SPATIAL OVERLAP OF LARGE MARINE VERTEBRATES WITH FLOATING MACRO-LITTER IN THE SPANISH MEDITERRANEAN SEA

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INTRODUCTION

- Floating marine litter is considered to be an emerging issue threatening marine biodiversity.
- The more widely recognized impacts of floating litter on marine fauna are those associated with entanglement and ingestion.
- The high concentration of floating plastics in pelagic areas in the Mediterranean Sea expose marine fauna to such impacts.

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AIM **To investigate the composition, density and spatial distribution of floating marine macro-litter and its overlap with large marine vertebrates, from aerial surveys carried out in waters off East Spain (western Mediterranean)**

METHODS

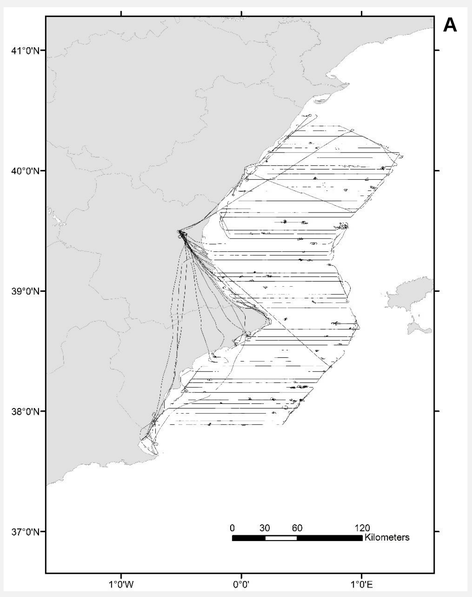


Figure 1. **Study area**.
Study area where aerial surveys were conducted. **A**. Line transect survey designs covered a total area of 26300 km^2 in the waters of the Valencia region, from the coast to the 2000 m depth during the four seasons of the study. **B**. Observation of a group of striped dolphins (*S. coeruleoalba*).

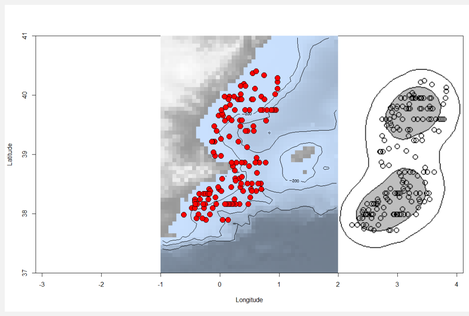
- Four seasonal surveys (2013) following the line transect methodology.
- Twin-engine high-wing aircraft (Partenavia P-68). Constant flight altitude (750 feet) and speed (100 knots).
- Three taxa studied: **Marine mammals** (*Stenella coeruleoalba, Tursiops truncatus, Balaenoptera physalus, Grampus griseus, Globicephala melas, Physeter macrocephalus, Ziphius cavirostris*), **Sea turtles** (*Caretta caretta*) and **Fishes** (*Mola mola*).
- For all the debris over 30 cm, debris sighting-related information: **1)** source, **2)** type of material, **3)** composition, colour, and size.
- Kernel density estimations. 95% KDE density contours were used to evaluate **spatial distribution** of marine vertebrates and marine litter. Their **overlap** was estimated as the probability to find litter in the area covered by each taxon.

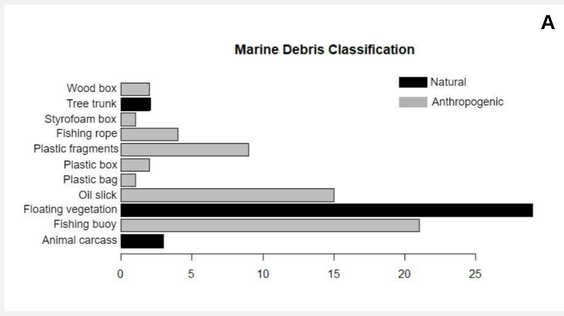
RESULTS AND DISCUSSION

Table 1. Results of floating macro-litter density of distribution. h value = smoothing parameter.

Observation	Spatial distribution		
	h value (m)	Kernel 50% (Km^2)	Kernel 95% (Km^2)
Marine litter	27701.1	1492.9	5104.3

Figure 2. **Floating marine litter sightings**. We accounted for 168 litter sightings. Home range 95% KDE (non filled line) and 50% KDE (grey filled line).





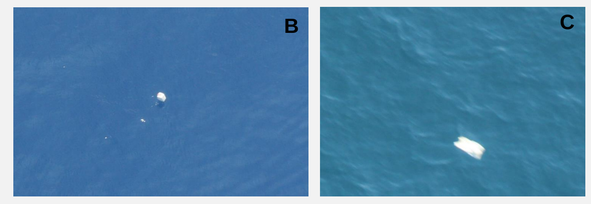
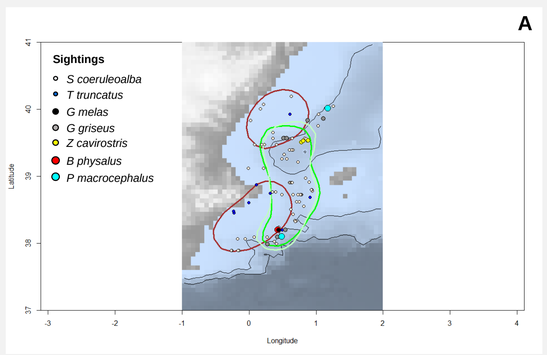


Figure 3. **A**. Composition of floating macro-litter categories observed during the whole 2013 study period. **B**-**C**. Floating plastics observed during aerial surveys.

Table 2. Summary of observations for cetaceans recorded from aerial surveys in 2013. h value = smoothing parameter; overlap = Probability litter within cetacean 95% Kernel (between 0 and 1).

Taxa	No. observations	Mean group size/location	Spatial distribution			overlap
			h value (m)	Kernel 50% (Km^2)	Kernel 95% (Km^2)	
Cetacean	99		26250.3	1313.0	4777.9	**0.89**
S. Coeruleoalba	75	19.1 ± 31.4	26835.9	1259.5	4702.1	**0.87**



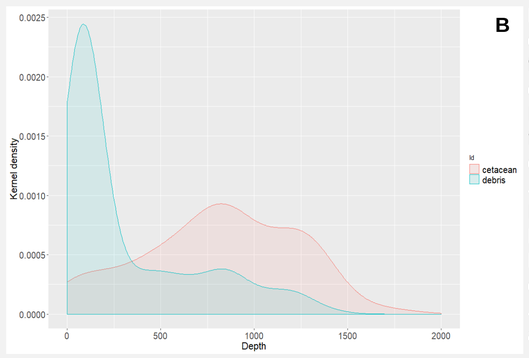
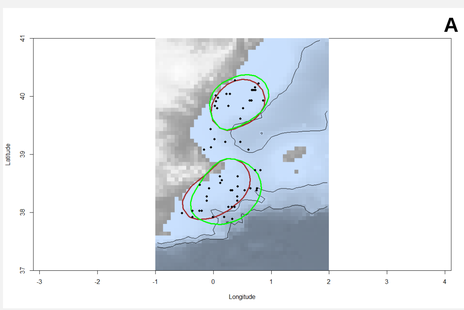


Figure 4. A. Kernel density estimation performed on floating macro-litter and cetaceans.
Home range 95% KDE for floating macro-litter (brown line), cetaceans (light green line) and *S coeruleoalba* (green line). For other species only sightings locations are shown. **B**. Overlap between the distributions of floating macro-litter and *S. coeruleoalba*. Plots are according to bathymetry.

Table 3. Results of sea turtle density of distribution. h value = smoothing parameter; overlap = Probability litter within turtle 95% Kernel (between 0 and 1).

Species	Spatial distribution			overlap
	h value (m)	Kernel 50% (Km^2)	Kernel 95% (Km^2)	
C. caretta	34855.2	1869.8	6489.4	**0.98**



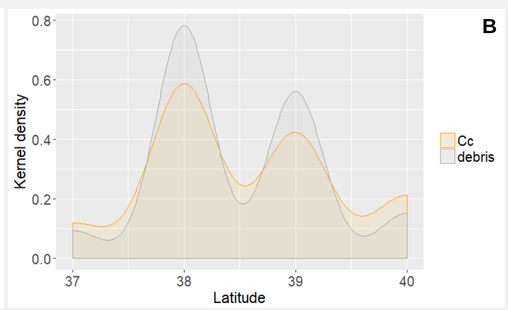


Figure 5. **A**. *C caretta* sightings during the whole 2013 study period (n= 58). Home range 95% KDE for floating macro-litter (brown line) and 95% KDE for *C caretta* (green line). **B**. The kernel density shows the overlap between the distributions of floating macro-litter and *C caretta*. Plots are according to latitude.

- We obtained high probability values of overlap between litter and marine vertebrates (89% to 98%), similar to the ones obtained in other areas in the Mediterranean for sea turtles[1] and cetaceans[2]. These results show that all marine vertebrates are highly exposed to marine litter.
- Highest values of overlap with macro-litter for *Caretta caretta*. Spatial distribution of litter occurs within the range of depths used by *C caretta*, whereas higher densities of *S coeruleoalba* were observed over depths around 600 m, where less presence of floating macro-litter was detected (Fig. 4B).
- High overlap with *C caretta* could be related with their feeding behavior, they could occupy areas where passive preys are concentrated and where litter also accumulates.
- This preliminary study shows that the three studied taxa are highly exposed to litter impacts, such as ingestion, entanglement and exposition to pollutants, known to affect these taxa.

Table 4. Results of sunfish (*Mola mola*) density of distribution. h value = smoothing parameter; overlap = Probability litter within sunfish 95% Kernel (between 0 and 1).

Species	Spatial distribution			overlap
	h value (m)	Kernel 50% (Km^2)	Kernel 95% (Km^2)	
Mola mola	24423	1340.9	4501.5	**0.90**

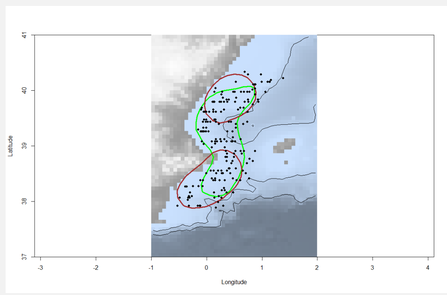


Figure 6. *M mola* sightings during the whole 2013 study period (n= 189). Home range 95% KDE for floating macro-litter (brown line) and 95% KDE for *M mola* (green line).

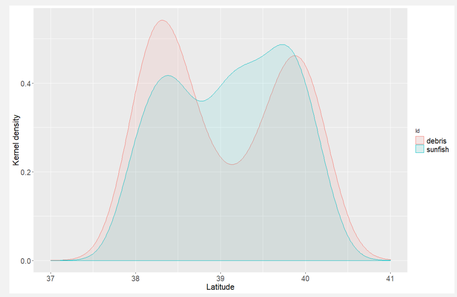


Figure 7. Spatial variation in distribution patterns of floating macro-litter (debris) and *M mola* in the study area. The kernel density shows the overlap between them. Plots are according to latitude.

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References. [1]Darmon, G., et al., Risk assessment reveals high exposure of sea turtles to marine debris in French Mediterranean and metropolitan Atlantic waters. Deep-Sea Res. II (2016), http://dx.doi.org/10.1016/j.dsr2.2016.07.005i. Di-Méglio et al., Floating macrolitter Marine along the Mediterranean French coast: composition, density, distribution and overlap with cetacean range. Pollution Bulletin 118 (2017) 155–166.