INVESTIGATING MICROPLASTIC POLLUTION IN SEASONALLY STRATIFIED WATERS

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BACKGROUND

Figure 1: Marine Debris Ball within the North Pacific Garage Patch Credit: Ocean Voyages Institute/Greg Yoder/Sasha Delaage

The retention of plastic waste in oceanic gyres, more commonly known as "garbage patches", is a phenomenon well-known to researchers and the general public alike (Figure 1). These gyres are permanent circulating currents collecting marine debris over decades (Lebreton *et al.,* 2018).

In contrast, small, seasonal gyres operate on smaller spatiotemporal scales allowing for a higher resolution analysis of microplastic presence and distribution. A cyclonic near surface gyre in the Western Irish Sea is known to collect biological matter however its ability to retain microplastic and the general concentrations of microplastic in most of the Irish Sea is unknown. Due to secondary currents associated with the gyre we hypothesise that microplastic concentrations in the centre of the gyre will be greater than the peripheral concentrations.

This study aims to:

- determine the presence of microplastic in the Irish Sea
- quantify microplastic concentrations throughout the water column through sampling surface waters, sub surface waters and sea bed sediments.

STUDY SITE: *The Western Irish Sea Gyre*

Large gyre systems are known to accumulate microplastic, however less is known about smaller, seasonal gyres.

The Western Irish Sea Gyre forms following the onset of stratification where a cool, dense dome of water is trapped by a well mixed layer during spring and summer where the cooler water warms slowly relative to the well mixed surface layer (Figure 2). Abrupt changes from well mixed to stratified waters occurs at tidal mixing fronts where the frontal density gradients drive a baroclinic flow which is geostrophic to first approximation. This flow presents itself at the surface as a cyclonic circulation of water where the flow is parallel to the isopycnals. This residual circulation of has been known to retain biological matter (e.g larval and juvenile fish) (Robins *et al.,* 2013).

A 40 km transect (northwest to southeast), consisting of 12 sample stations, was chosen chosen to represent the gyre at during July, 2020 (Figure 3).

Figure 2: Schematic representation of a baroclinic gyre. Dotted circles denotes flow out of the page and crossed circles denotes flow into the page. Figure adapted from Horsburgh (1999).

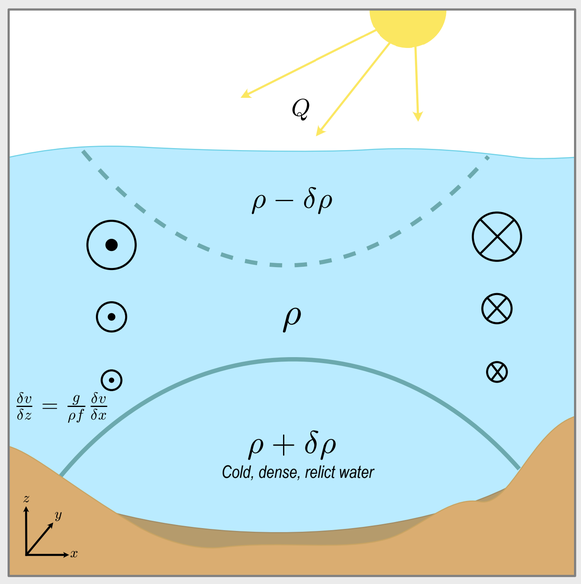
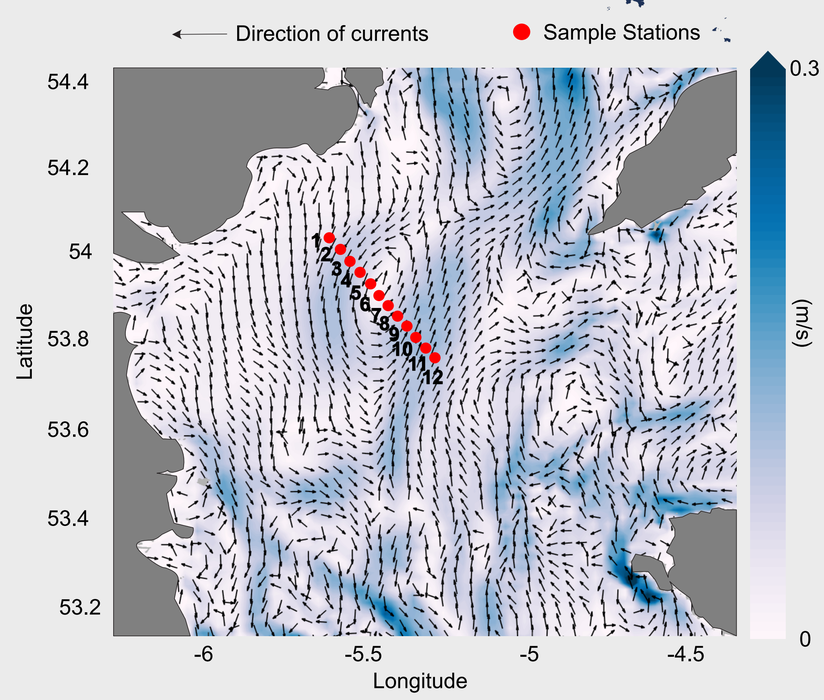


Figure 3: Location of transect through the Western Irish Sea Gyre



SAMPLING METHODS

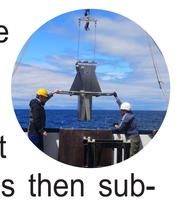
1 SURFACE WATER

Surface water was sampled with a 250 µm Trongo Net, being towed for 3 minutes at each of the 12 sample stations. The samples in the three nets were then transferred to three sample bottles using a 250 µm sieve and filtered seawater.

2 SUBSURFACE WATER

Subsurface waters were sampled at 10m depth across the 12 sample stations with a niskin bottle rosette capturing ~36 litres per station. Samples were concentrated with a 250 µm sieve and filtered seawater.

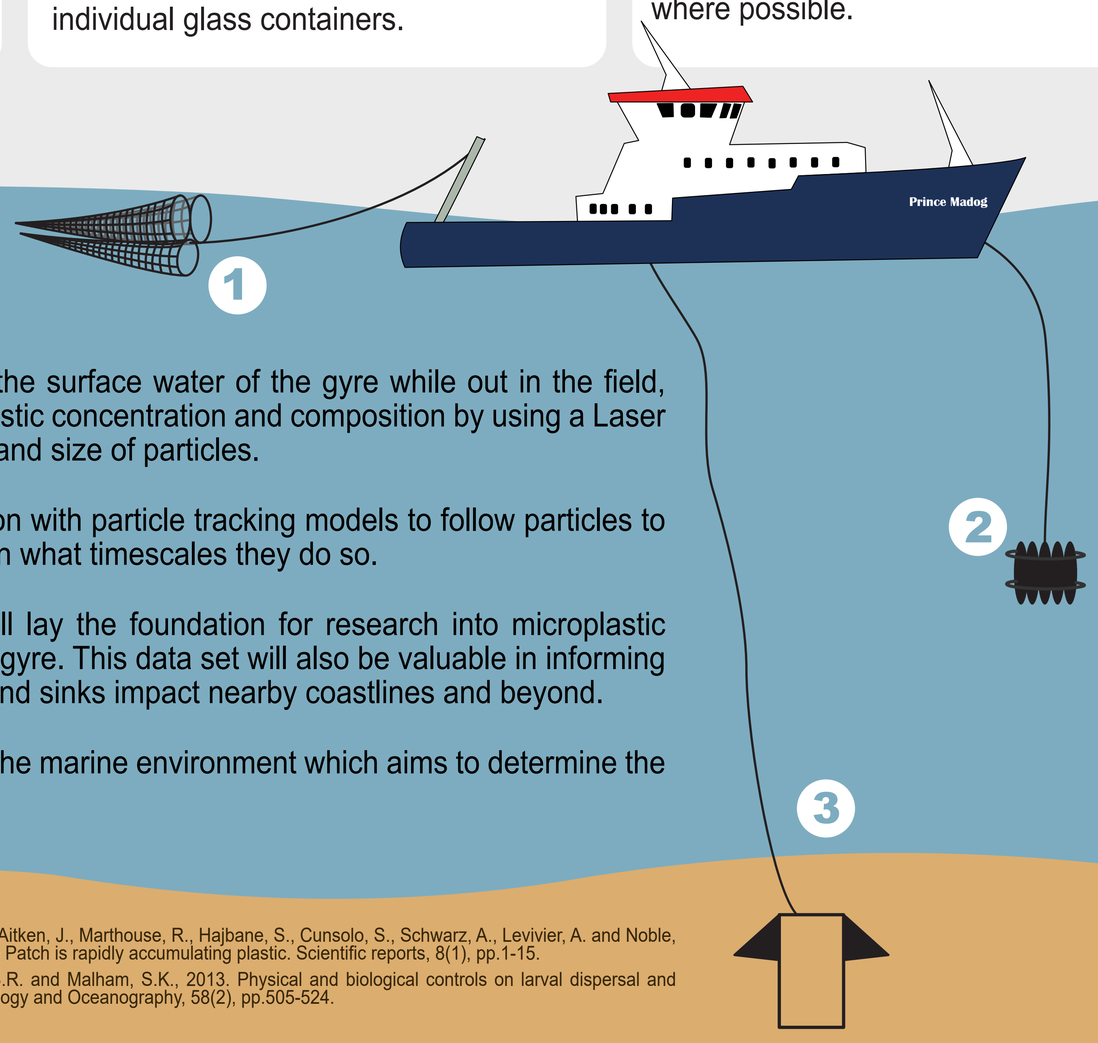
3 SEA BED SEDIMENTS



Three stations were sampled for sea bed sediments using the box corer to maintain sediment structure. Each sample was then sub-sampled on deck at 5, 10 and 15 cm depth respectively and transferred to individual glass containers.

CONTAMINATION CONTROL

Contamination control was maintained throughout the cruise by restricting the number of scientists sampling (2), wearing cotton/well washed clothes to reduce fibre contamination and using glass and stainless steel equipment where possible.



NEXT STEPS

Analysis: Possible microplastic particles as well as larger plastic litter were observed in the surface water of the gyre while out in the field, however more detailed analysis is now underway. The samples will be analysed for microplastic concentration and composition by using a Laser Direct Infrared (LDIR) which willl be able to define the type of plastic as well as the amount and size of particles.

Following this, hydrodynamic models developed by the Met Office will be used in conjunction with particle tracking models to follow particles to see where/if the particles move *en masse* or if they disperse throughout the Irish Sea and on what timescales they do so.

Application: Being able to quanitfy contamination within the Western Irish Sea Gyre will lay the foundation for research into microplastic contamination on a larger shelf sea scale and provide insight into the hydrodynamics of the gyre. This data set will also be valuable in informing future models of how microplastic moves around the region, and how the specific sources and sinks impact nearby coastlines and beyond.

This study is a part of a wider PhD studentship investigating the dispersal of microplastic in the marine environment which aims to determine the spatiotemporal variability of microplastic and the pathways from estuaries to shelf seas.

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References

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Robins, P.E., Neill, S.P., Giménez, L., Jenkins, S.R. and Malham, S.K., 2013. Physical and biological controls on larval dispersal and connectivity in a highly energetic shelf sea. Limnology and Oceanography, 58(2), pp.505-524.