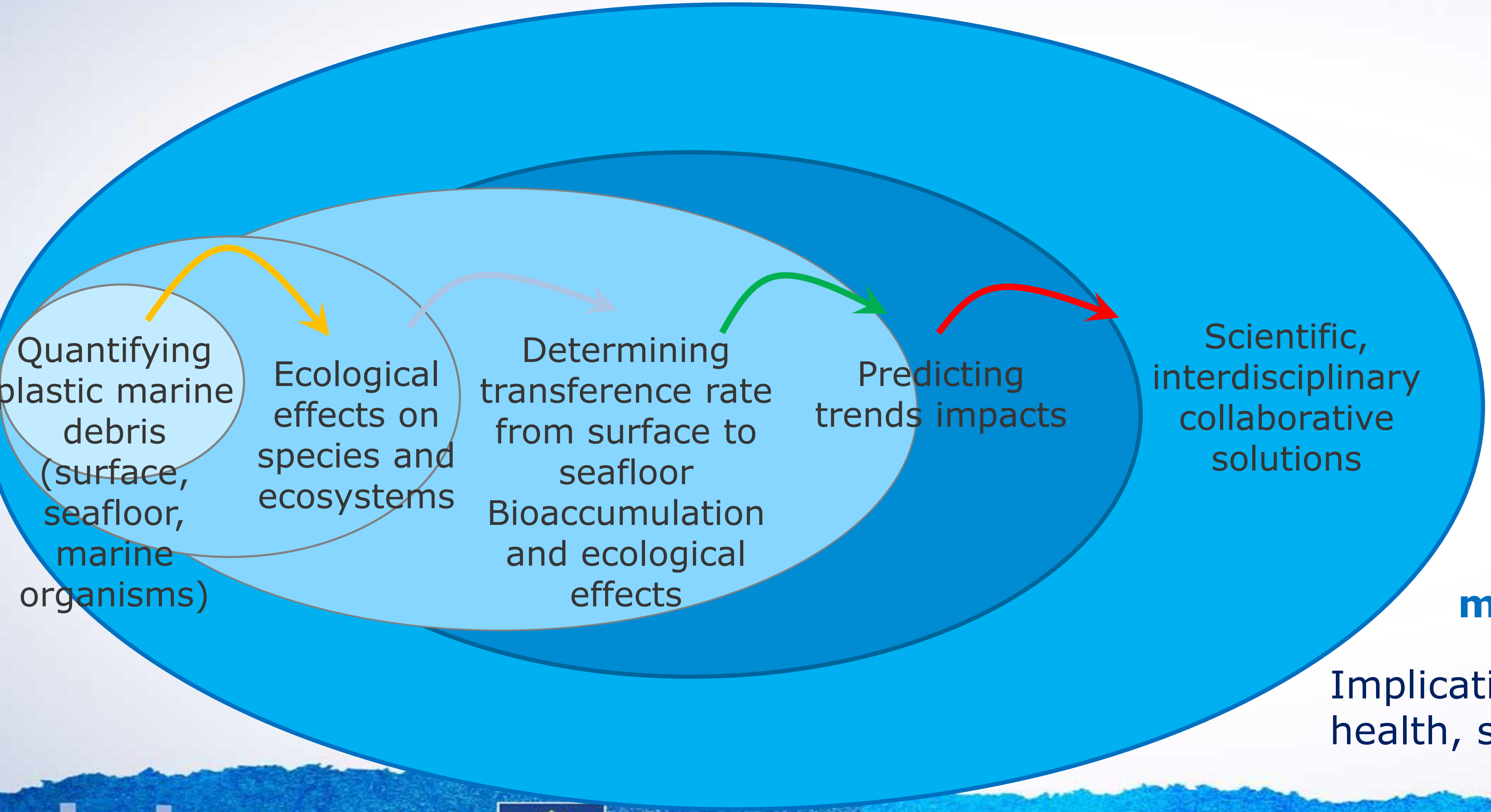
Plastic ingestion in marine

Indicators of Good Environmental

Economic, social and environmental costs are difficult to determine at a global

Need to establish the environmental cost from the loss of the structure and function of marine ecosystem

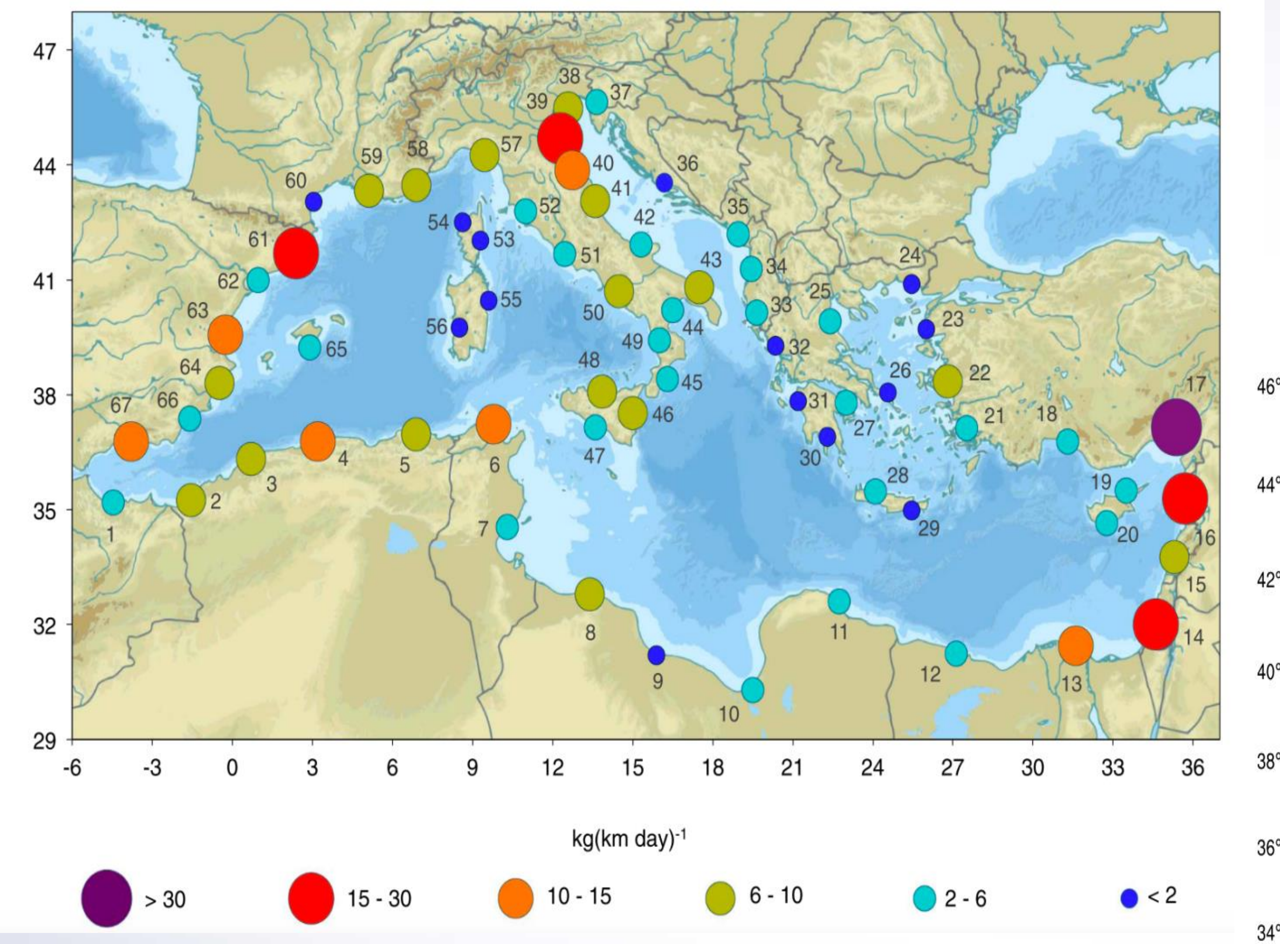
Plastics at sea: an emerging threat
Research and actions



Collaborative and multidisciplinary actions

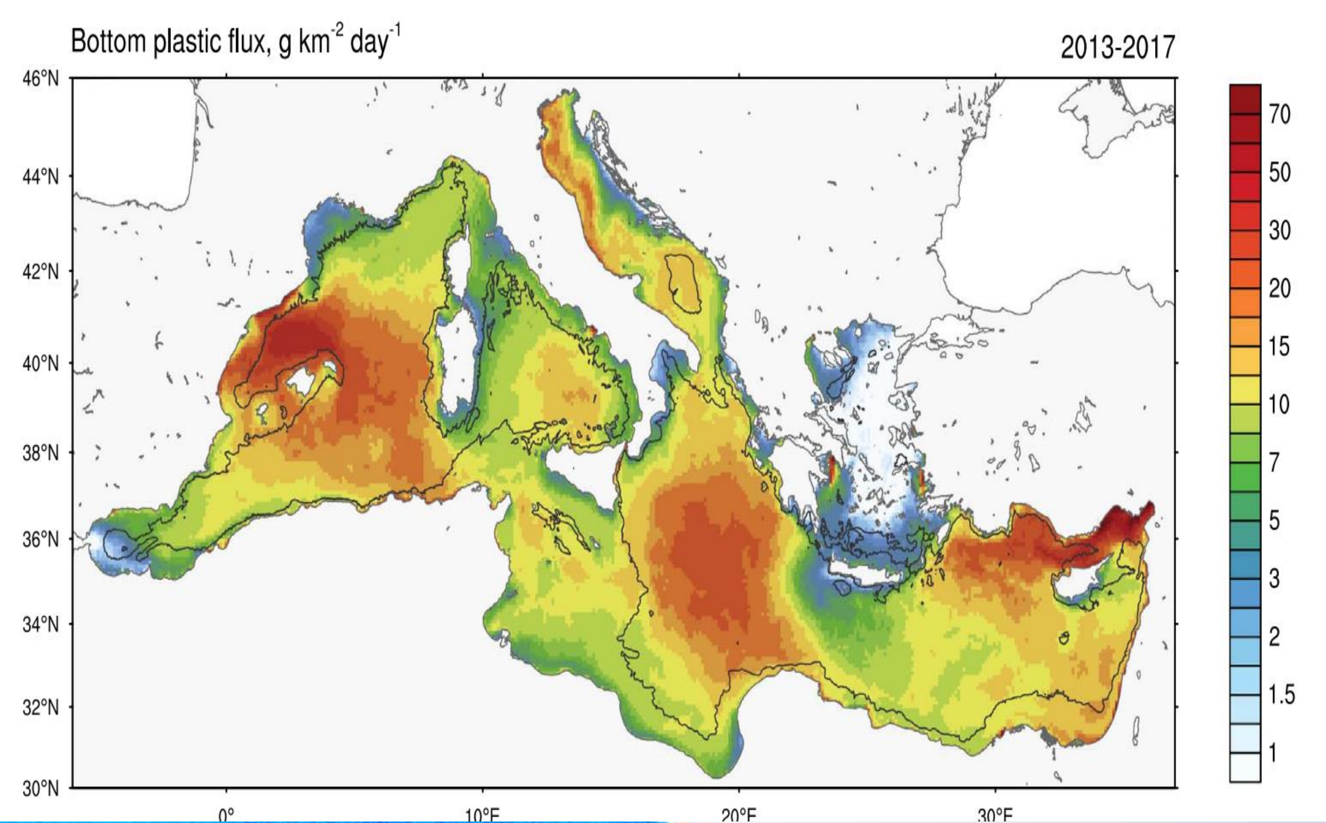
Implications for ecosystems, human health, socio-economic approaches

Mediterranean: marine litter



(Liubartseva et al. 2018)

Marine Protected Areas are not free from marine litter
Dispersion factors Connectivity processes



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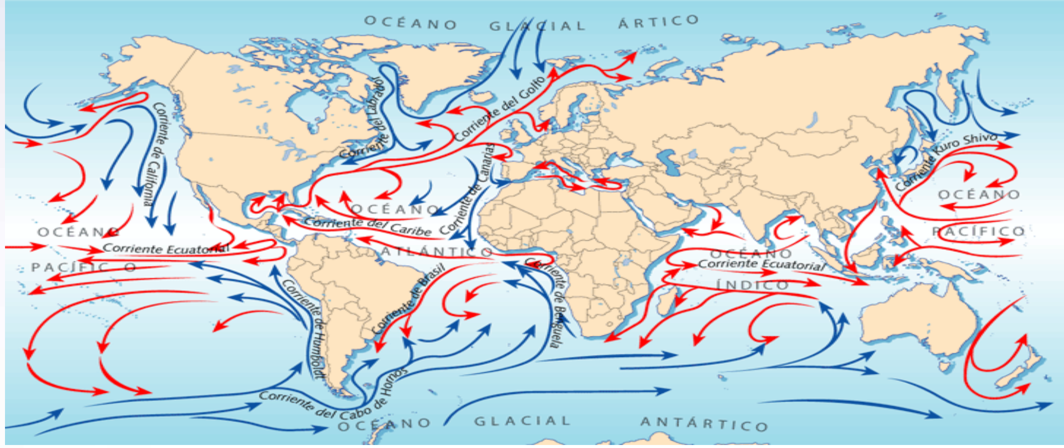
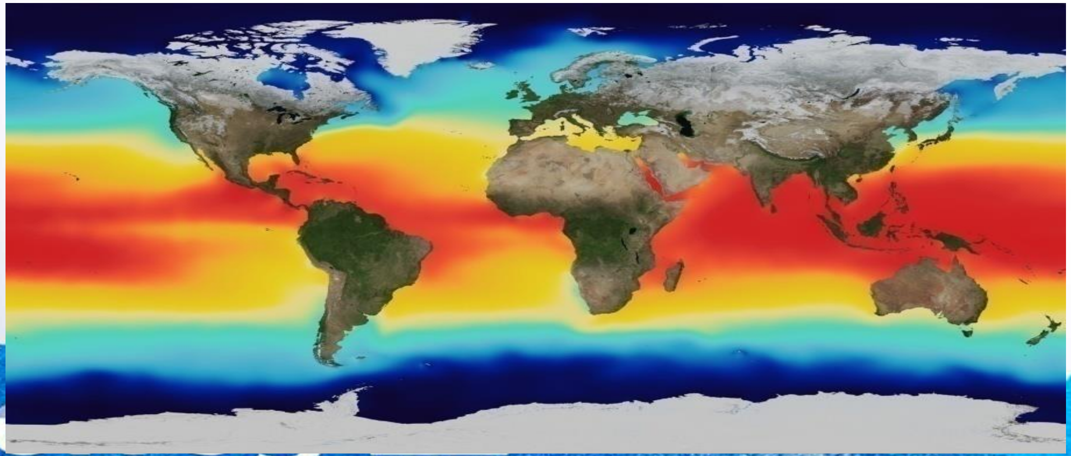
Dispersion factors of Marine Litter

Currents-global scale

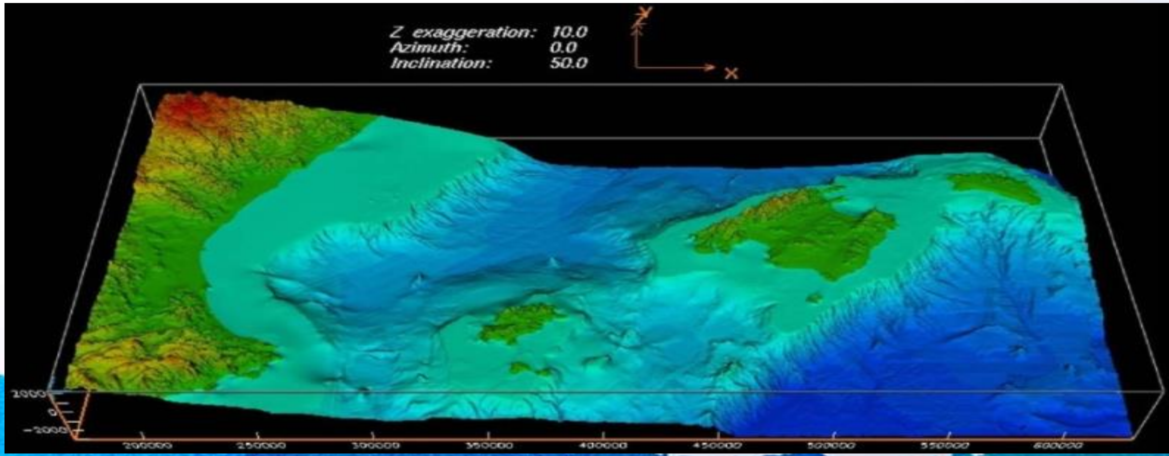


Oceanographic, anthropogenic, biological and ecological factors play a vital role in the distribution and sink sources of marine litter

Sea temperature



Geomorphology



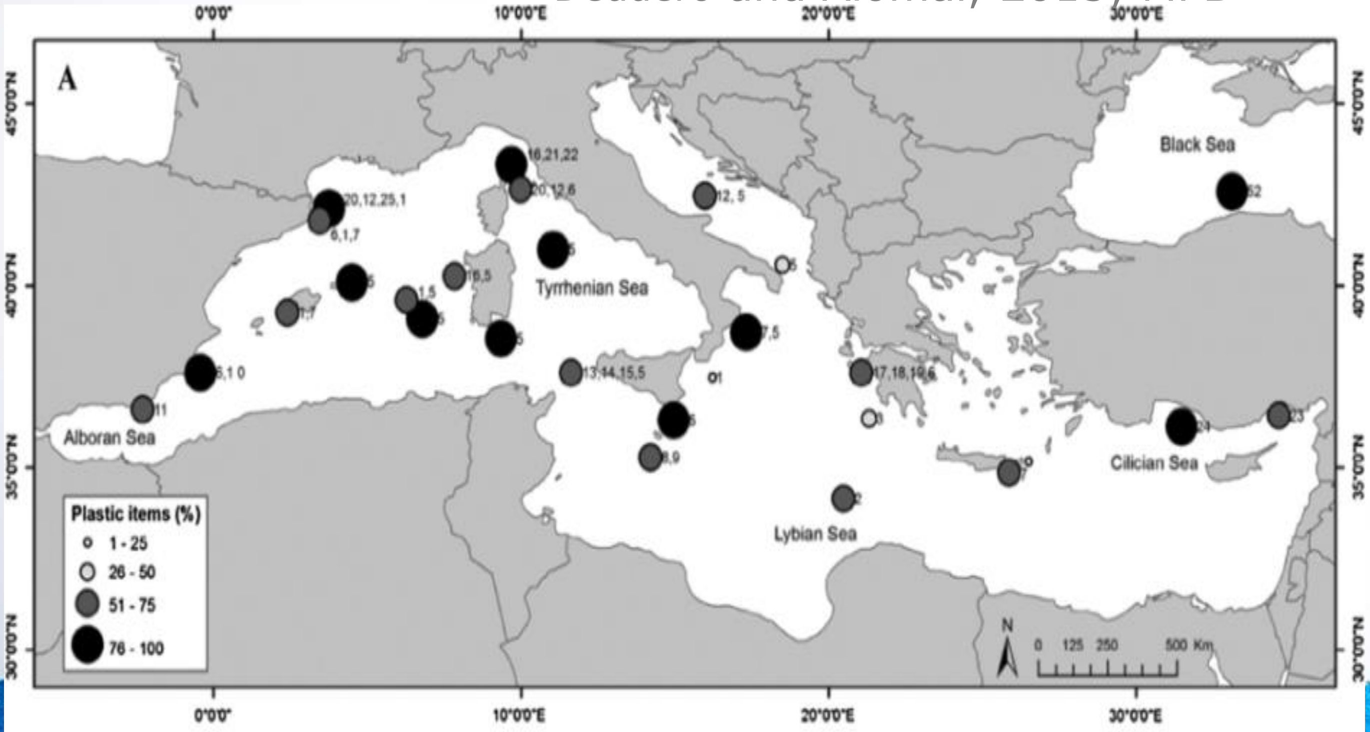
Plastic and Microplastic research (IMPACT @SEA group)

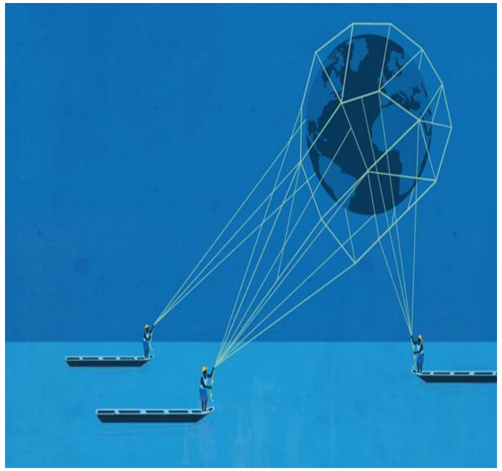
Ingestion of microplastics in organisms and implications for food webs

Spatial and temporal studies of marine litter in sea surface and sea floor habitats

From LOCAL towards GLOBAL perspective to determine sink and sources

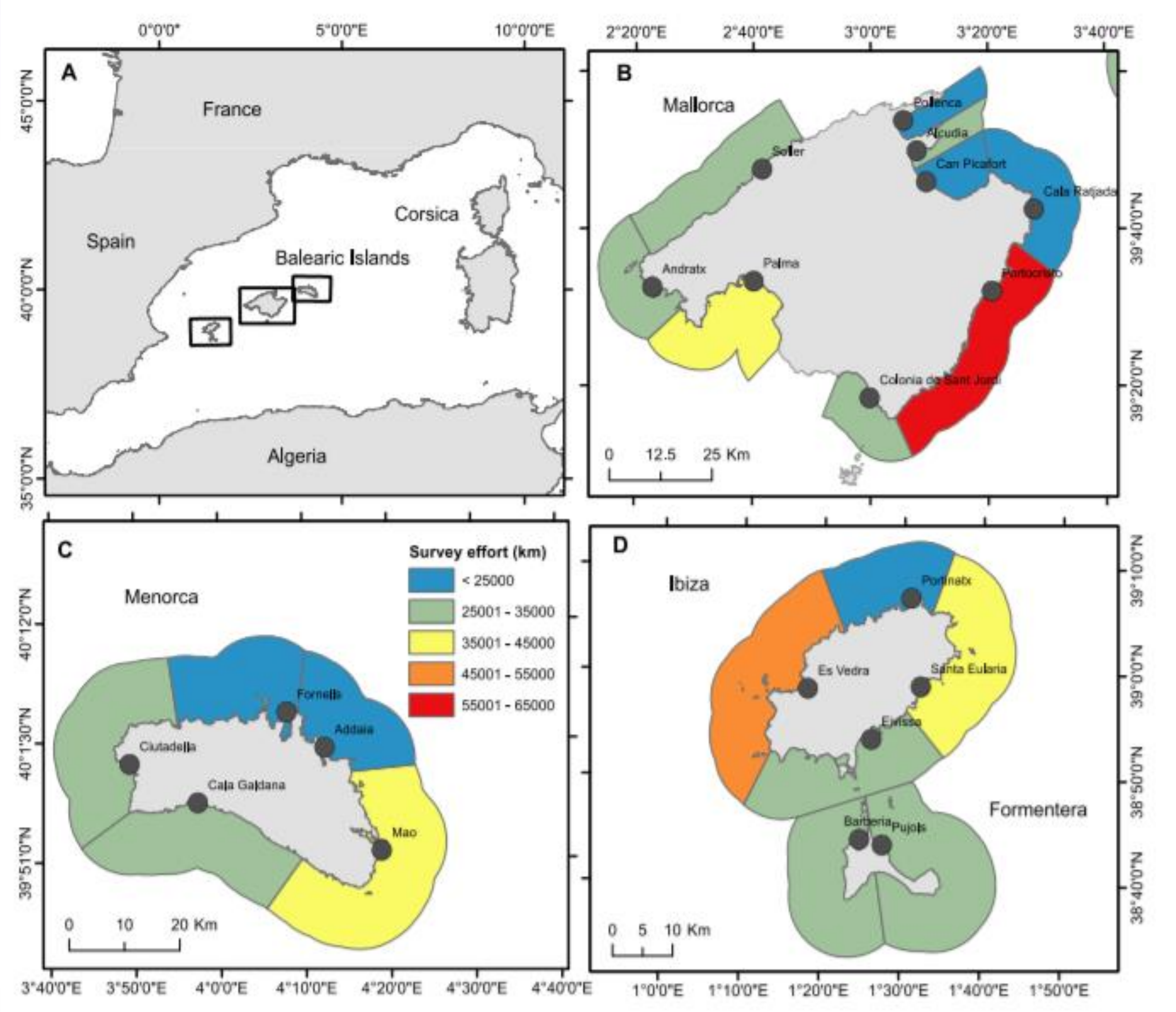
Deudero and Alomar, 2015; MPB





Spatial and temporal distribution floating marine litter

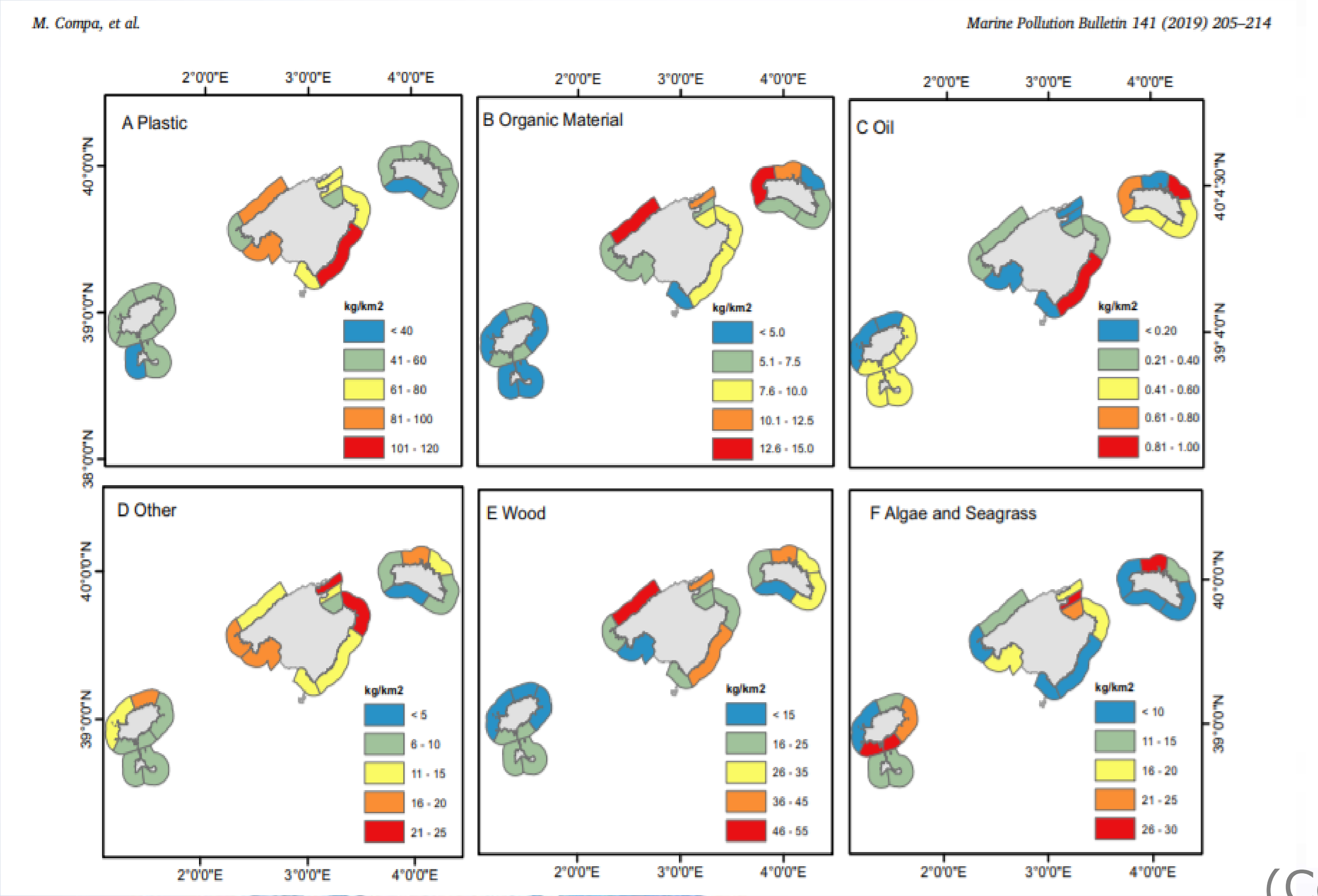
- Sea-cleaning boat monitoring provides long-term information spatio-temporal trends coastal marine debris
- Marine debris collected **2005 -2015** ranged annually **27 -100 tonnes**
- An integrated approach increased marine debris collection coastal areas
- 54% marine debris collected was plastic

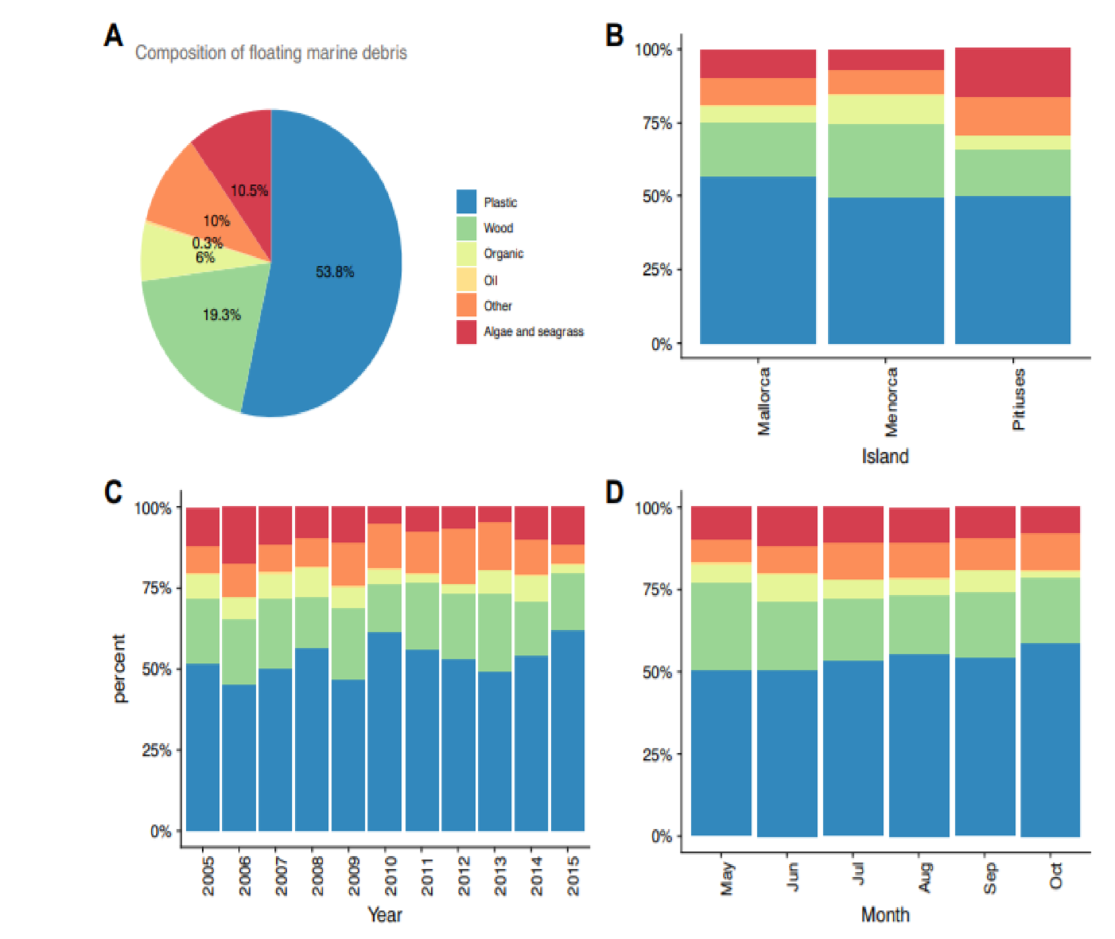


(Compa et al. 2019)

Spatial and temporal distribution floating marine litter

Spatial aggregation indicates low temporal variability plastic debris but consistency in regional spatial abundance

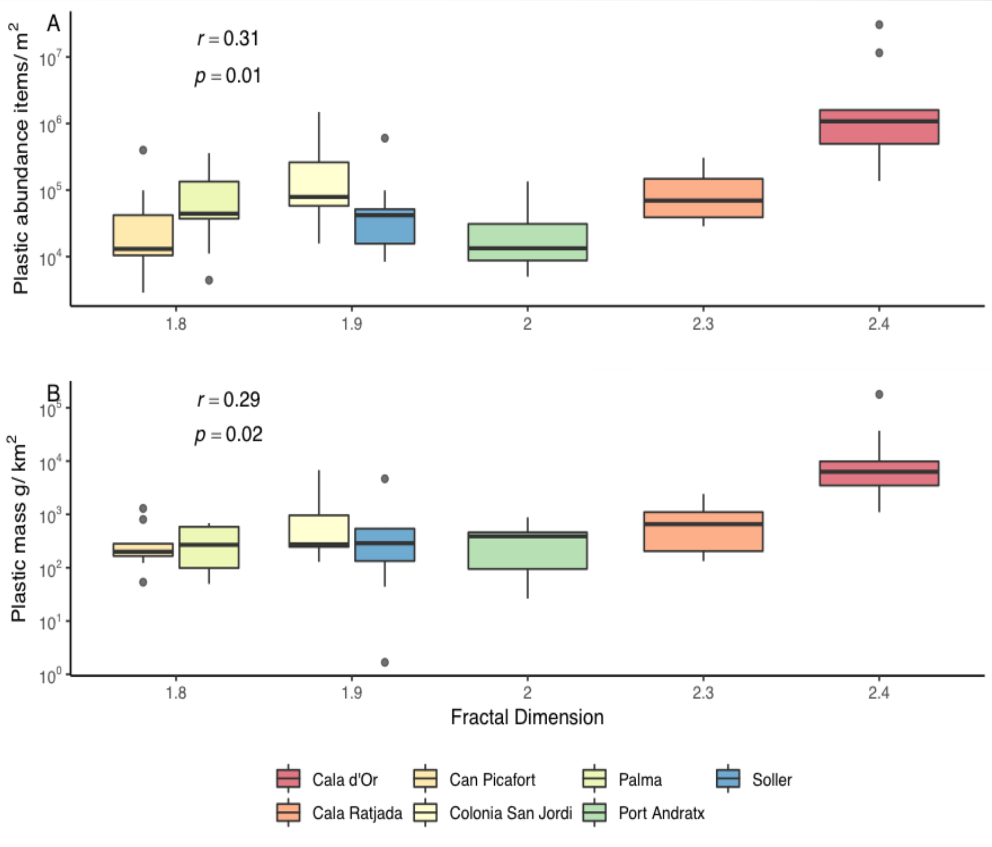


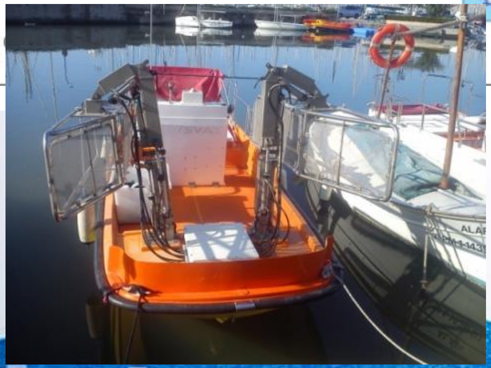


(Compa et al. 2019)

Spatial and temporal distribution floating marine litter (microplastic)

MPs in sea surface waters: range 0.02 ± 0.01 to 0.38 ±0.14 MPs/m³





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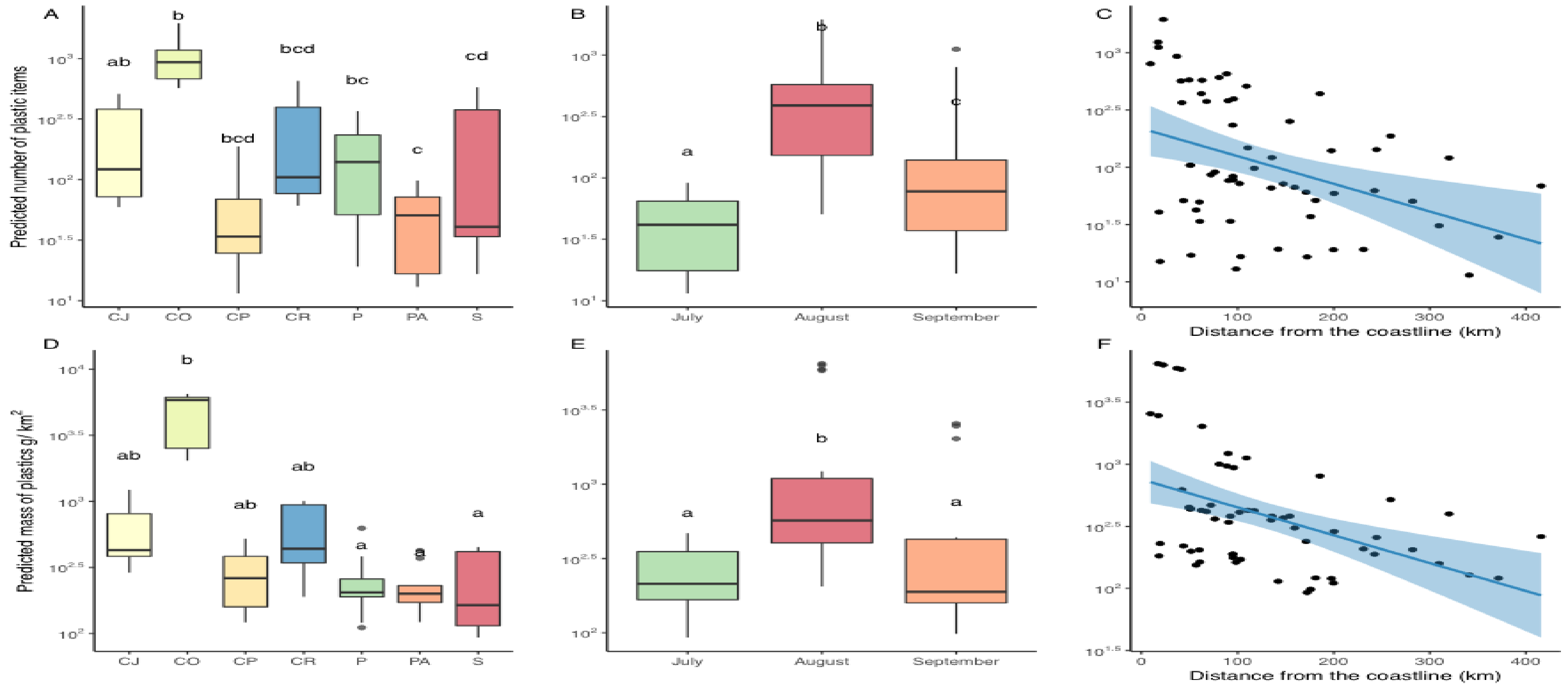
PLASTIC BUSTERS MPAs

Spatial and temporal distribution floating marine litter

100 % manta trawl samples contained plastic items (micro and mesoplastics)
High small-scale variability abundance and mass of plastic debris among locations
Increased fractal dimension coastline increased residence time fostering accumulation areas plastic



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(Compa et al. In progress)

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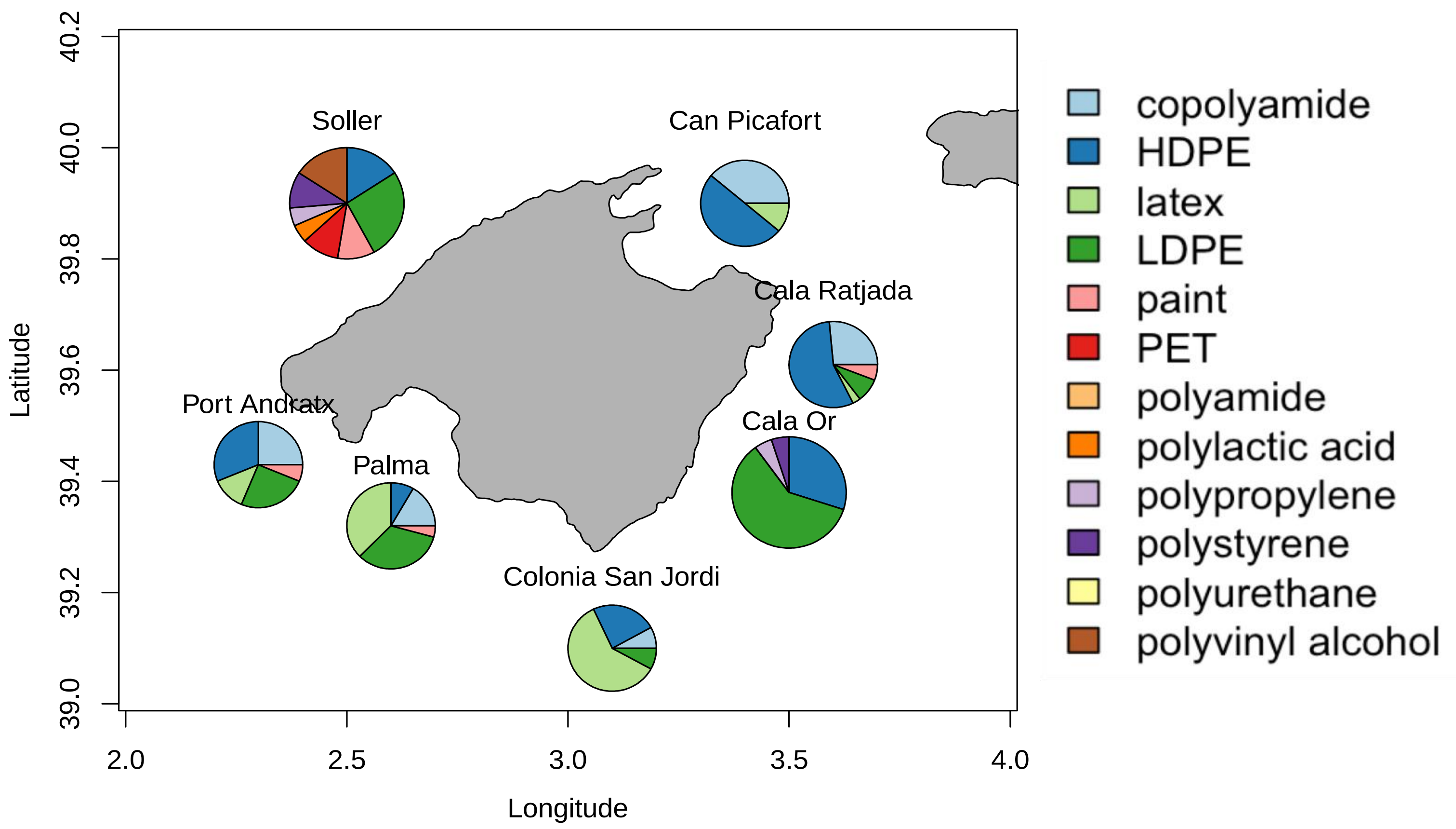
Spatial and temporal distribution floating marine litter (microplastic)- tipologies, sink/sources proxies

HDPE, LDPE and polypropylene principal items found

Increased polymer diversity on the north-western coastline



(Compa et al. submitted)

QUANTIFYING SEAFLOOR LITTER

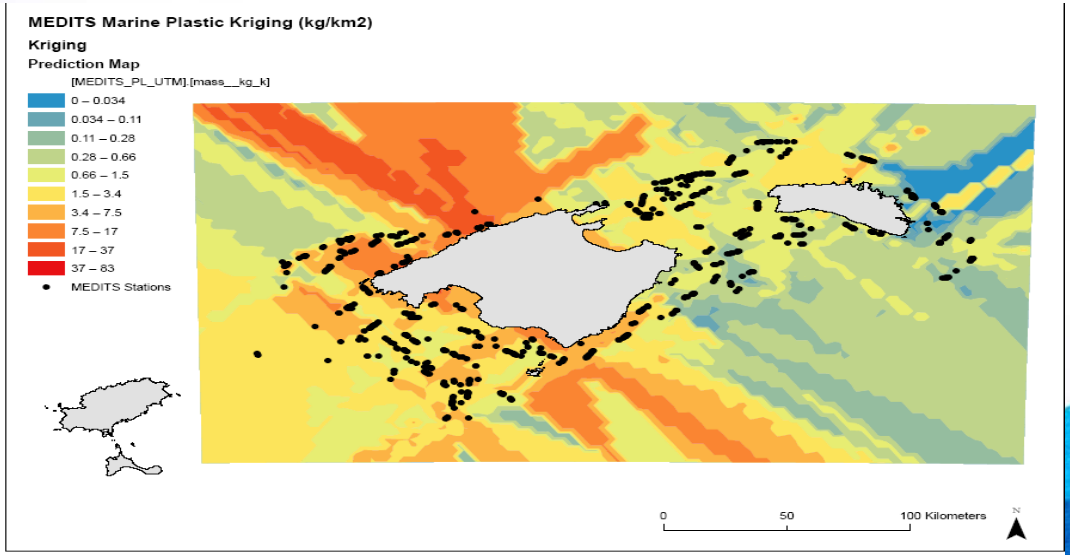
Scientific bottom trawl surveys with experimental fishing gears:

Seafloor habitats around the Balearic Islands; up to 21 nm from the cost

Time series: 2001 - ongoing

Depth range: 50 - 800 m

Number of stations: aprox 41 -69 trawls/year



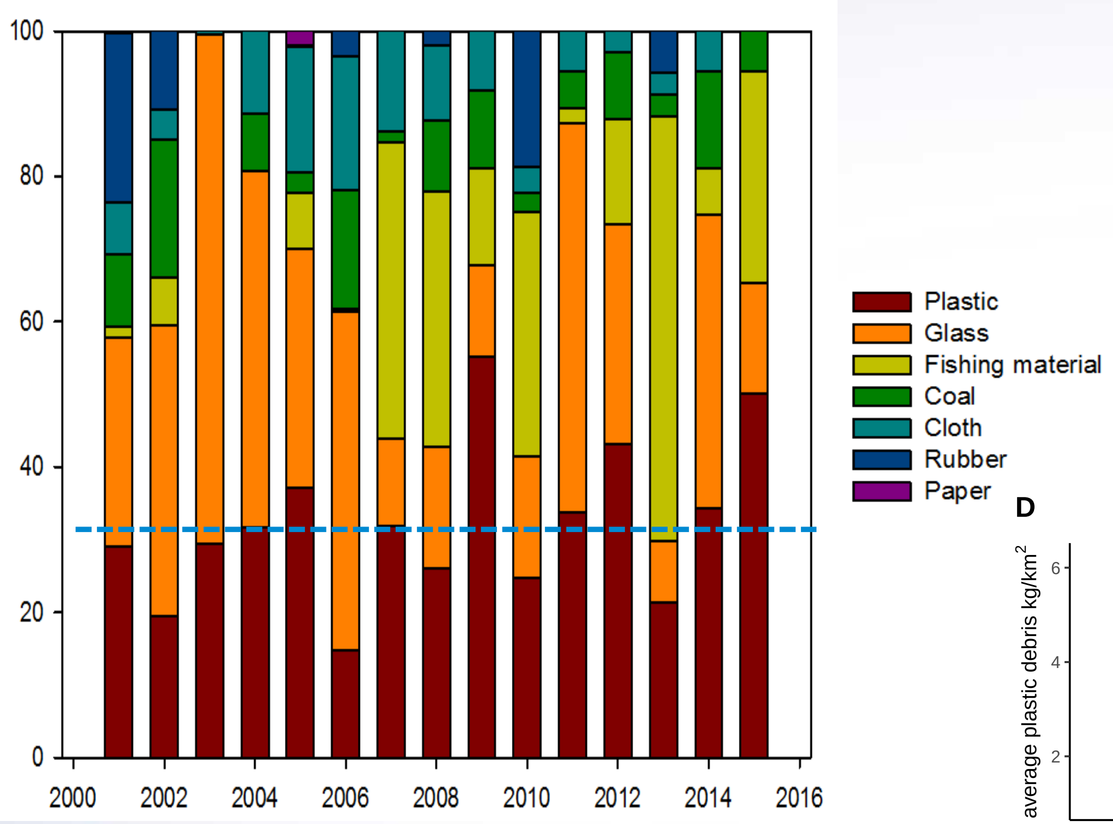
Spatial variation of macroplastics:

Ordinary kriging to study the spatial distribution of the plastic fraction around the Balearic Islands

Maximum values **of 82.95 kg** of macroplastics/km^2

(Alomar et al. In progress)

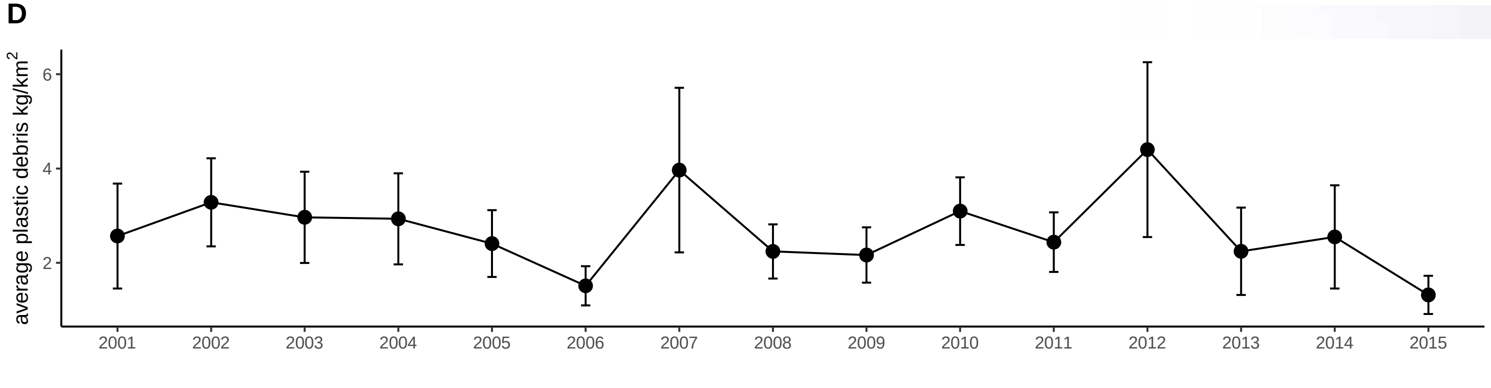
Temporal distribution seafloor marine litter



Percentage breakdown of marine litter categories bottom trawl hauls

Marine litter quantified in 88% of the hauls

mean value 1.39 ± 0.13 kg /km2



No clear trend for the plastic fraction in 15 years of data

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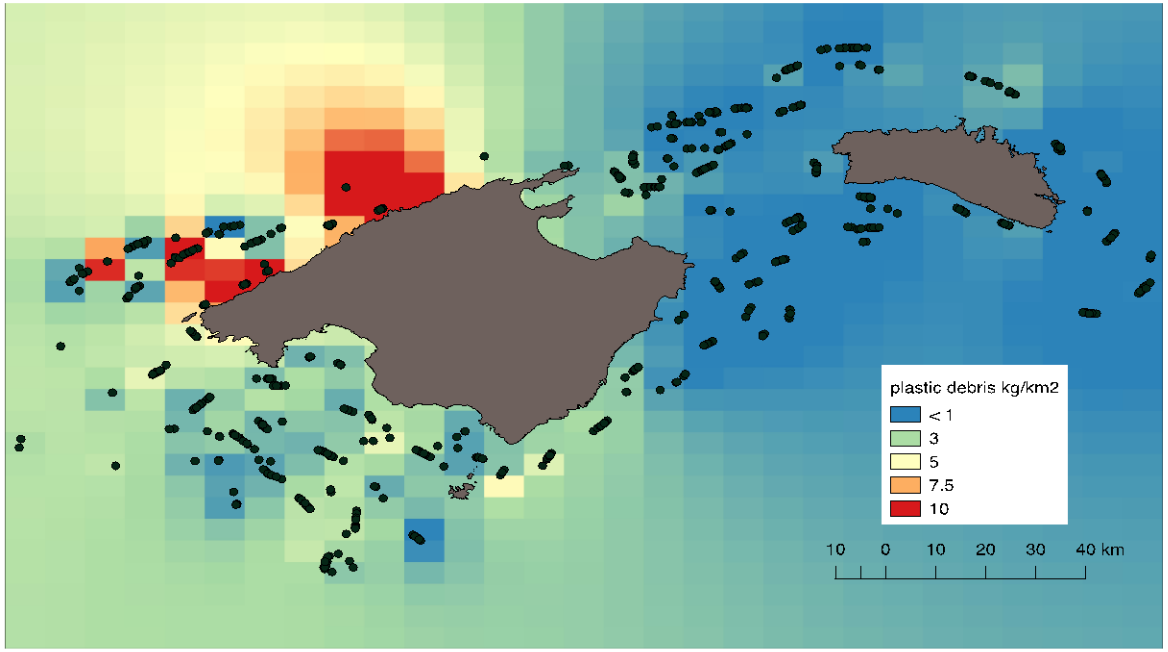
Spatial and temporal distribution of seafloor marine litter

Mean plastic: 2.73 ± 0.26 kg/km^2

66% of the hauls contained plastics

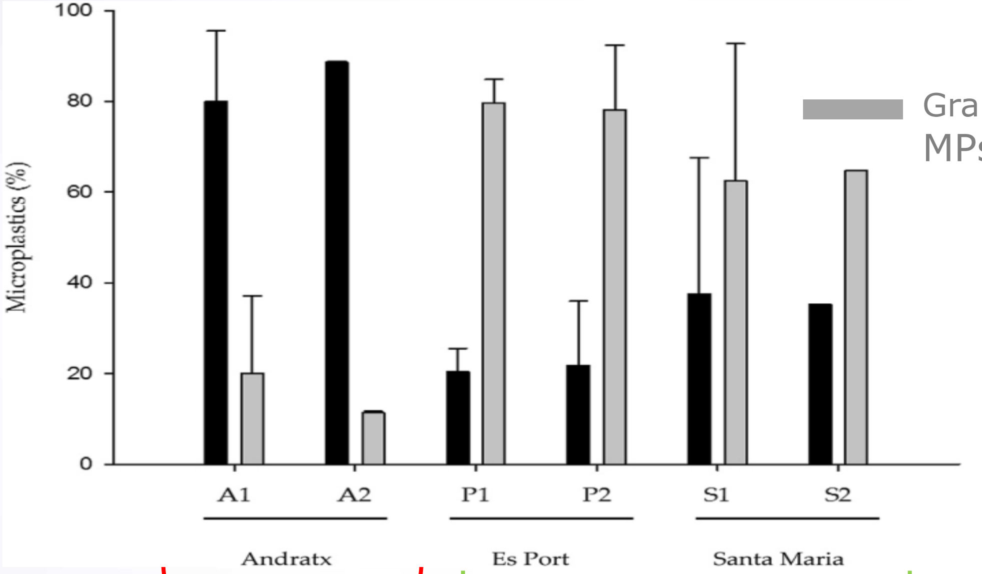
Sampling area, **bathymetric strata** and **distance to the coastline** are explaining the distribution of plastic litter in the seafloor of the study area (GAM results)



(Alomar et al. In progress)

MPs IN SEAFLOOR MICROPLASTICS IN SEDIMENTS

Quantifying microplastics in coastal areas (8 – 10 m depth)
Microplastics in sediments MPA *vs* urbanized areas: MPA up to 0.90 ± 0.10 MPs/g coastal sediment



Filament type MPs

Granular type MPs

- ➢Sediment cores sampled with scuba divers in an urbanized and a Marine Protected Area (MPA)
- ➢Higher concentrations of MPs in MPA: up to 0.90 ± 0.10 MPs/g of dry coastal sediment
- ➢Example of transferred contamination
- ➢Indirect estimation of sources (filaments=sewage inputs; granular= fragmentation)

Urbanized Area

Marine Protected Area

(Alomar et al. 2016)

Quantifying impacts on marine life
Plastic ingestion: bioaccumulation, food web

Pelagic fish:

Bluefin tuna: 32.4%
Albacore: 12.9%
Swordfish: 12.5%
(Romeo et al. 2015)

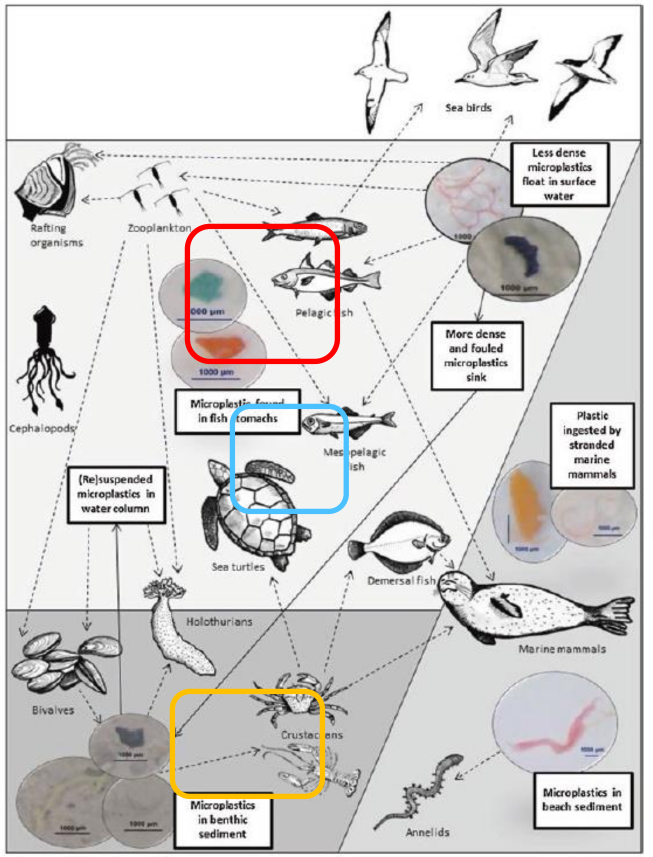
Trachinotus ovatus (Derbio): 24.3%
(Battaglia et al. 2016)

Demersal fish

Red mullet: **18.8%;** 1.90 ± 1.29 MPs/fish
(Bellas et al. 2016)

Mean MPs all species: 1.30 ± 0.20 MPs/fish

Stingray: 50%
Velvet belly: 6.3%
Blackmouth catshark: 3.2%
Blackspot red seabream: 1.7%
Longnose spurdog: 1.3%
(Anastasopoulou et al. 2013)



A. Lusher , 2015

Mesopelagic fish

Bogue: 68%;
3.75 ± 0.25 MPs/fish
(Nadal et al. 2016)

Bogue: 41%;
1.46 ± 0.65 MPs/fish

Anchovy: 17%;
1.18 ± 0.40 MPs/fish

Sardine: 12%;
1.43 ± 0.79 MPs/fish
(Compa et al. 2016)

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Microplastic ingestion in species with different feeding habits

Microplastic ingestion in fish and shark species from different sea compartments: pelagic, semi-pelagic and demersal: **Higher ingestion values in species which feed closer to the seafloor**

Species	sample size (n)	individuals showing ingestion	% ingestion	MPs (mean ± se)
Sardina pilchardus	105	16	15	0.21 ± 0.09
Engraulis encrasicolus	105	15	14	0.18 ± 0.08
Boops boops	288	198	68	3.75 ± 0.25
Galeus melastomus	125	21	17	0.34 ± 0.07
Mullus surmuletus	417	114	27	0.42 ± 0.04




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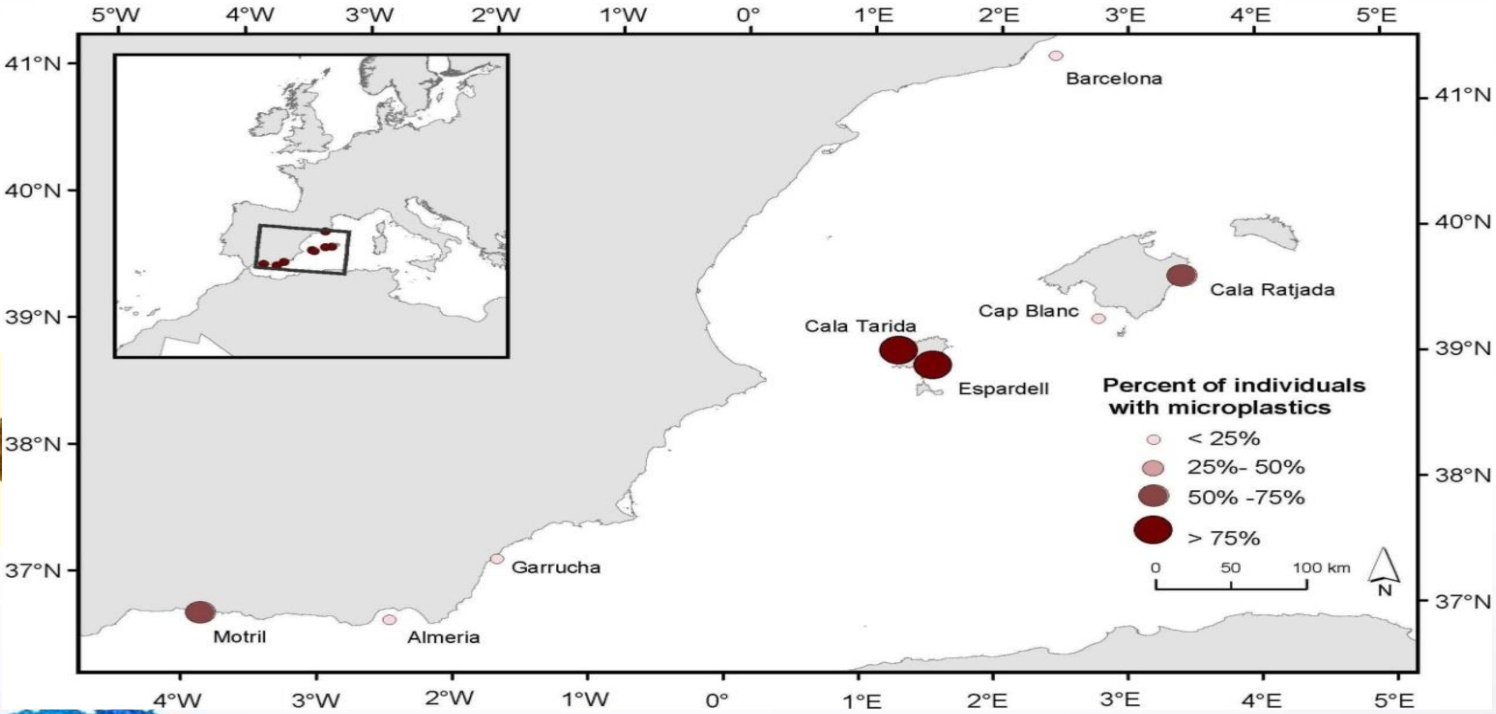
Compa et al., 2018; Alomar et al., 2017; Alomar and Deudero, 2017

Impacts on marine life Comparing results at a regional scale- Spanish Coast example

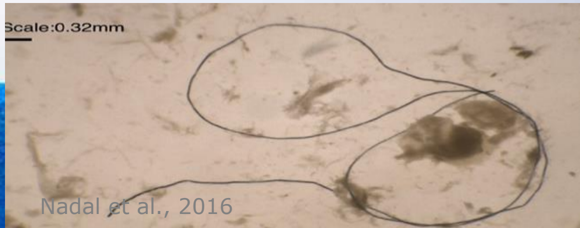
Highly touristic area (Ibiza): small pelagic fish with highest percentage of MP ingestion (Espardell 79.5%; Cala Tarida 76.1%)

Highly urbanized area and with an important commercial port (Barcelona): lowest percentage of MP ingestion (13%)

Boops boops
case study

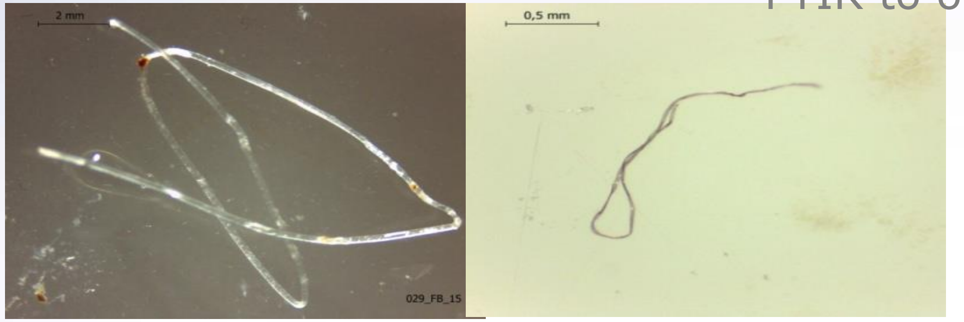


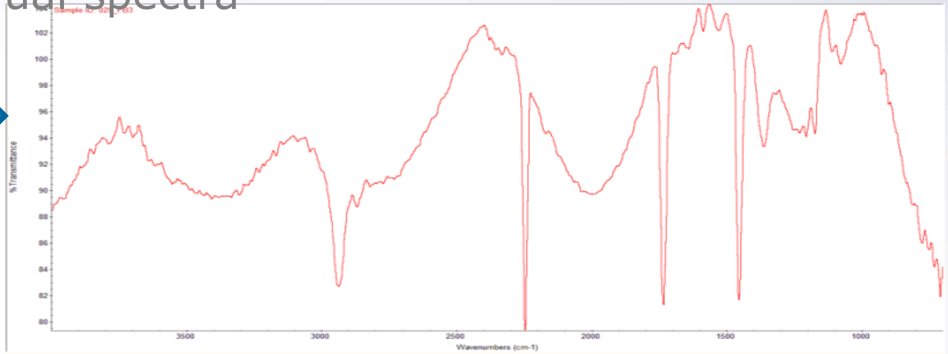
Nadal eet al., 2016
(Compa et al., 2016; 41st CIESM Congress)



Impacts on biota, Characterization polymers MPs (fish & shark)

FTIR to obtain individual spectra





Subset of samples from:
915 fish
127 sharks

Identifying MPs sources

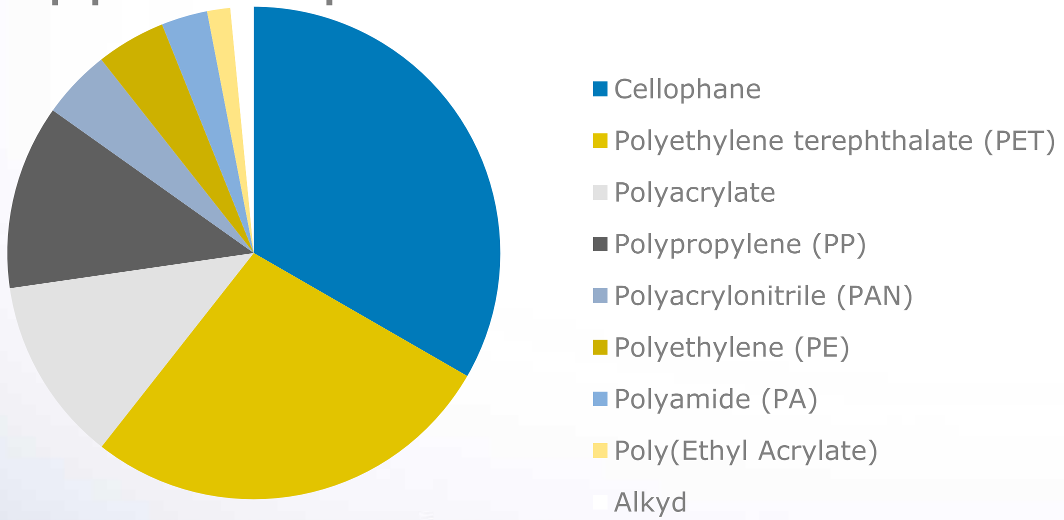
Plastic polymer type	%
Cellophane	33.33
Polyacrylonitrile (PAN)	4.55
Polyethylene (PE)	4.55
Polyethylene terephthalate (PET)	27.27
Poly(Ethyl Acrylate)	1.52
Polyacrylate	12.12
Polyamide (PA)	3.03
Polypropylene (PP)	12.12
Alkyd	1.52

Colour	%
Black	12.12
Blue	31.82
Red	10.61
Tranparente	42.43
White	3.03

In collaboration with the University of Finland

Sources, dispersion factors, accumulation areas Plastic Busters Project

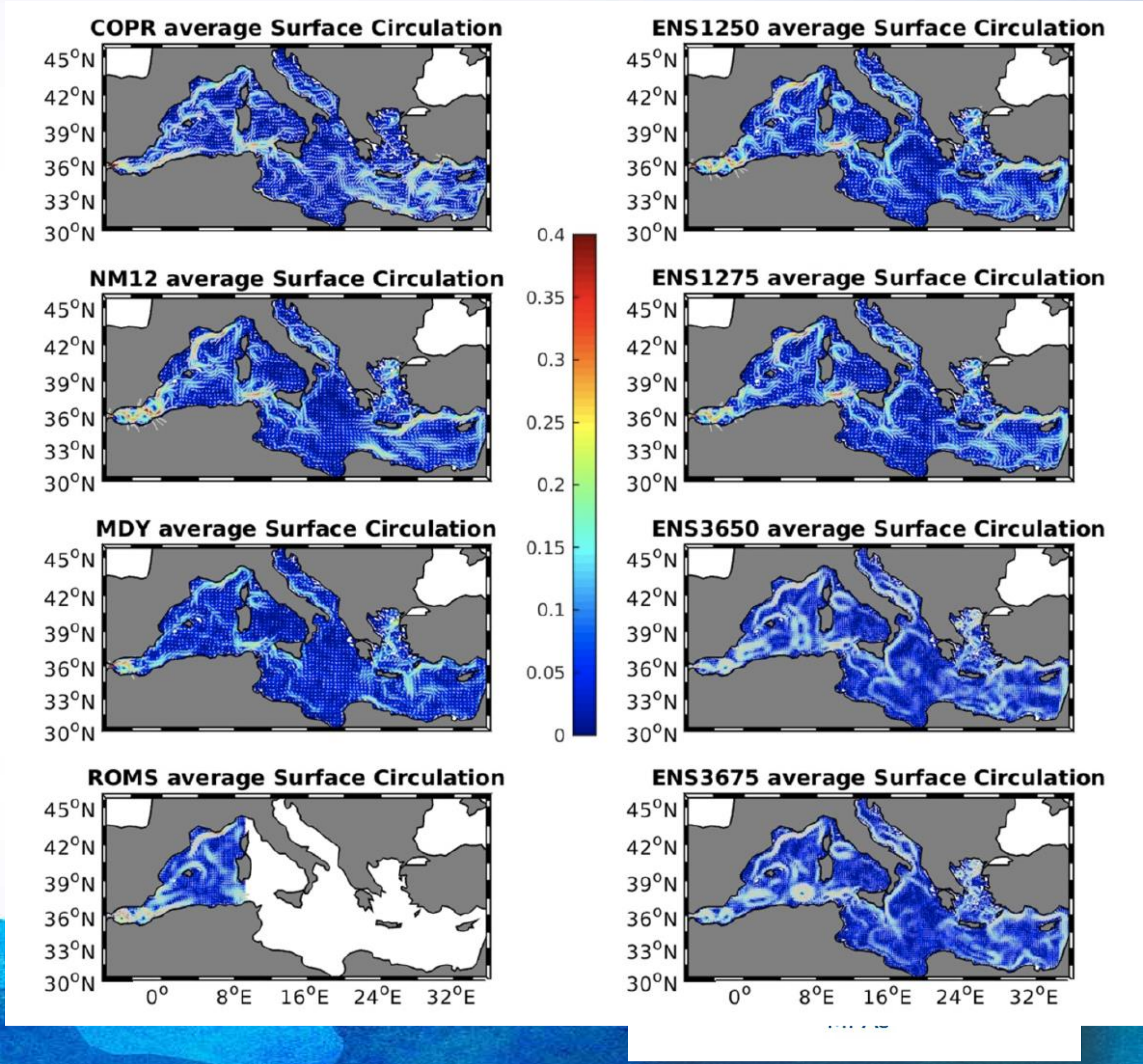
- Identify accumulation areas ML in MPAs throughout Mediterranean
  - Ocean currents and convergence areas
  - Identify hotspot areas for ML monitoring
  - Support implemented marine litter management efforts



MPAs in the Mediterranean Sea

- Modelling approaches
- Climatic simulations Med (8 models)
  - 1987-2017
  - temporal, horizontal, vertical resolutions
  - Boundary and atmospheric forcing

- Identify models better reproduce circulation patterns Mediterranean



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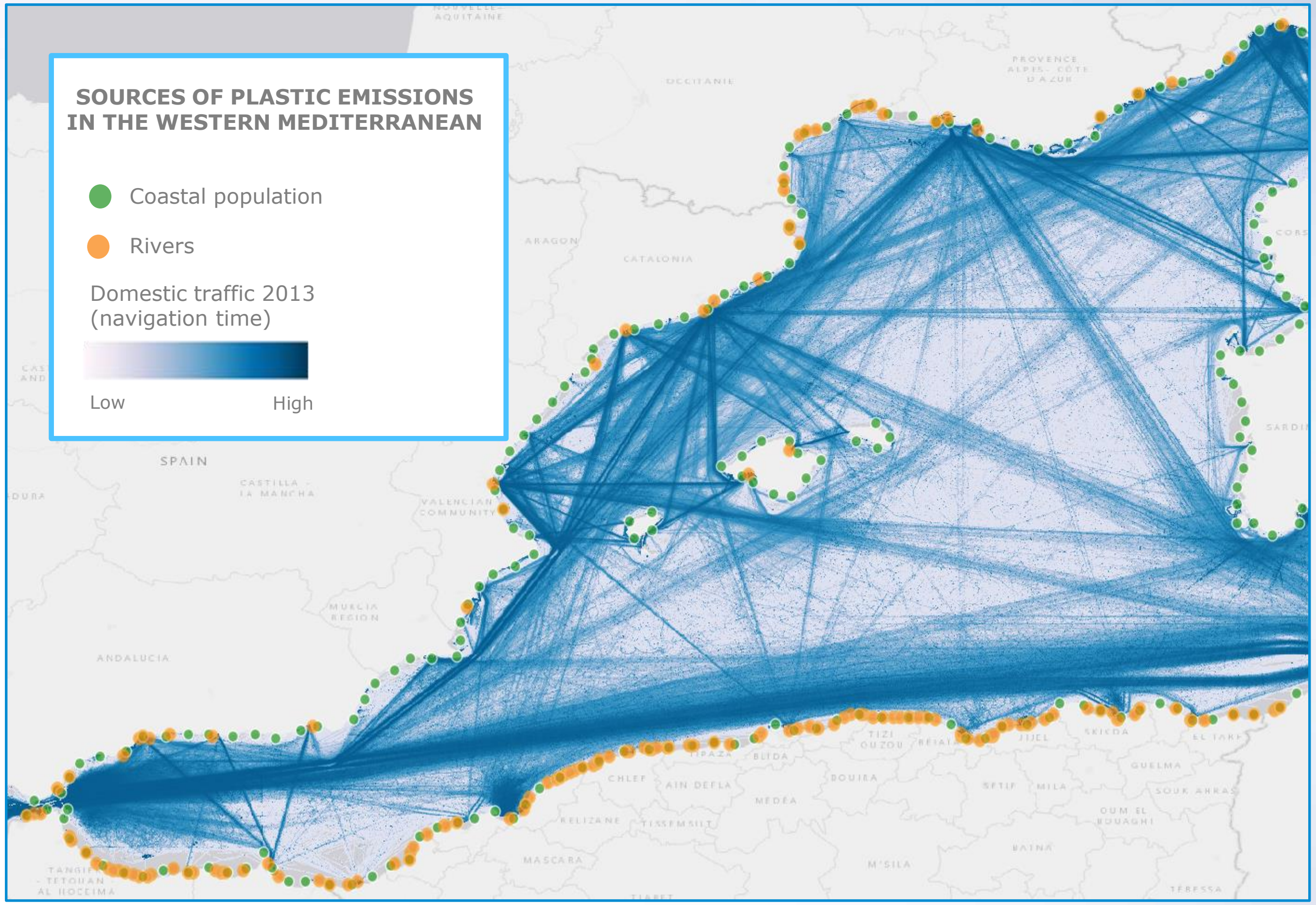
Modelling marine litter inputs

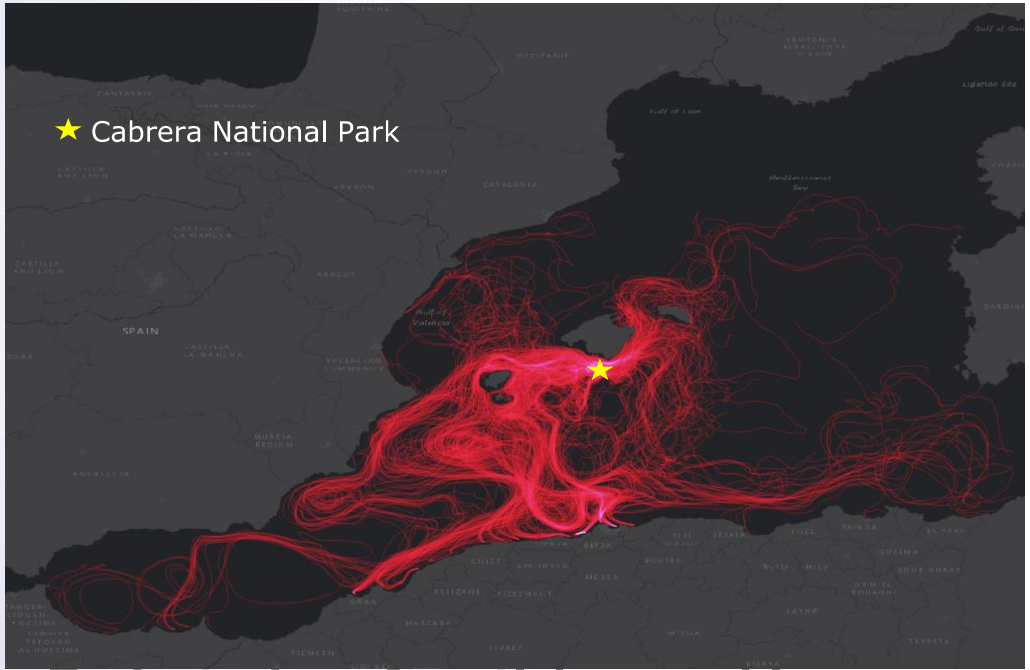
- **Objective**
  - Estimate plastic emissions (in kg/day) from multiple sources during 2012-2014
- **Land-based sources**
  - Coastal population (annual variation)[1]
  - River inputs (monthly variation)[2]
- **Ocean-based sources**
  - Marine traffic: domestic, fishing, recreative
  - Navigation time (monthly variation)[3]



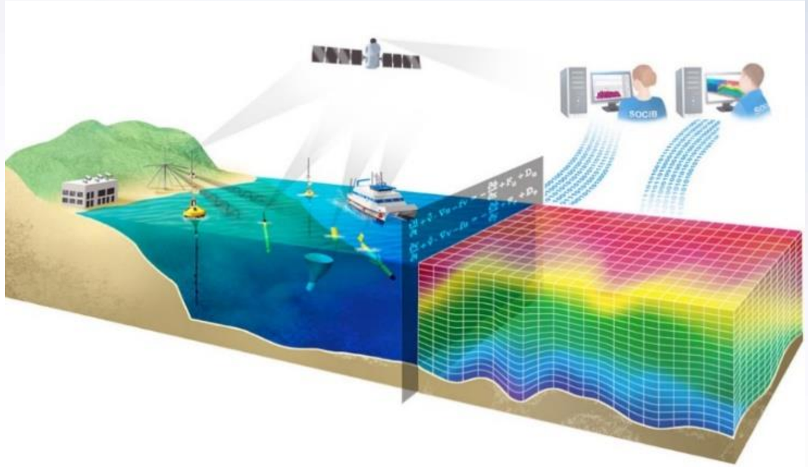
Spatial distribution of floating debris inputs in the W Mediterranean

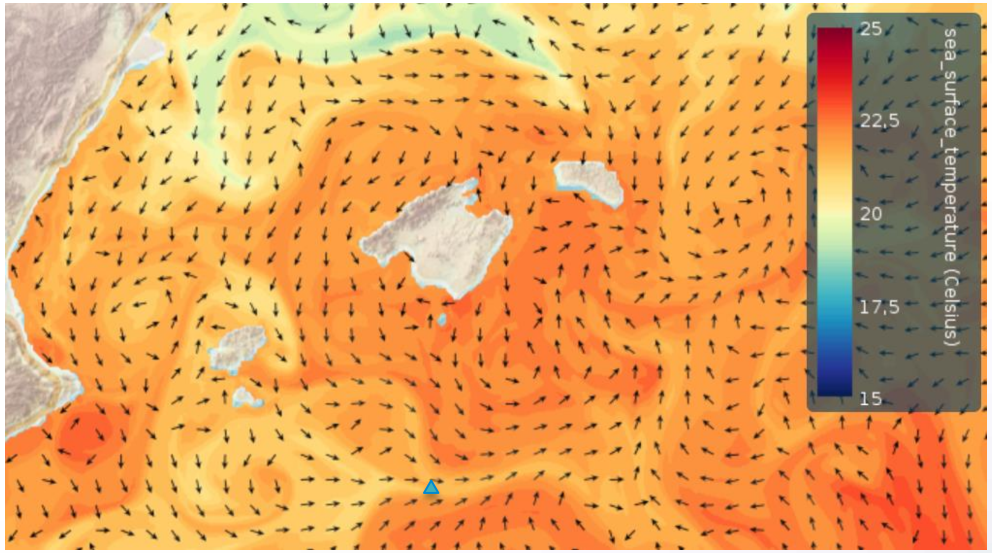
[1] Jambeck et al. (2015) Science 347, 768–771
[2] Lebreton et al. (2017) Nat Comm 81:15611
[3] SOCIB AIS Database

Lagragian simulations,



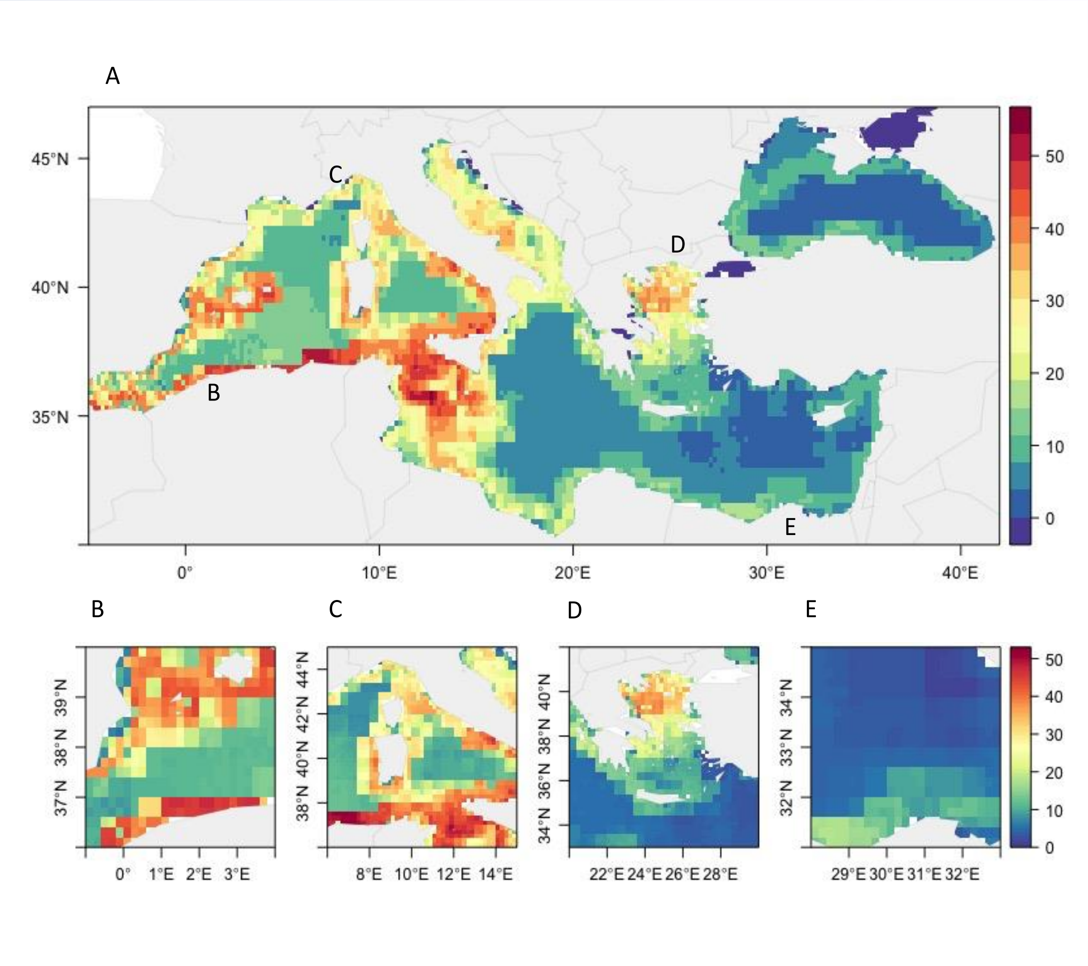
Trajectories of particles reaching Cabrera National Park

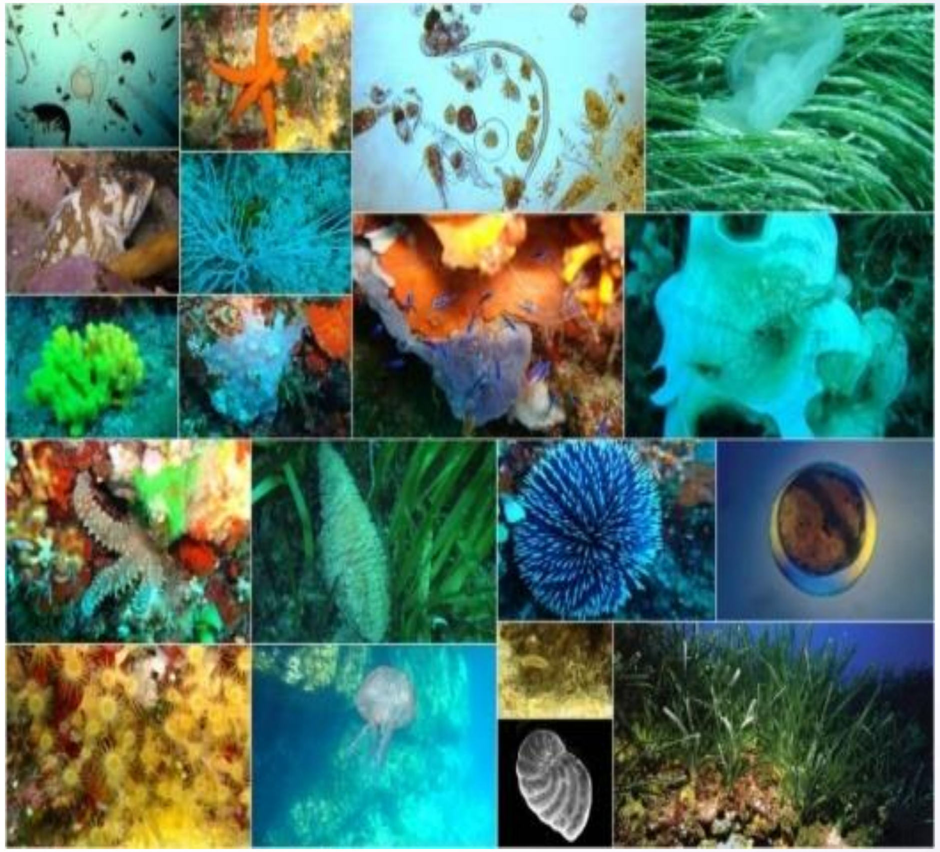




WMOP (Western Mediterranean Operational model)

Risk assessment of plastic pollution on marine diversity





Compa et al., under review

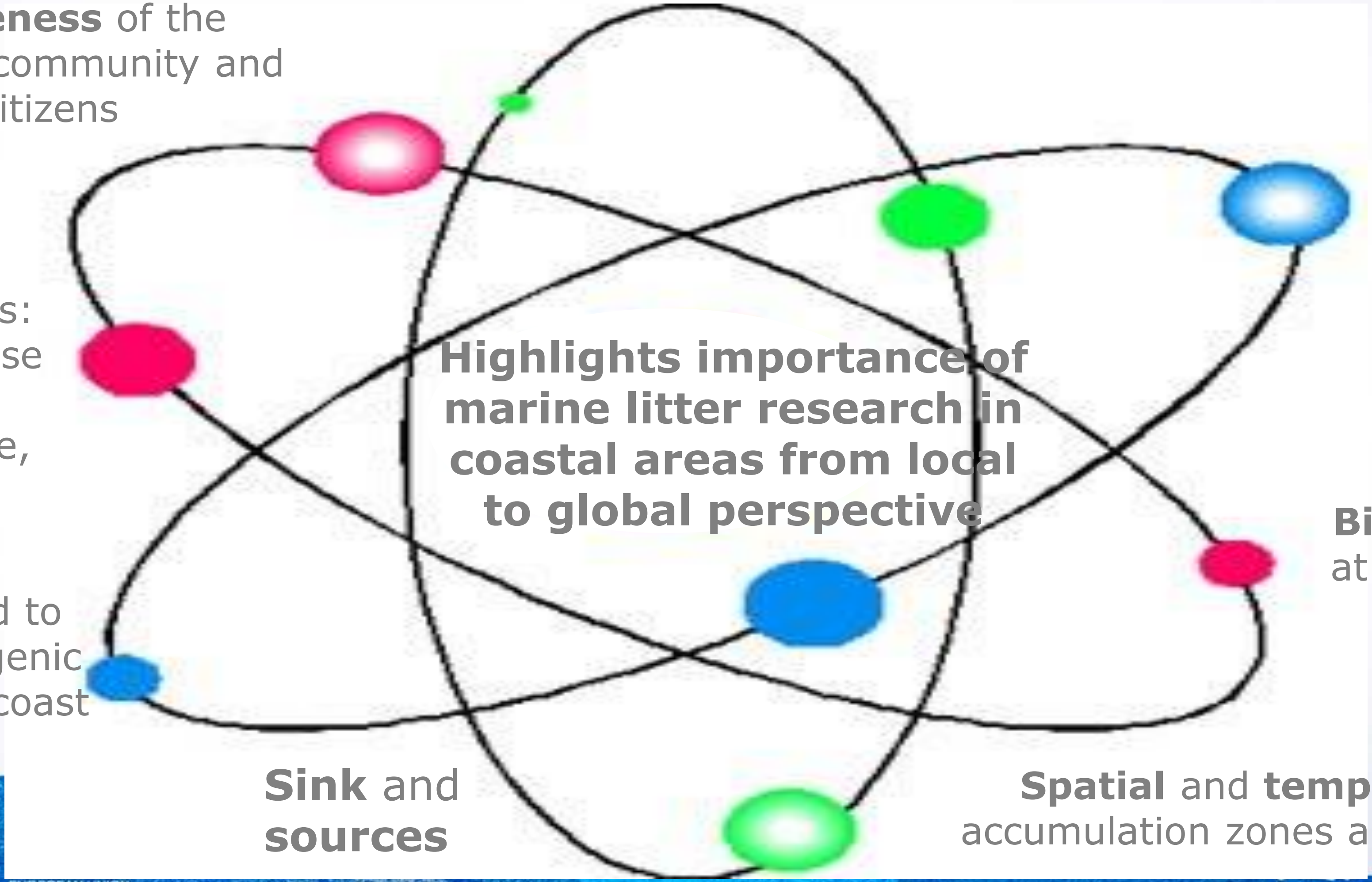
Marine litter studies mediterranean mpas

Quantification of high abundances of plastics in marine ecosystems

Awareness of the scientific community and citizens

Ingestion and **quantification** (shark and fish species)

Characterization MPs: predominance single use plastics (bottles and packaging) shape, size, colour, polymer type



Highlights importance of marine litter research in coastal areas from local to global perspective

Bioaccumulation at different trophic levels

Sources related to higher anthropogenic pressures in the coast

Sink and **sources**

Spatial and **temporal trends**- accumulation zones and sinking areas

Thanks to be here !

IMPACT@SEA research group Spanish Institute of Oceanography (IEO)
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@MedMarineLitter
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