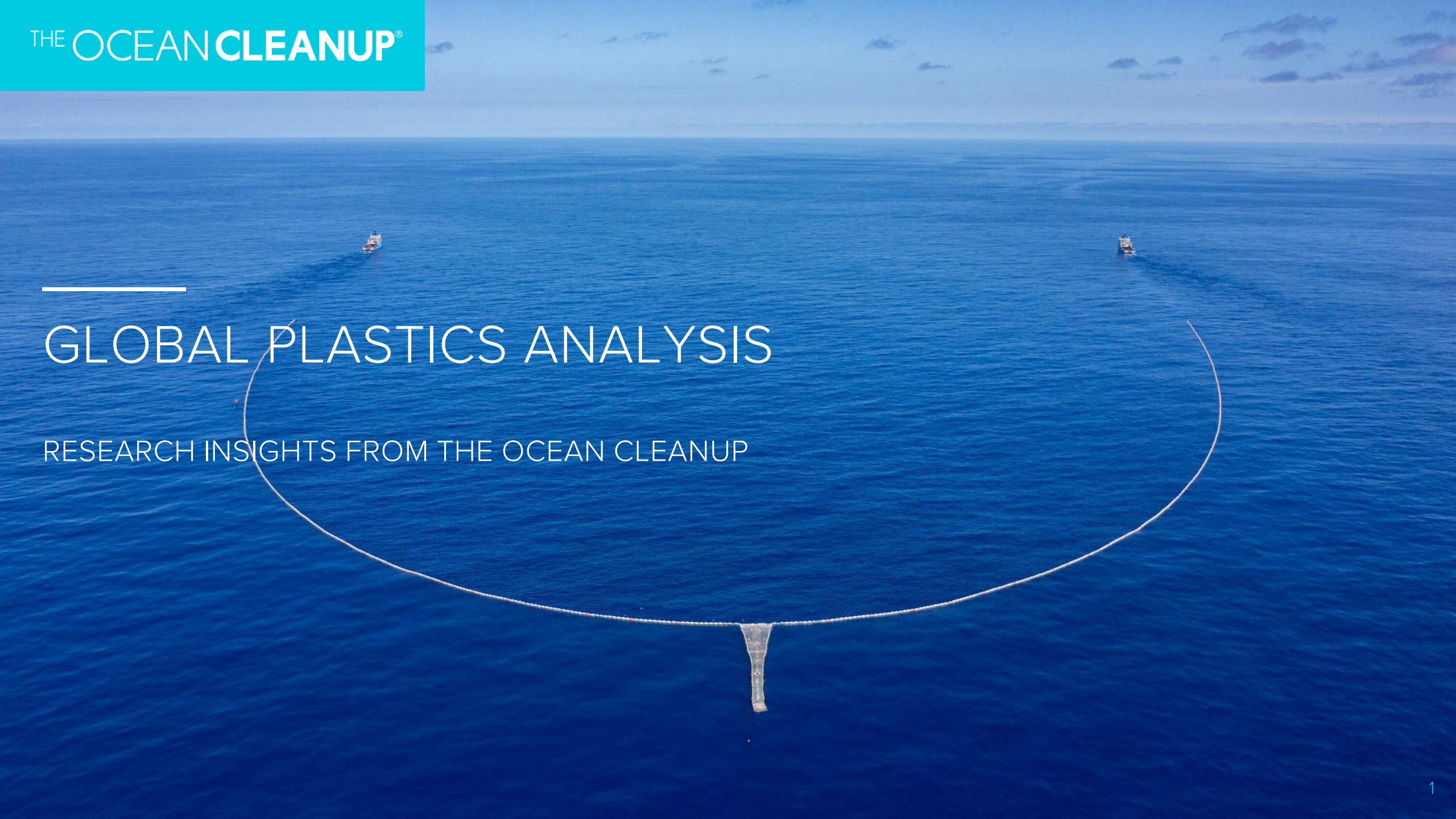
THE OCEAN CLEANUP®

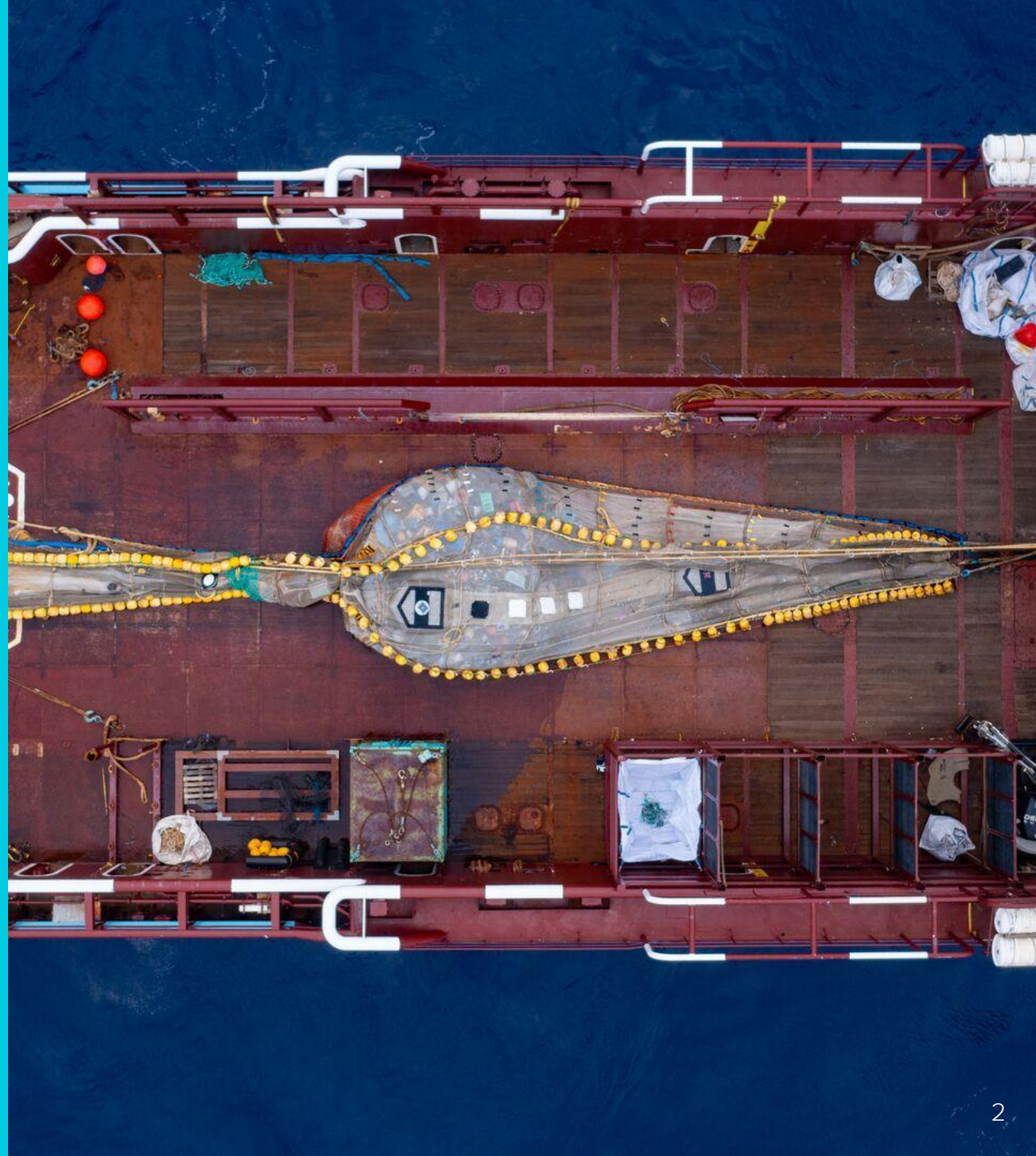


GLOBAL PLASTICS ANALYSIS

RESEARCH INSIGHTS FROM THE OCEAN CLEANUP

1

THE OCEAN CLEANUP



SYSTEM CONFIGURATIONS

SYSTEM 03

- 2.2 km total length
- 4 m deep
- 16 mm x 16 mm netting

RETENTION ZONE

- 10 mm x 10 mm inner netting
- 50 mm x 50 mm outter netting

DESIGN

- LED lights
- Acoustic deterrents
- Camera skiff connected to underwater cameras
- Access to air
- Escape aids
- Emergency release

MITIGATION MEASURES

OPERATIONAL

- Slow towing speed (<2.5 knots)
- Minimal acoustic energy and night-time lighting
- Smart steering strategy (avoid specific sea surface temperatures)
- Minimal environmental impact operation mode activated upon sighting of animal
- Emergency plastic extraction if animal observed in distress

MONITORING

- Onboard protected species observers
- Cameras (underwater and vessel mounted)
- Drone surveys
- Manta trawls to monitor impacts on plankton and neuston
- Incidental catch analysis after each extraction

2

GLOBAL PLASTICS MONITORING

RESEARCH TOOLBOX

	Method	Scientific output
1.	Manta trawl	Concentrations of plastics > 0.5cm, Composition of plastics & neuston > 0.5cm
2.	Mega trawl	Calculate concentrations of plastics > 5 cm
3.	ADIS cameras	Automated detection of plastics > 50 cm Potential to aid in detection of ghost nets
4.	Plastic survey app	Calculate concentrations of plastics > 5 cm and report on common or problematic items
5.	Visual observations	Understand the presence of marine megafauna in relation to plastic densities

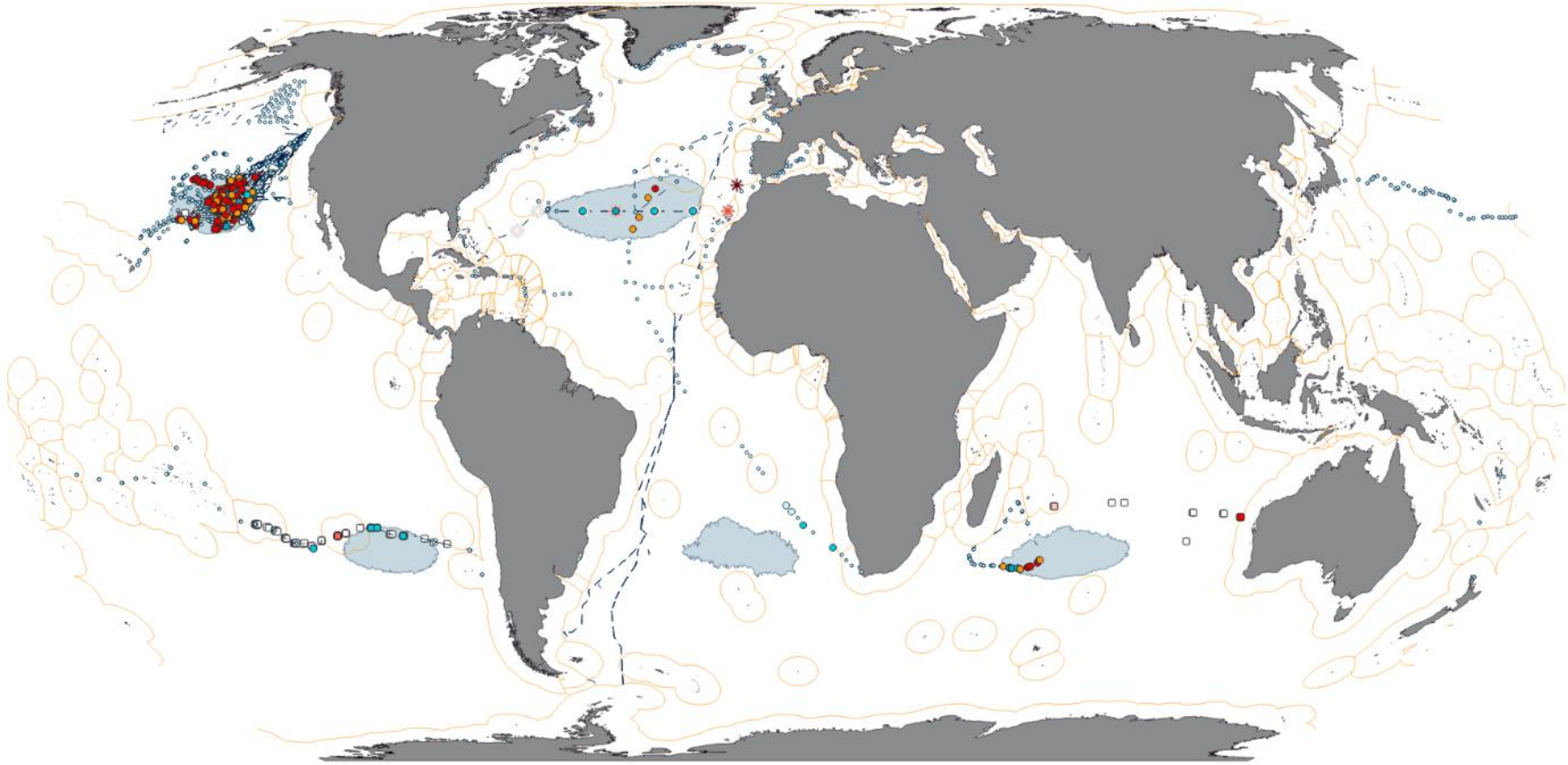
HOW WE DO OCEAN RESEARCH

Credit: NIOZ MNF

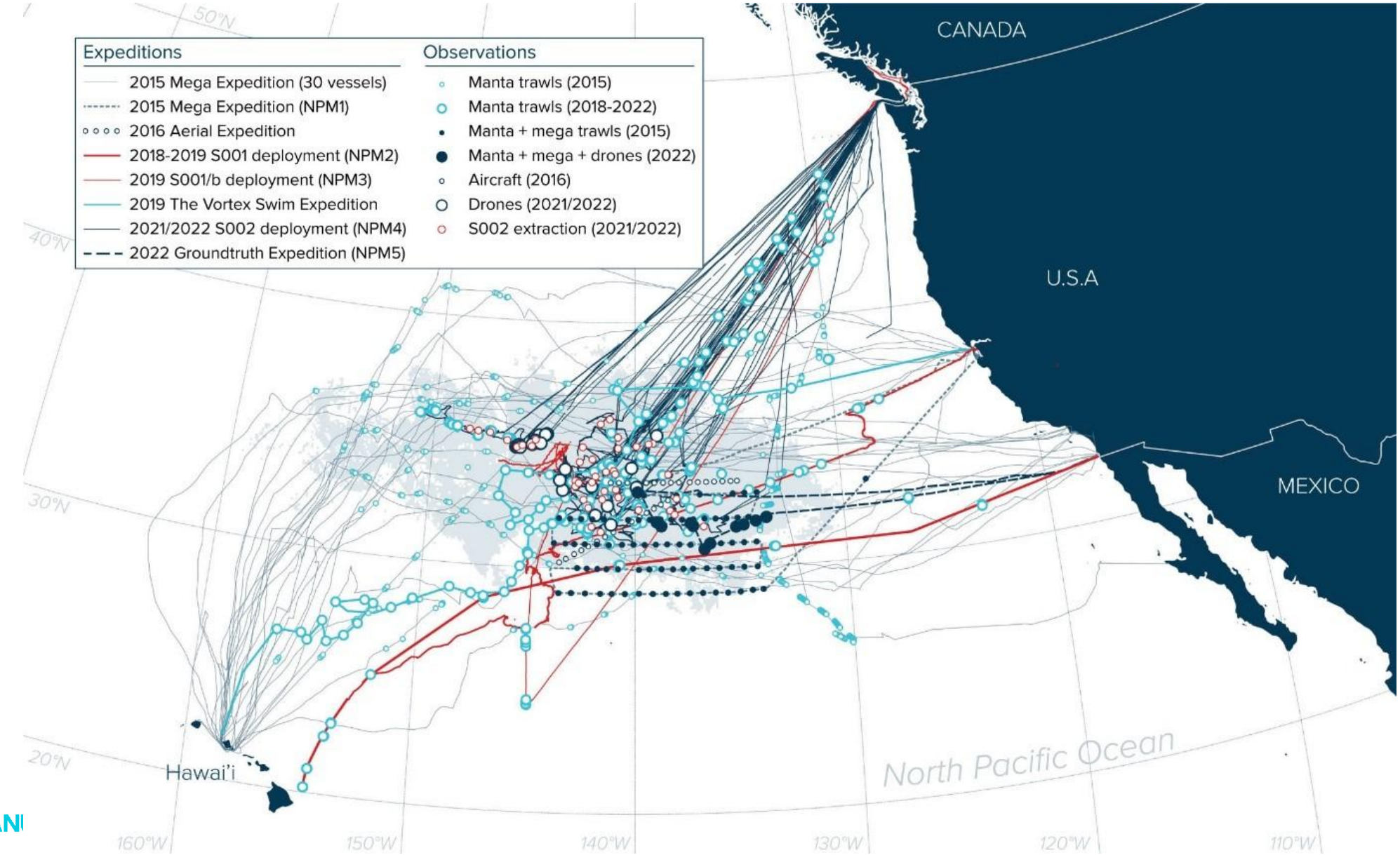

Credit: Mission Nerrivik

OVERVIEW

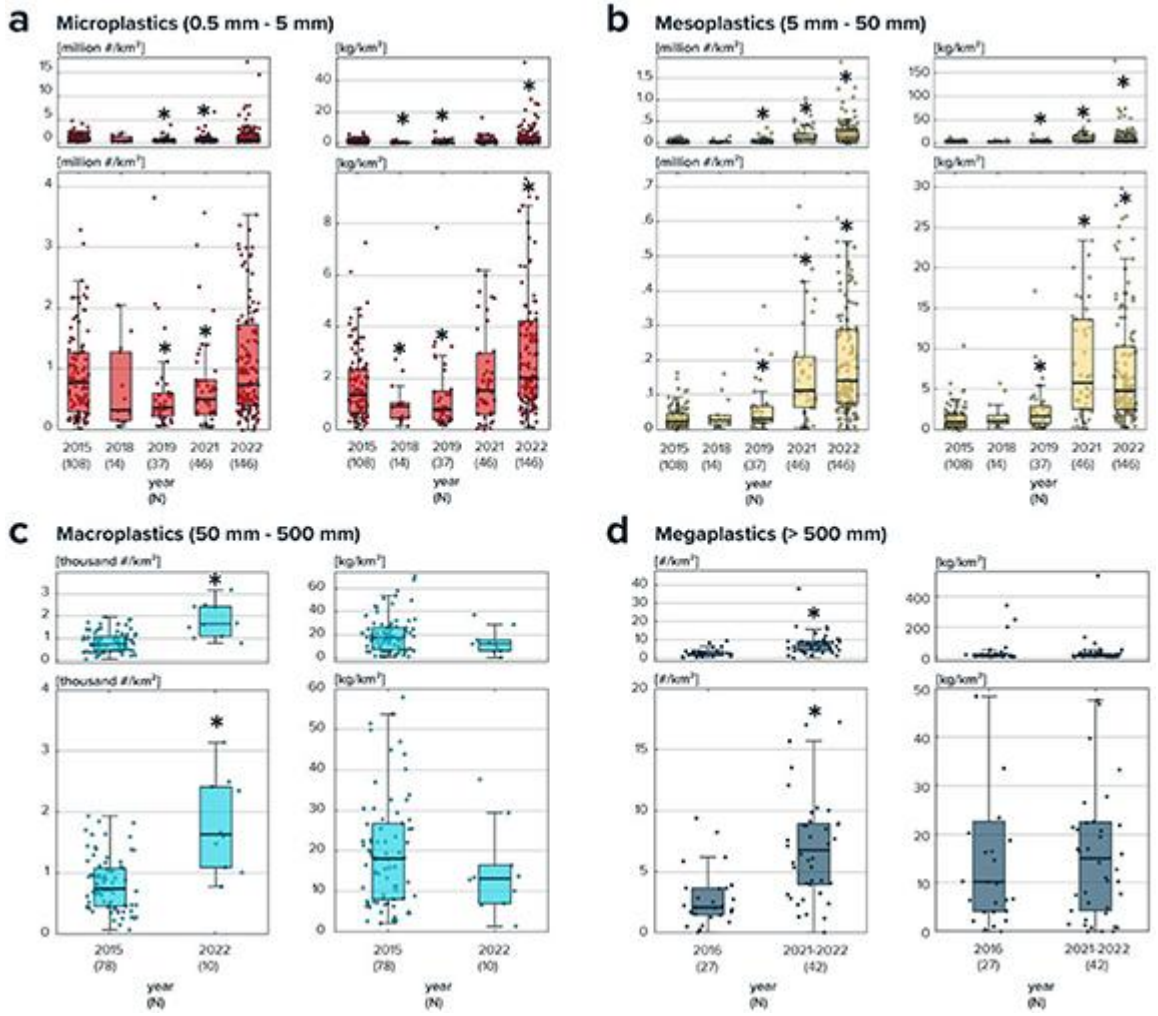
Ocean/Gyre	Manta	Mega	ADIS	Visual Survey
North Pacific	9 missions	2 missions	10+ crossings	10+ crossings
South Pacific	1 mission	-	1 crossing	1 crossing
North Atlantic	4 missions	1 mission	2 crossings	1 crossing
South Atlantic	1 mission	-	-	-
Indian	1 mission	-	1 crossing	1 crossing



OVERVIEW - GPGP



OVERVIEW - GPGP



ENVIRONMENTAL RESEARCH
LETTERS

LETTER

Seven years into the North Pacific garbage patch: legacy plastic fragments rising disproportionally faster than larger floating objects

Laurent Lebreton*, Robin de Vries, Yannick Pham, Helen Wolter, Marjolein van Vulpen, Peter Puskic, Bruno Sainte-Rose, Sarah-Jeanne Royer and Matthias Egger
The Ocean Cleanup
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Keywords: plastic pollution, North Pacific garbage patch, ocean plastics
Supplementary material for this article is available online

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Abstract
The North Pacific garbage patch has accumulated floating plastic pollution for several decades. The Ocean Cleanup, a not-for-profit organization that works to retrieve this floating plastic, has conducted systematic surveys in the North Pacific Subtropical Gyre since 2015. The dataset, now spanning seven years, includes the deployment of trawls of varying sizes and the collection of aerial imagery. Here, we report a synthesis of these measurements and highlight an unexpected rise in mass concentration of plastic fragments (0.5–50 mm, from 2.9 kg km^{-2} in 2015 to 14.2 kg km^{-2} in 2022), increasing at a faster rate than that of larger items (>50 mm). With a mass balance model, we show that a substantial fraction of this material (74%–96%) is new to the region and does not result from the degradation of larger items that were already present in these waters seven years ago. Instead, we hypothesise it is the signature of the degradation and transport processes of legacy floating plastic pollution left accumulated in the global marine environment for the past decades.

1. Introduction

As member states of the United Nations are currently negotiating the outline of a legally binding treaty to end plastic pollution, including in the marine environment, the global environmental crisis triggered by exponentially increasing plastic production and the mishandling of the resulting waste, is worsening (OECD 2022). The North Pacific garbage patch (NPGP) in the North Pacific Subtropical Gyre perfectly illustrates the situation. Here, persistent floating plastics, after years of traveling from distant sources, have been accumulating and their number have been surpassing those of living organisms (Moore *et al* 2001, Egger *et al* 2021, 2024). This pollution threatens the local ecosystem with the ingestion of plastic by marine life (Savoca *et al* 2022) and the entanglement of numerous species (Høiberg *et al* 2022) adding to effects on zooplankton grazing resulting in potential impacts on the global carbon cycle (Richon *et al* 2024). The North Pacific Subtropical Gyre is also home to floating life known as neuston (Egger *et al* 2021, 2024, Chong *et al* 2023). Because of the presence and accumulation of floating plastics, these open ocean species are now in direct competition with a new community rafting on debris composed of various coastal species (García-Gómez *et al* 2021, Haram *et al* 2021, Póvoa *et al* 2021). The long-term ecological and environmental impacts of the presence of this neo-pelagic community on high sea biodiversity are largely unknown.

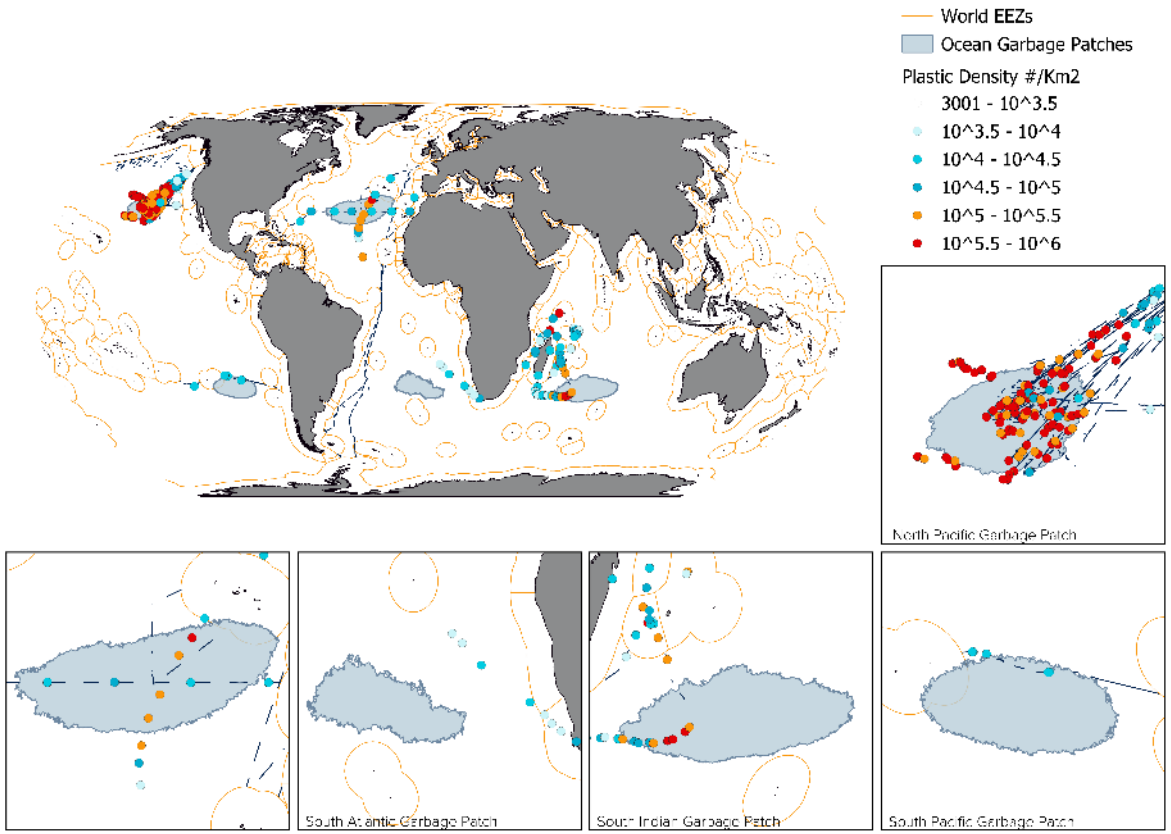
There have been several observational attempts at quantifying the extent of plastic pollution in the NPGP (Cozar *et al* 2014, Eriksen *et al* 2014, Law *et al* 2014). A comprehensive assessment was presented in 2018 with field observations from 2015 and 2016, combining various sampling methods targeting simultaneously different plastic sizes to draw a wider picture of the composition and extent of the accumulated debris (Lebreton *et al* 2018). The study

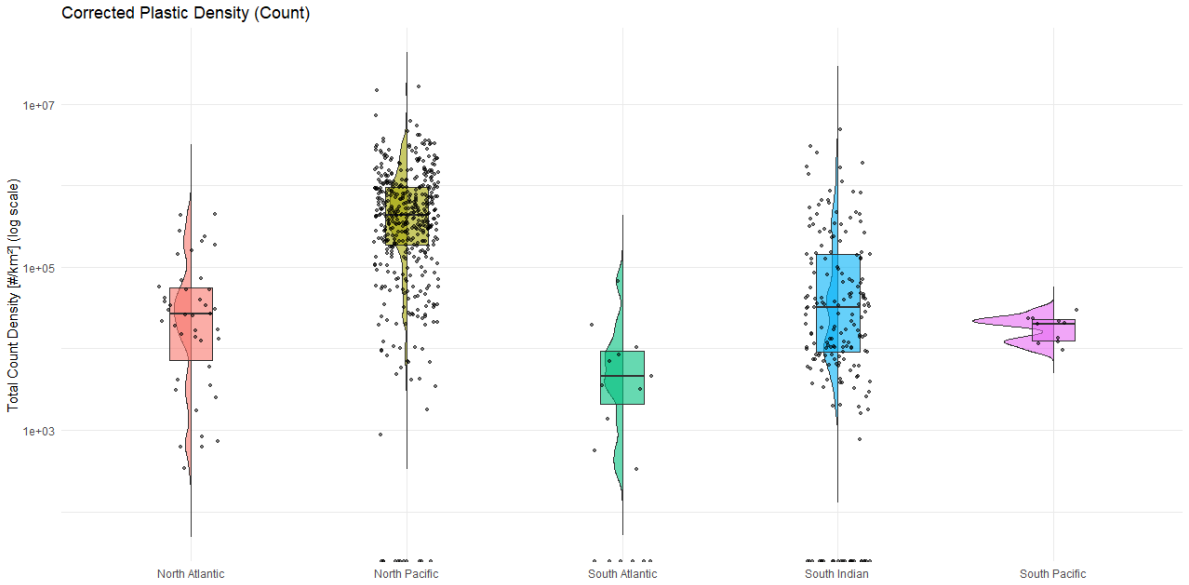
MANTA TRAWLS

- The dataset comes from The Ocean Cleanup Survey app and includes visual survey records collected across several gyres, through both citizen science projects and targeted projects.

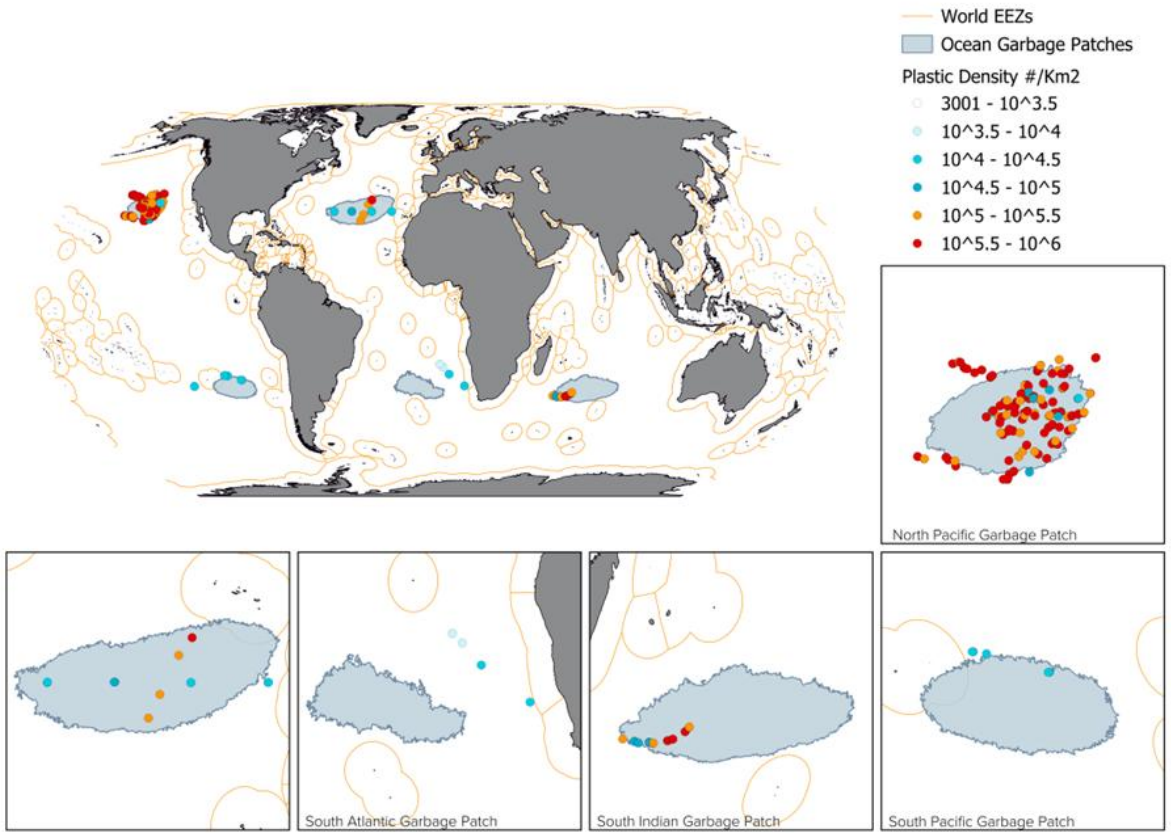
Ocean	Basin	Dataset Name	Collection Year
Pacific			
	North	NPM1/Mega	2015
		NPM2	2018
		Longest Swim	2019
		NPM3	2019
		Vortex Swim	2018
		NPM4	2022
		NPM5	2022
		NPM6	2023
		NPM7	2024
	South	SPM1	2024
Atlantic			
	North	Trans-Atlantic	2019
		NAM3/PE480	2020
		NAM4	2023
		Bark Europa	2025
	South	Trans-Atlantic	2019
		Bark Europa	2025
Indian			
	South	SPM1	2022

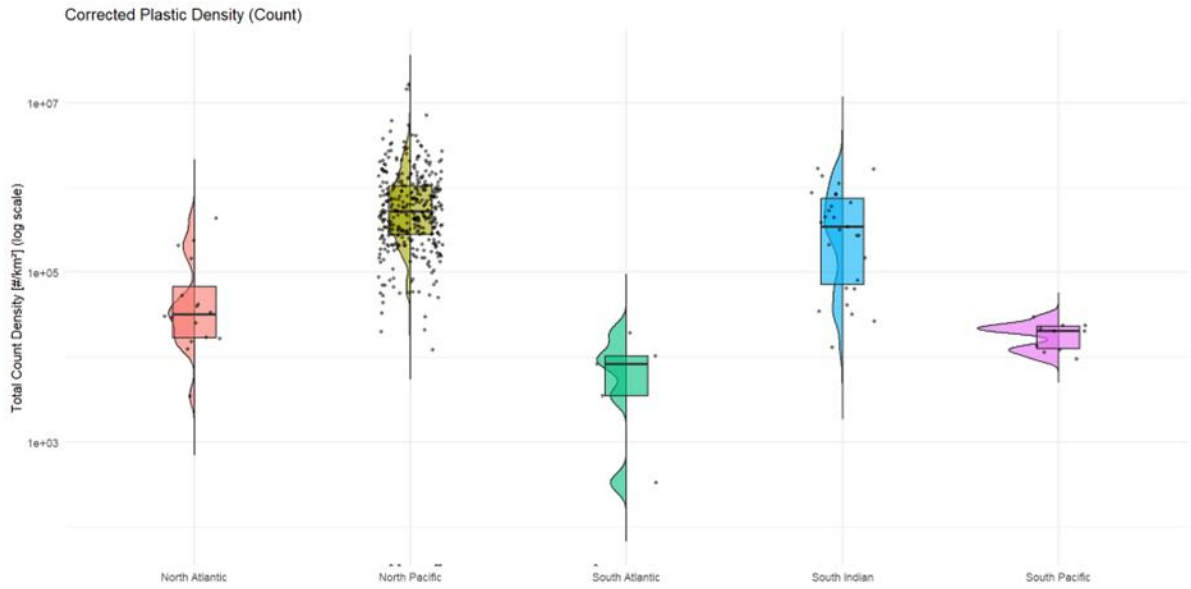
GLOBAL OCEAN





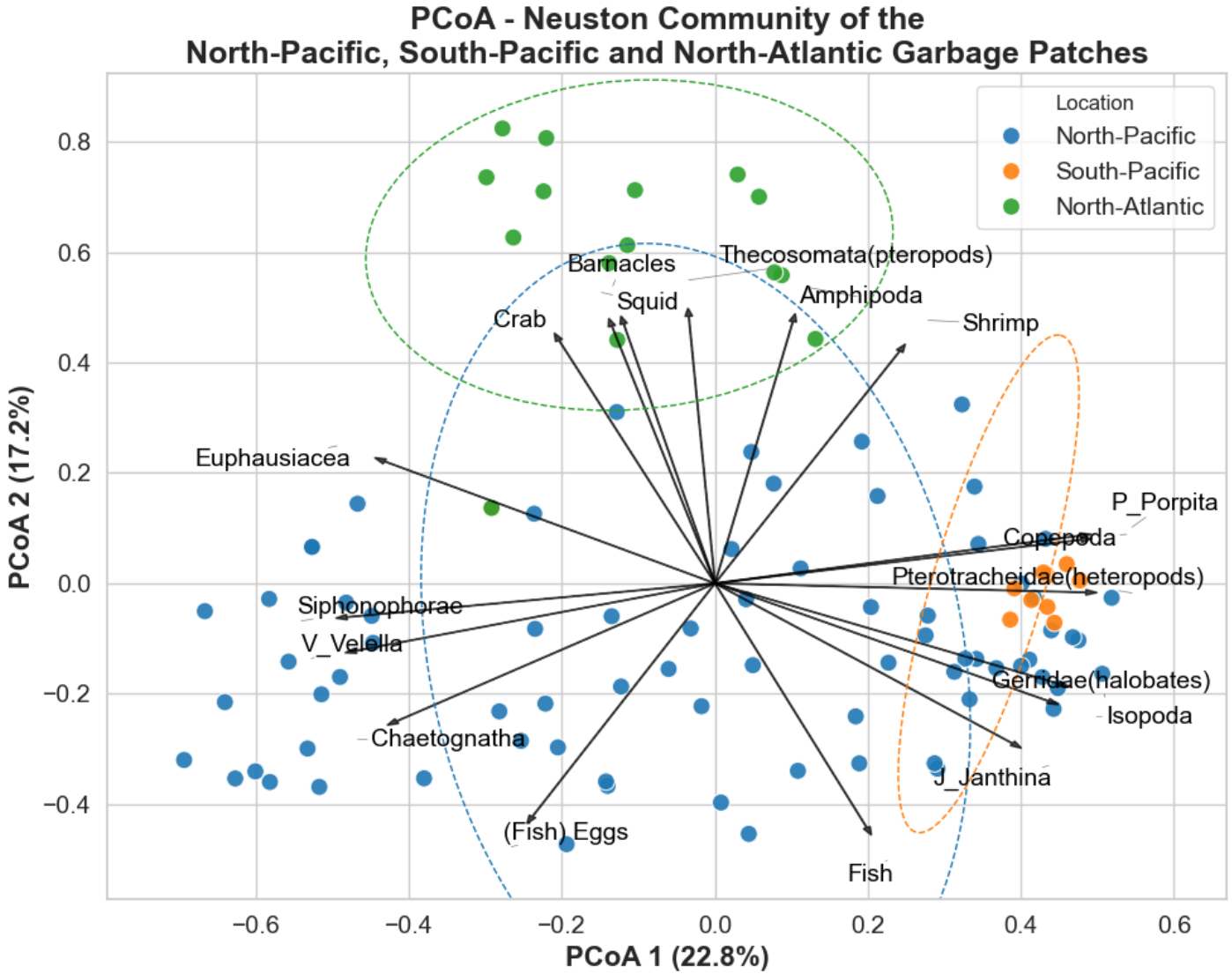
GYRES ONLY


World EEZs
Ocean Garbage Patches
Plastic Density #/Km2
3001 - 10^3.5
10^3.5 - 10^4
10^4 - 10^4.5
10^4.5 - 10^5
10^5 - 10^5.5
10^5.5 - 10^6
North Pacific Garbage Patch
South Atlantic Garbage Patch
South Indian Garbage Patch
South Pacific Garbage Patch


Corrected Plastic Density (Count)
Total Count Density [#/km²] (log scale)
1e+07
1e+05
1e+03
North Atlantic
North Pacific
South Atlantic
South Indian
South Pacific

UNDERSTANDING NEUSTON

- Describing the ecosystems of the garbage patches
- Comparing plankton and marine life across oceans.
- Previous research shows no link between plastic and neuston densities



2. MEGA TRAWL

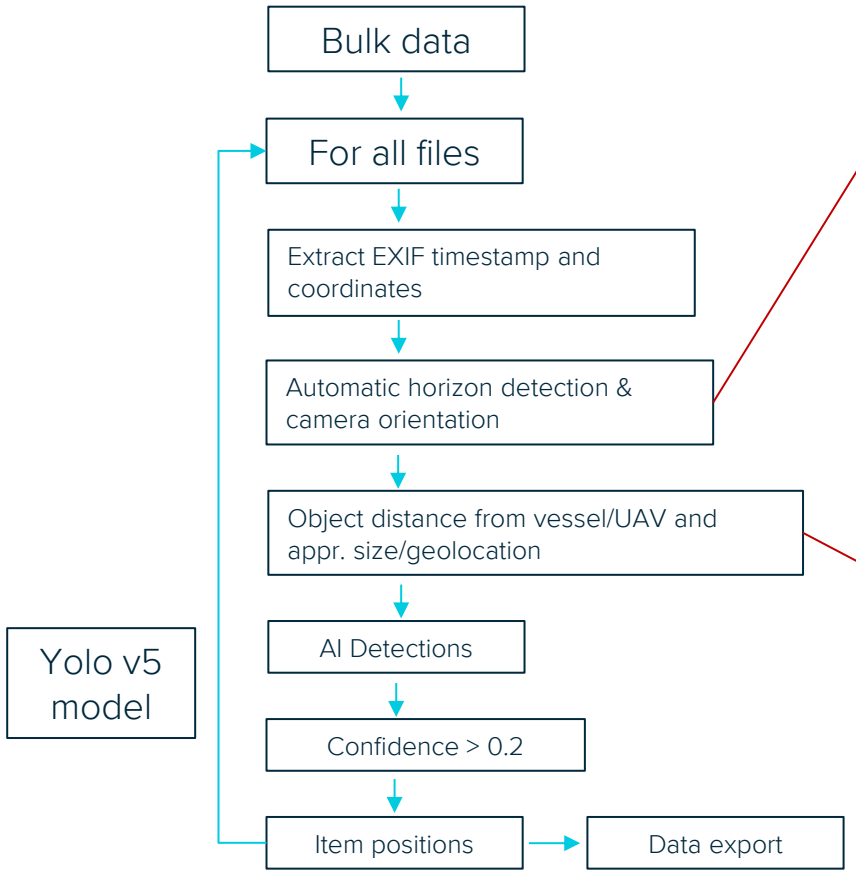
- 90min surface water trawl
- Concentrations of plastics > 5cm
- Rapid sample collection to data analysis pipeline
- Requires vessel with A-frame
- Manta trawls can be done in tandem.

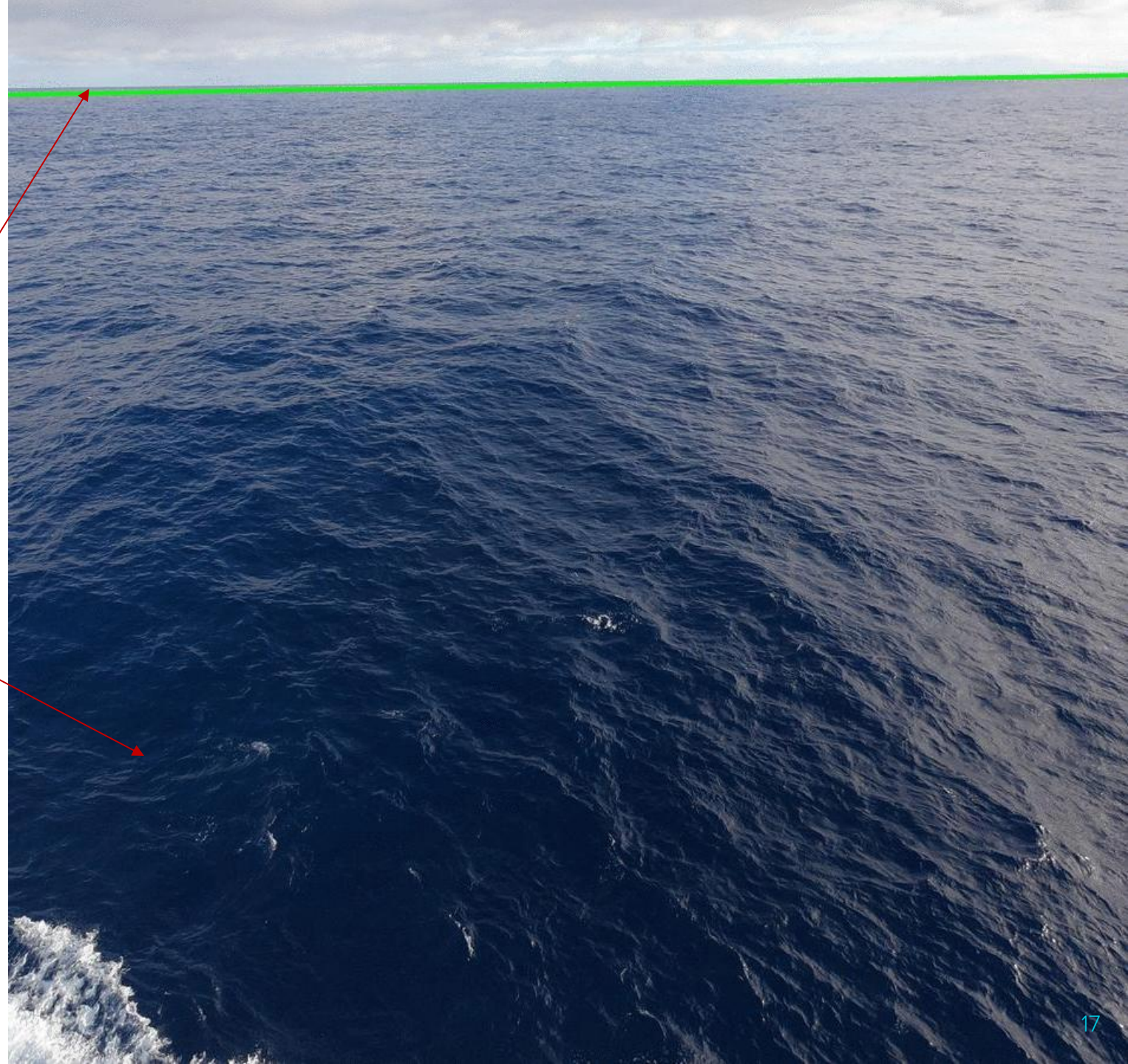
AUTOMATED DEBRIS IMAGING SYSTEM (ADIS)

- ADIS cameras take timelapse photography of the sea surface
- AI detection of plastics. Data sent back to The Ocean Cleanup HQ for analysis.
- To be mounted on railing or mast facing the water.
- *Requires constant power source.
- Each unit is approximately 12 x 12 x 8 cm.
- Each ADIS sensor weighs approximately 400 g.

EXAMPLES OF DETECTED OBJECTS

PROCESSING **METHOD**

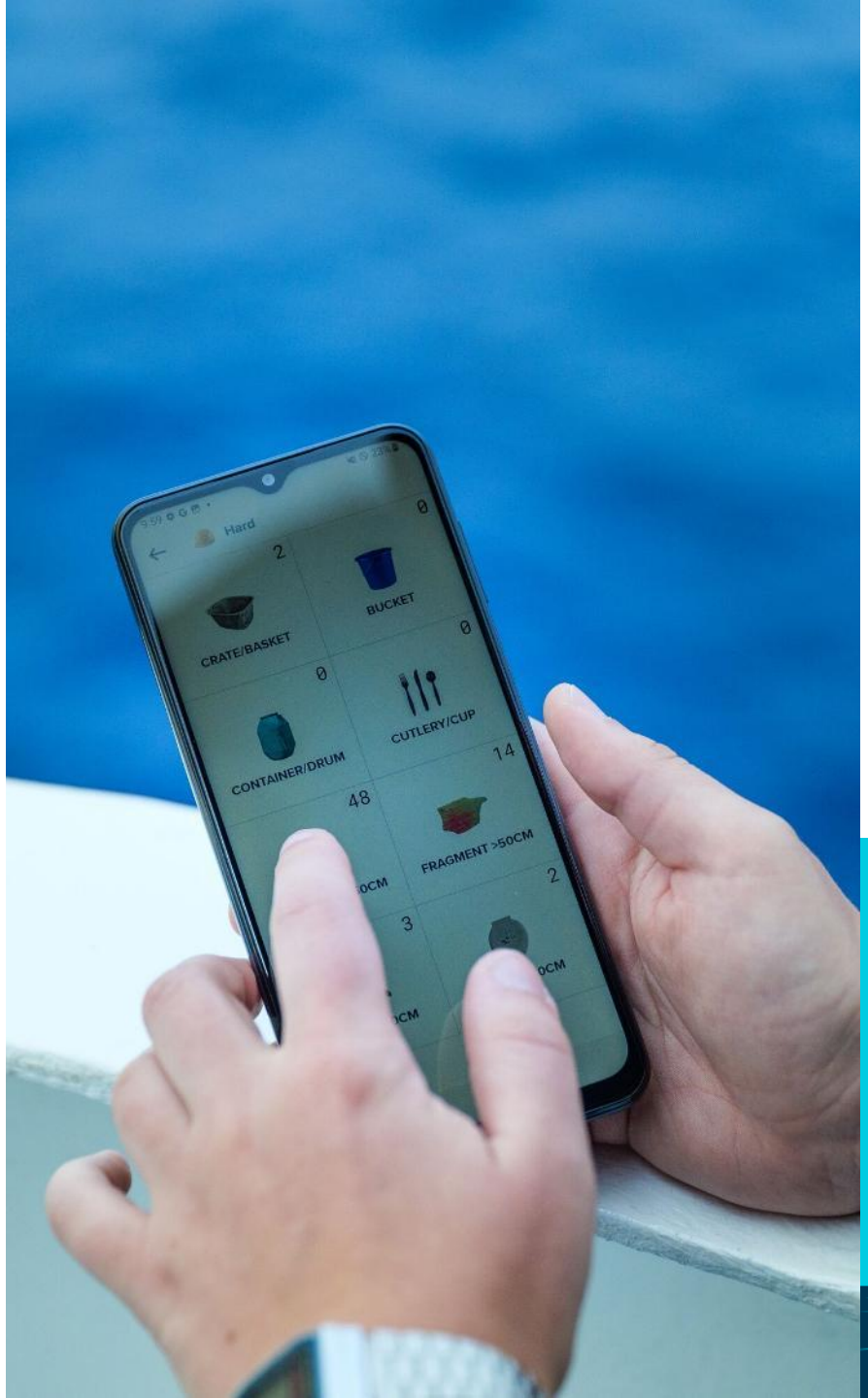


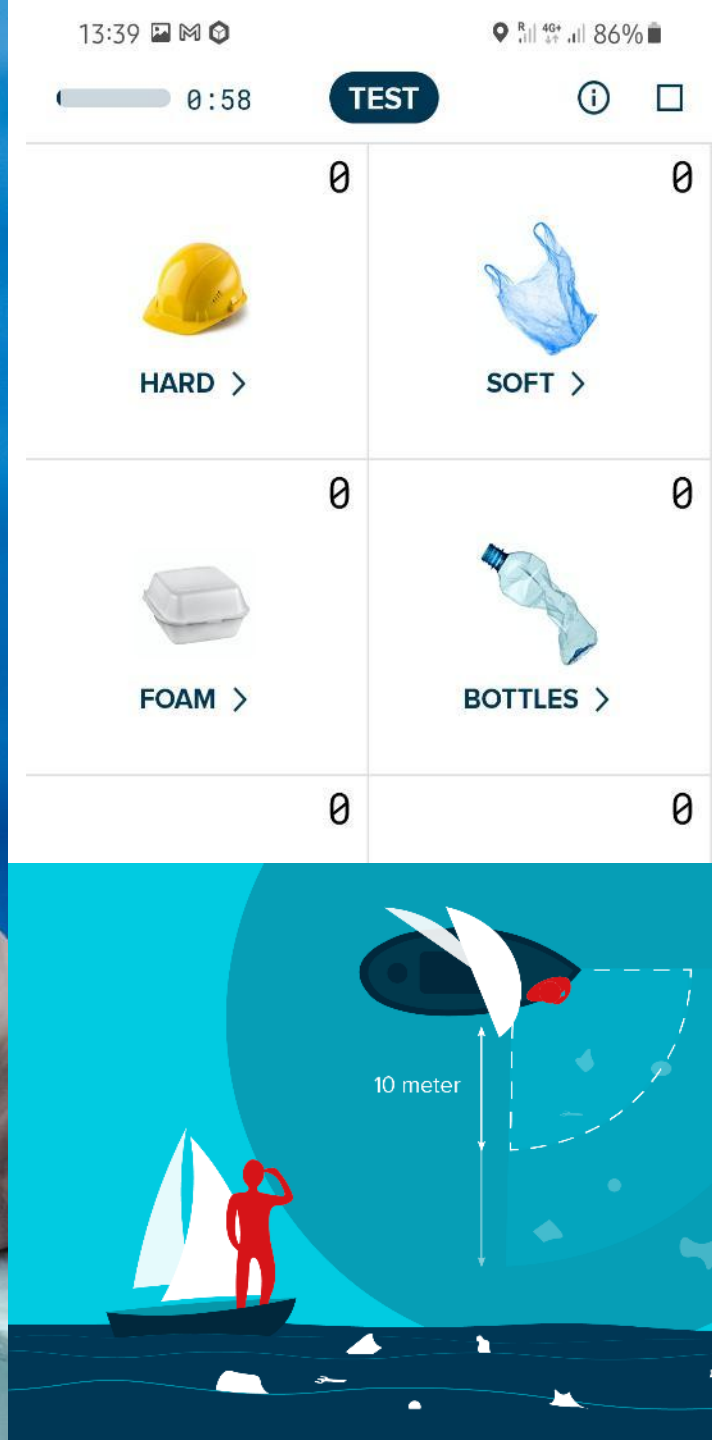


4. PLASTIC SURVEY APP

- The dataset comes from The Ocean Cleanup Survey app and includes visual survey records collected across several gyres, through both citizen science projects and targeted projects.

- We have 163 Ocean Survey Users and over 1145 Surveys!

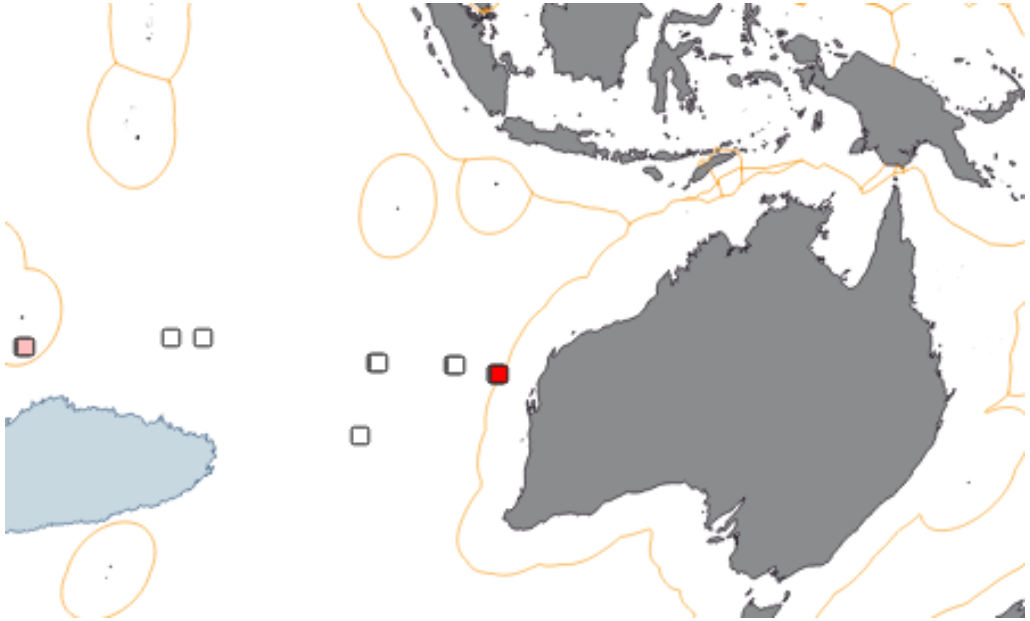


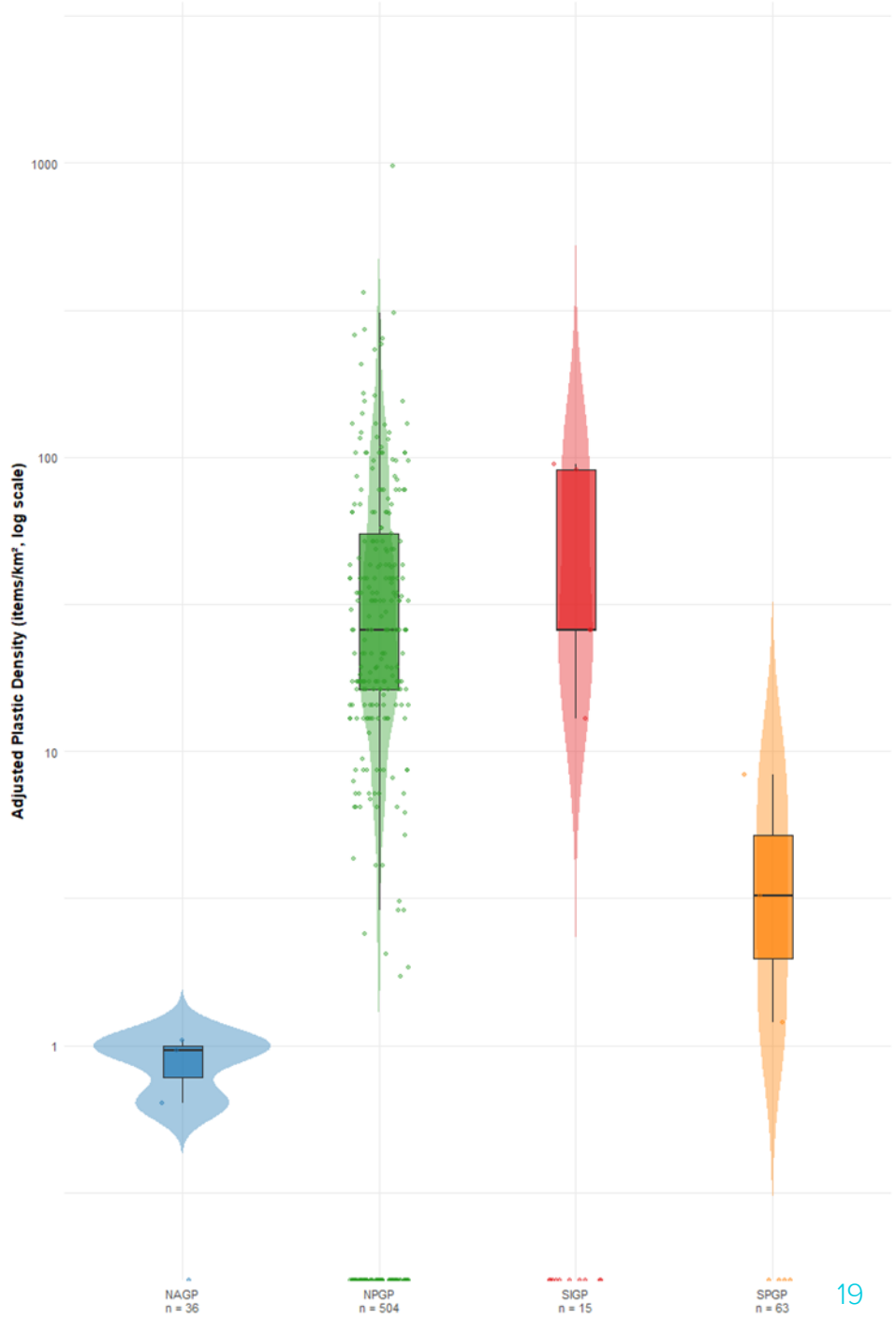


4. PLASTIC SURVEY APP

- Adjusted plastic densities (per Km2) accounting for sea-state and platform height, then log scale.

- SIGP appears high due to a few points near Aus and Reunion Island, assumed to be due to proximity to coasts.





3

CITIZEN SCIENCE

CITIZEN SCIENCE

HIGHLY ENGAGED MARINE USERS

1. Has specific skills necessary to access ocean environments (e.g. scuba diving, sailing, surfing);
2. Has access to specific equipment necessary to reach ocean environments (e.g. vessels or water sports equipment);
3. Has access to ocean areas for their recreational endeavours and professional water sport activities;
4. Their ocean use is sustainable and non-destructive.

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ELSEVIER

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Highly engaged marine users can help monitor marine plastic pollution in under accessed environments

Peter S. Puskic [a b c], Isabelle Cramer [a], Emma Church [b c], Emily Deery [d], Matthias Egger [a e], Natalie Fox [f], William P. de Haan [g], Laurent Lebreton [a h], Arianna Liconti [i], Anna Sanchez-Vidal [g], Helen Wolter [a]

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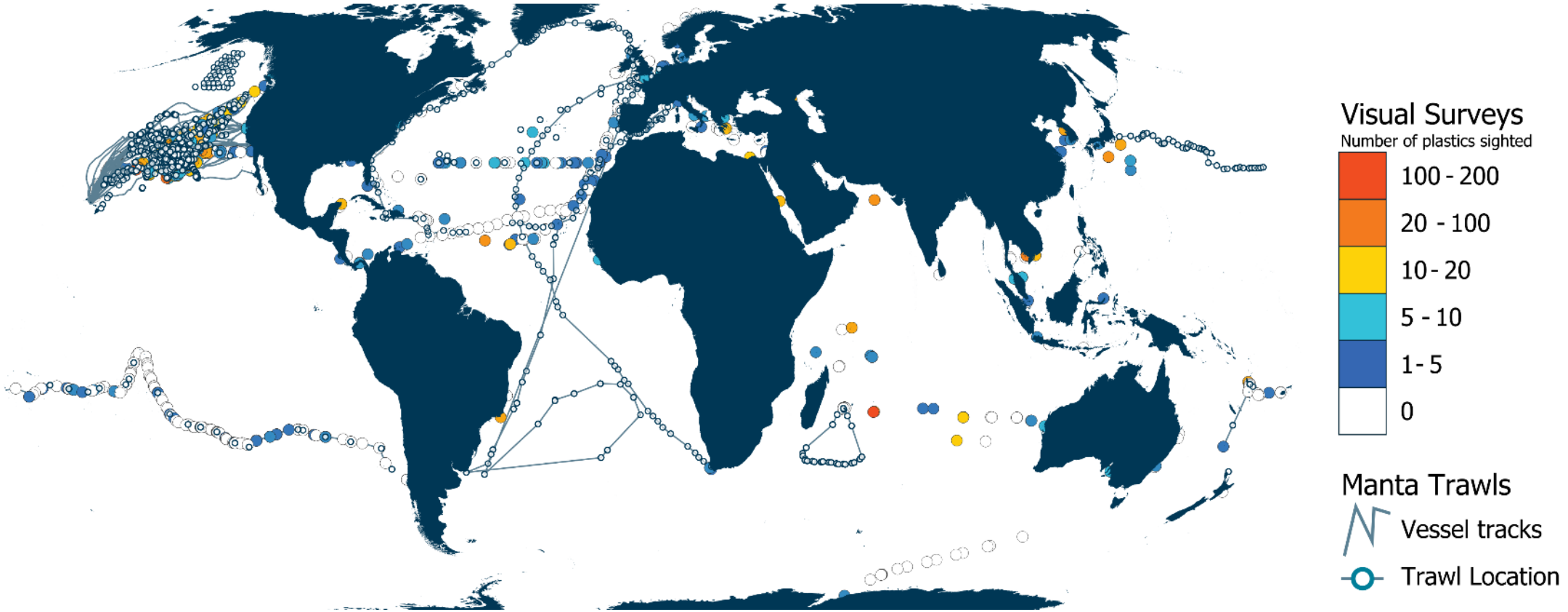
Highlights

- Highly engaged marine users can monitor plastic pollution in difficult-to-access environments.
- These users contribute to both data generation and increased ocean stewardship.
- Engaging surfers, divers, and seafarers supports UN Ocean Decade and Plastics Treaty goals.
- Institutional support for highly engaged marine users enhances marine monitoring and policy outcomes.

HIGHLY ENGAGED MARINE USERS



4

NEXT STEPS

CONSIDERATIONS AND NEXT STEPS

- Continued monitoring of the North Pacific Garbage Patch.
- Continued work in the other 4 ocean gyres.
- Making data more accessible (AOMI, EDMODNET).

- Finding databases for data on large stuff.
- Colour, shape and other 2D characteristics.
- Focus of most databases on microplastics.
- Data repositories for biological data.

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