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Is wind a good proxy for floating microplastics? A case study in Galway Bay, Ireland

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INTRODUCTION

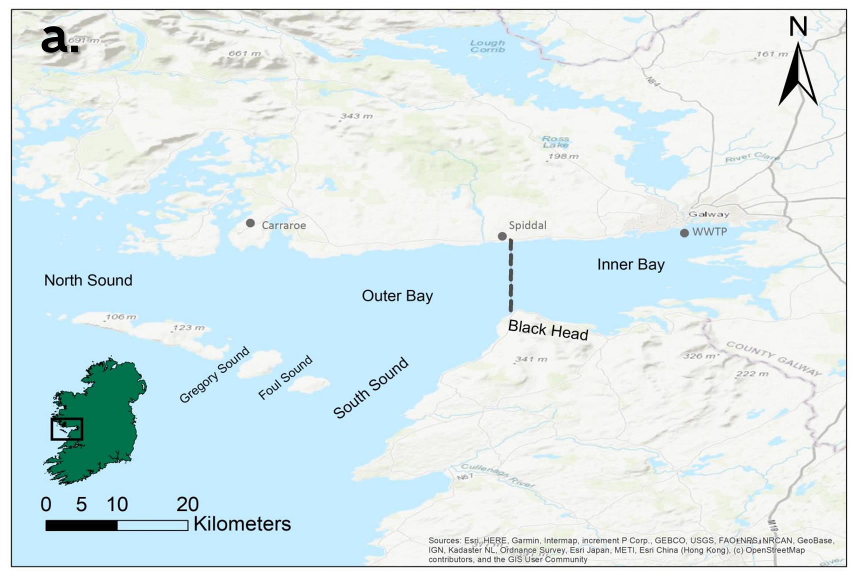
Plastic items of all shapes, colours and sizes are **stockpiling globally in the marine environment** at **unprecedented rates**[1,2,3], while global production continues to rise exponentially[4]. Among marine litter, **microplastics (MPs)**[5,6] represent higher risks for marine wildlife, particularly planktonic organisms[7], who are the basis of aquatic food webs. It is estimated that **floating microplastics at the ocean's surface represent ~1%** of plastic distribution in the environment. Deposition in beaches and/or coastal areas accounts for 5% and most plastics are thought to be deposited at the bottom of the ocean (94%)[8].

This exploratory work intended to assess the density of floating microplastics in Galway Bay, as well as to find a representative baseline for this emerging pollutant. One of the main goals of the study was to assess whether wind is a good proxy to assess hotspots of floating microplastics.

SAMPLING SITE

Galway Bay is a large semi-enclosed bay, located in the West of Ireland. It is protected by the strong Atlantic Ocean swells by the Aran Islands, as seen in left side of **Fig. 1. a.**

A total of 20 manta trawl samples were collected between October and December 2017 (**Fig. 1. b.**). Stations were selected taking into consideration proximity to Galway City and potential inflow sources of microplastics into the bay (e.g. the River Corrib). Sampling stations followed transect lines: in the Inner Bay the transect went from Galway City towards Blackhead, Co. Clare; and in the Outer Bay several transects were made following circulation patterns within the bay. All trawls are independent and were dependent on weather conditions.



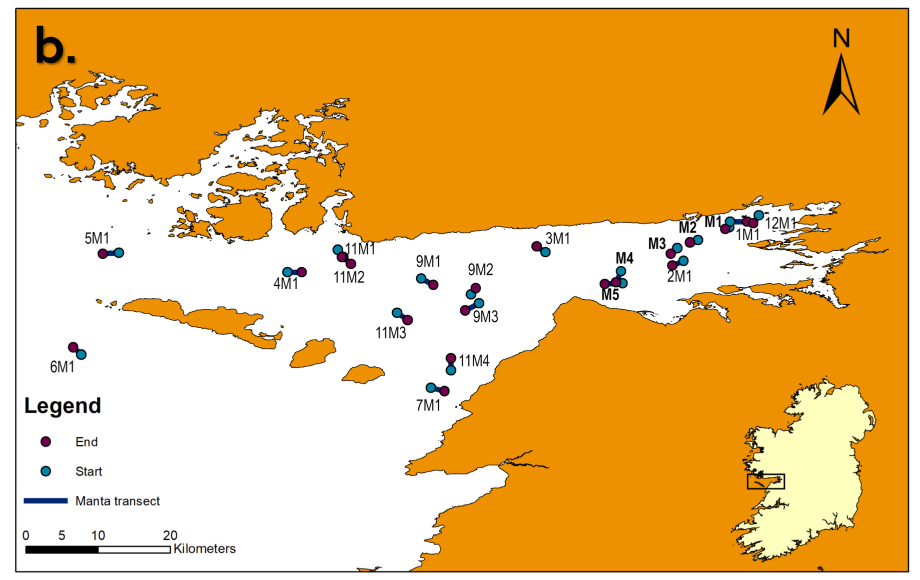


Figure 1. a. Galway Bay and inner and outer bay boundary. **b.** Starting (purple) and ending point (blue) for each trawl.

MATERIALS AND METHODS

Seawater surface samples were collected on board of the RV *Celtic Voyager* (**Fig. 2**), using a manta trawl (**Fig. 3**). The manta trawl frame is made of aluminium and has a rectangular aperture of 15 cm high and 61 cm wide, to which a 2 m long, 300 µm mesh size nylon net with a 30 × 10 cm² cod end was attached.

Figure 2. Irish Marine Institute RV Celtic Voyager

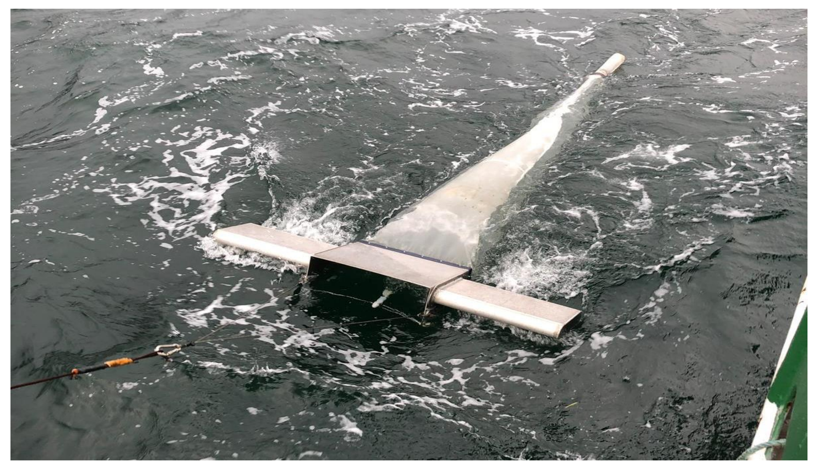


Figure 3. Manta trawl used for sampling

The cod end was made of 3-mm thick grey PVC tubes with a total length of 23 cm and a diameter of 11 cm. The trawl frame was also equipped with a Hydro-Bios mechanical flowmeter with a run stop, whose revolutions were registered prior to and after each tow, as well as the initial and final GPS coordinates.

The manta net was deployed from the starboard side of the vessel, at an average speed of 2 knots for approximately 20 min, following an adapted methodology from Viršek et al. (2016)[9], briefly the cod end was then thoroughly rinsed with ultrapure water from the outside, and the sample washed through a set of previously decontaminated stainless-steel sieves (100 and 300 µm). All natural and artificial litter larger >5 mm were carefully removed using metal tweezers, and not accounted for here. The sieve was rinsed with filtered seawater three times and the contents were added to the jar. **Samples were immediately frozen −20 °C, without adding fixing solutions, until further analysis.**

In the laboratory samples were defrosted and alkaline digested, using a 10% potassium hydroxide (KOH) solution. **Fig. 4** illustrates the laboratory procedure. Full details on the method used can be found in Frias et al. (2020)[10].

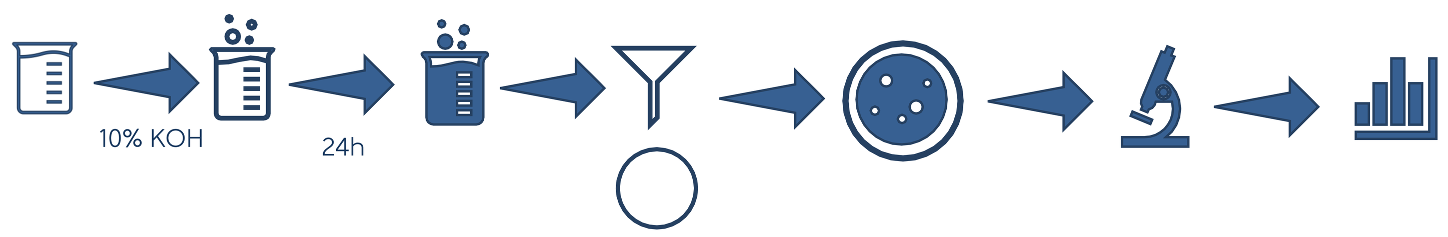


Figure 4. Simplified laboratory procedure

RESULTS

A total of 1182 MPs were retrieved from Galway Bay surface seawaters. These were diverse in colour, size and shape, as described in **Fig. 4.** In relation to MPs types, **fibres** represented **81%** of the total and **fragments 16%**. The predominant microplastic colours were **black, blue** and **red,** as seen in **Fig. 5.**

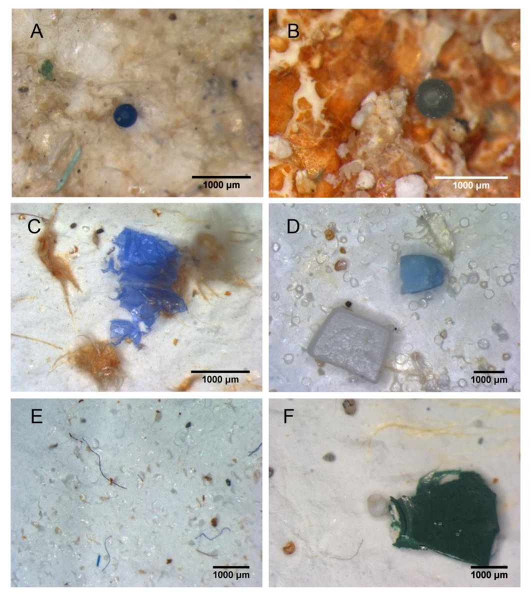


Figure 4. Microplastics retrieved. **A.&B.** microbeads, **C.** film, **D.** fragments, **E.** fibres, **F.** paint chip (potential vessel contamination).

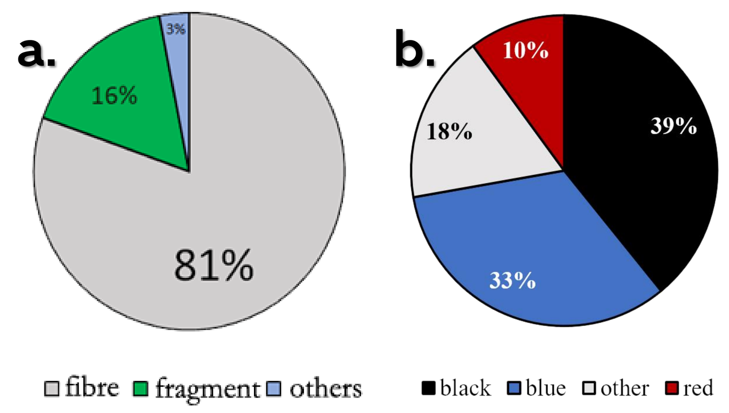


Figure 5. Predominant MPs types and colours

Microplastic density was higher in the Outer Bay (**0.46 ± 0.16 items m⁻³**) than in the Inner Bay (**0.62 ± 0.40 items m⁻³**). Variability in MPs densities can be found in **Fig. 6.**

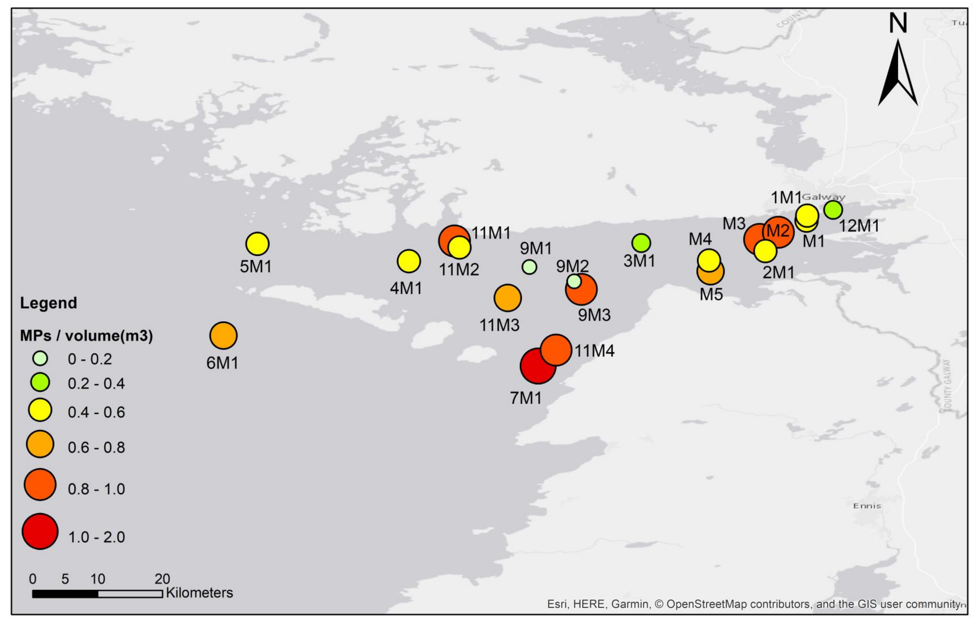


Figure 6. Density distribution of floating MPs in Galway Bay

Fig. 7. shows the microplastics densities (A) and the dominant wind speed and direction while sampling (B). Most stations are influenced by SW winds and five stations do not exhibit influence by the dominant wind. Strong hydrodynamic currents[11] seem to play a stronger in role in surface distribution compared to winds in the Bay.

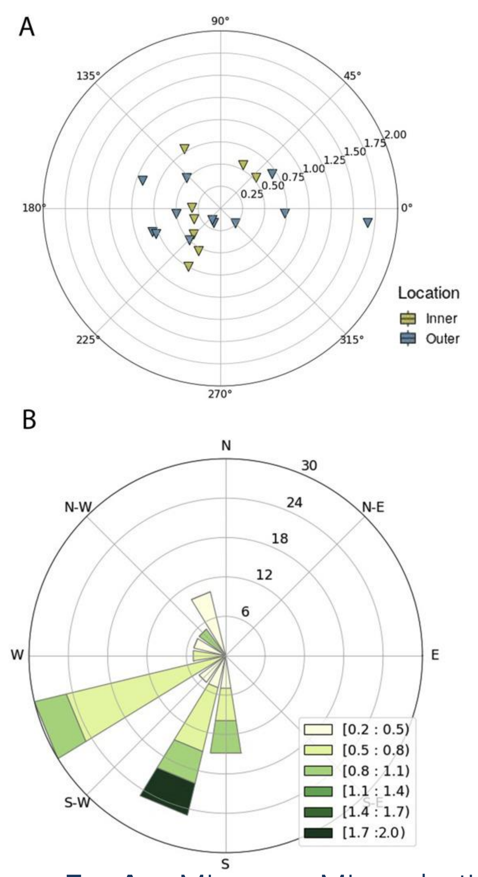


Figure7. A. Micro Microplastic density (MP m⁻³) azimuths for the 20 manta trawls and **B.** stacked wind rose with dominant wind speed and direction (m s⁻¹).

CONCLUSIONS

- A total of **1182 MPs** were retrieved from **2039.86 m³** of seawater
- The average MP density in Galway Bay is **0.56 ± 0.33 items m⁻³**
- **Water circulation** in this bay seems to be more influential than wind speed and direction
- **Wind by itself cannot serve as a proxy for** oceanographic data on **surface currents**
- **No** obvious density **distribution pattern was observed**
- Monitoring of microplastics in seawater surface, particularly in bays, should rely on at least **6-10 different sampling sites** to account for **variability** among samples & sites, as well as to have an overview of **influential factors** (e.g. river input, population density, atmospheric conditions) that might play an important role in MP distribution
- The authors recommend a **holistic approach** to sample collection, i.e. **collection of samples from different matrices in the same sites** (surface water, sediment, biota, etc.), and recording as many **environmental variables** (wind speed & direction, precipitation, current speed & direction, etc.) as possible.

REFERENCES

[1]Jambeck et al., (2015) Plastic waste inputs from land into the ocean. 10.1126/science.1260352
[2]Lebreton et al., (2018) Evidence that the Great Pacific Garbage Patch is rapidly accumulating plastic. 10.1038/s41598-018-22939-w
[3]Borelle et a., (2020). Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. 10.1126/science.aba3656
[4]PlasticsEurope (2019). Plastic – the Facts 2019. An Analysis of European Plastics Production, Demand and Waste Data https://www.plasticseurope.org/en/resources/publications/1804-plastics-facts-2019
[5]Frias and Nash (2019). Microplastics: finding a consensus on the definition. 10.1016/j.marpolbul.2018.11.022
[6] Hartmann et al (2020). Are we speaking the same language? Recommendations for a definition and categorization framework for plastic debris. 10.1021/acs.est.8b05297
[7] Botterell et al., (2020). Bioavailability of Microplastics to Marine Zooplankton: Effect of Shape and Infochemicals. 10.1021/acs.est.0c02715
[8]EUNOMIA, (2016). Sherrington, C. Plastics in the Marine Environment; Eunomia Research & Consulting Ltd: 2016; pp 1-13. https://www.eunomia.co.uk/reports-tools/plastics-in-the-marine-environment/
[9]Viršek et al. (2016). Protocol for Microplastics Sampling on the Sea Surface and Sample Analysis 10.3791/55161
[10]Frias et al (2020). Floating microplastics in a coastal embayment: A multifaceted issue. 10.1016/j.marpolbul.2020.111361
[11]Joshi and Farrell (2020). Physical Oceanographic drivers of geomorphology of rhodolith/maerl beds in Galway Bay, Ireland 10.1016/B978-0-12-814960-7.00012-9

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