20th PACIFIC CUP
The FUN Race to Hawaii

Plastic Particle Pollution (Microplastics) – An Emerging Environmental Threat

Perceptually Invisible, Numerically Significant

…..And why every sailboat race should be a scientific expedition!

CDR Bill Robberson, P.E.
US EPA Region 9 – San Francisco, CA

United Nations Environment Programme (UNEP)

51 trillion microplastics litter the seas……. up to 80 per cent of all litter in the oceans are made of plastic.

According to estimates, by 2050, 99 per cent of earth's seabirds will have ingested plastic

An illustration of the sheer magnitude of the problem is that as much as 51 trillion microplastic particles – 500 times more than stars in our galaxy – litter the seas.

Each year, more than eight million metric tonnes of plastic end up in oceans, wreaking havoc on marine wildlife, fisheries and tourism, and cost at least $8 billion in damage to marine ecosystems. According to estimates, by 2050, oceans will have more plastic than fish if present trends are not arrested.

USCG C-130 Aircraft preparing 01/17/12 for overflight in the vicinity of Midway Atoll. Observers from USEPA, NOAA and USFWS on board flight

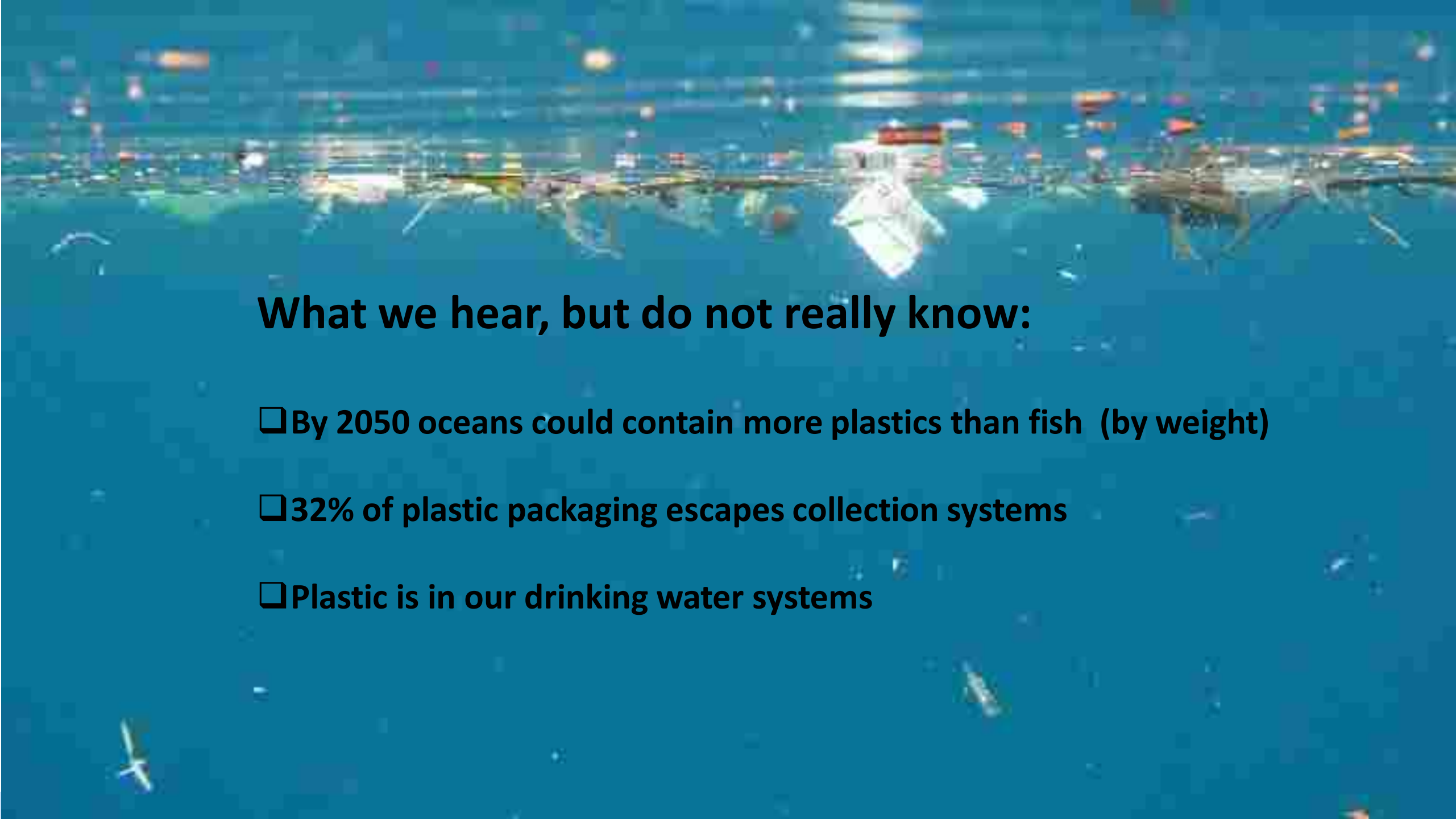
- **Midway Atoll is home to more than 2 million Albatross and thousands of other birds.**
- **The island is inundated with plastic pollution which washes up from the North Pacific Gyre.**
- **An additional 10,000 lbs/year is estimated to be brought to the island by adult birds mistakenly feeding it to their chicks as food.**

Occurrence of plastic particle pollution in the environment

- **It is generally accepted that the majority of plastic pollution originates from land-based sources.**
- **Every piece of “macro” plastic entering the aquatic environment is destined to fragment into smaller and smaller particles which will either be ingested by birds, fish and other wildlife, or which will sooner or later sink to the bottom of the waterbody.**
- **Samples from all rivers, lakes, harbors, seas, oceans and even the polar ice caps have demonstrated the presence of plastic particles.**

What we know:

- ❑ Plastic production continues to increase exponentially, doubling over the next 20 years and almost quadrupling by 2050
- ❑ Recycling rates for plastic over the last forty years remain stagnant at less than 10% globally



What we hear, but do not really know:

- By 2050 oceans could contain more plastics than fish (by weight)
- 32% of plastic packaging escapes collection systems
- Plastic is in our drinking water systems

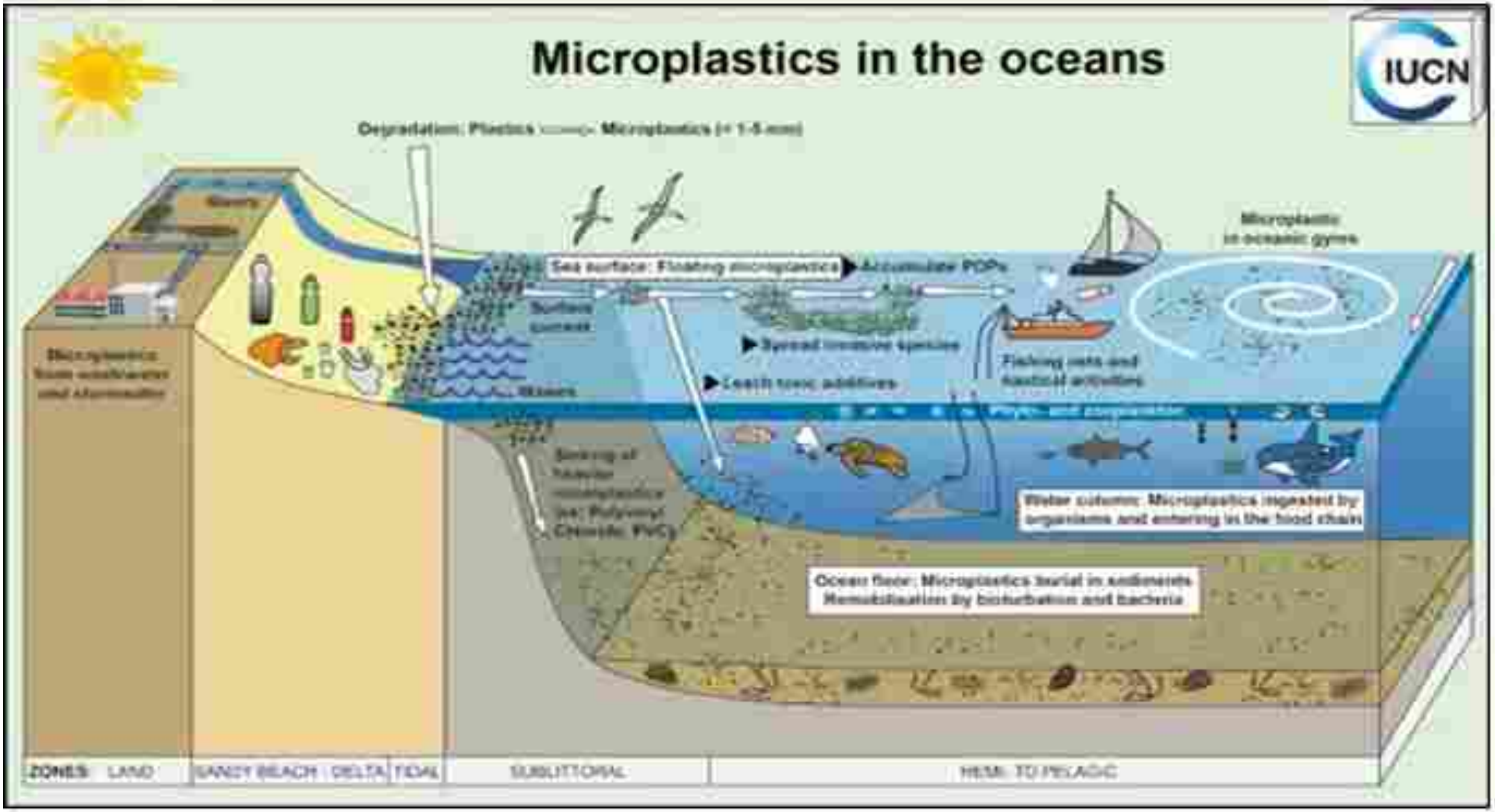
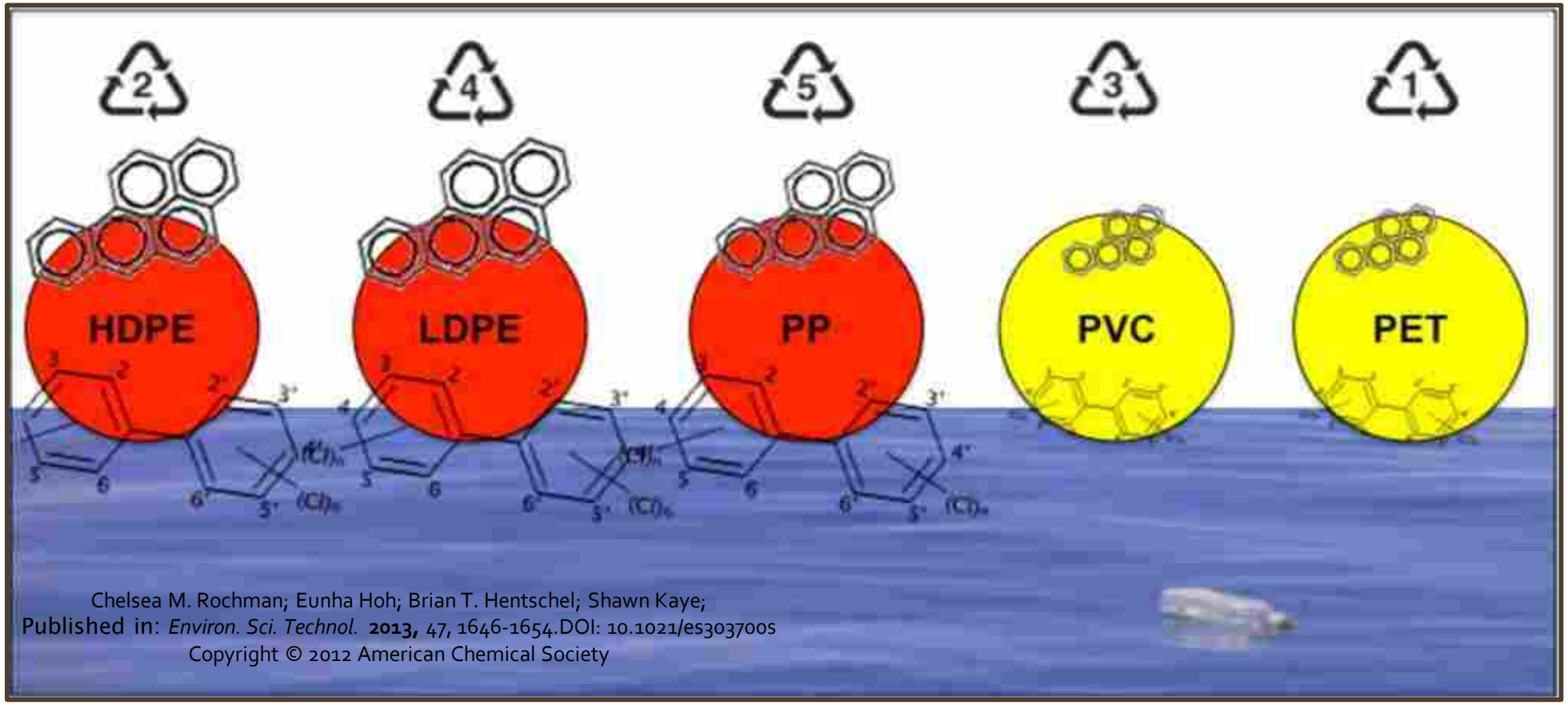


Figure 1.4: Schematic drawing showing the main sources and movement pathways for plastics debris in the oceans (Source: Florian Thevenon).



Chelsea M. Rochman; Eunha Hoh; Brian T. Hentschel; Shawn Kaye;
Published in: *Environ. Sci. Technol.* **2013,** 47, 1646-1654.DOI: 10.1021/es3037005

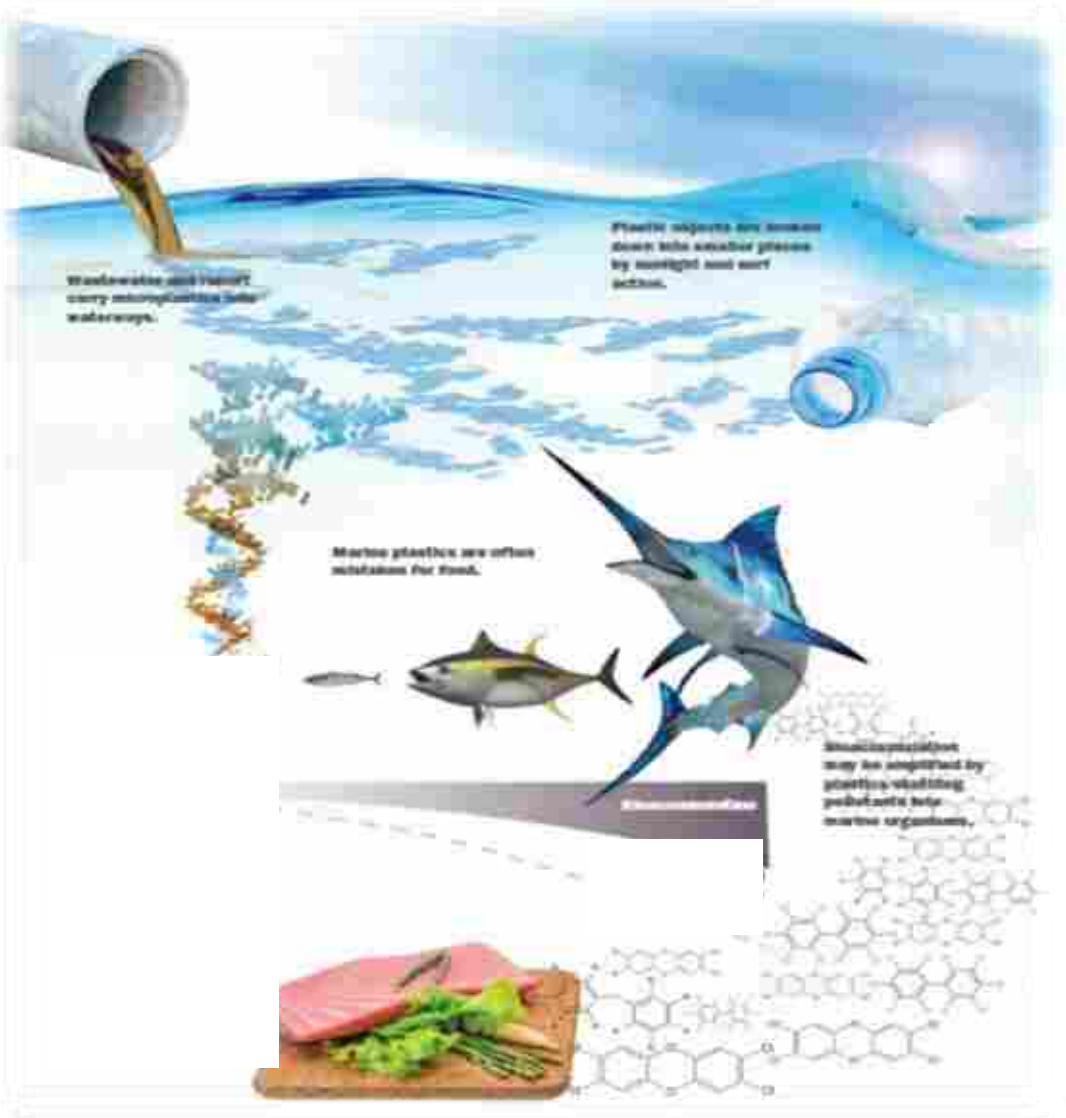
Plastic is not inert: particles readily sorb and hyper-accumulate Persistent Organic Pollutants/Persistent Bioaccumulative Toxic chemicals from the surrounding water environment, concentrating these contaminants by orders of magnitude. Often contaminants are present on plastic particles at levels 1,000 to 1,000,000 times higher than the concentrations of those chemicals in the surrounding water.

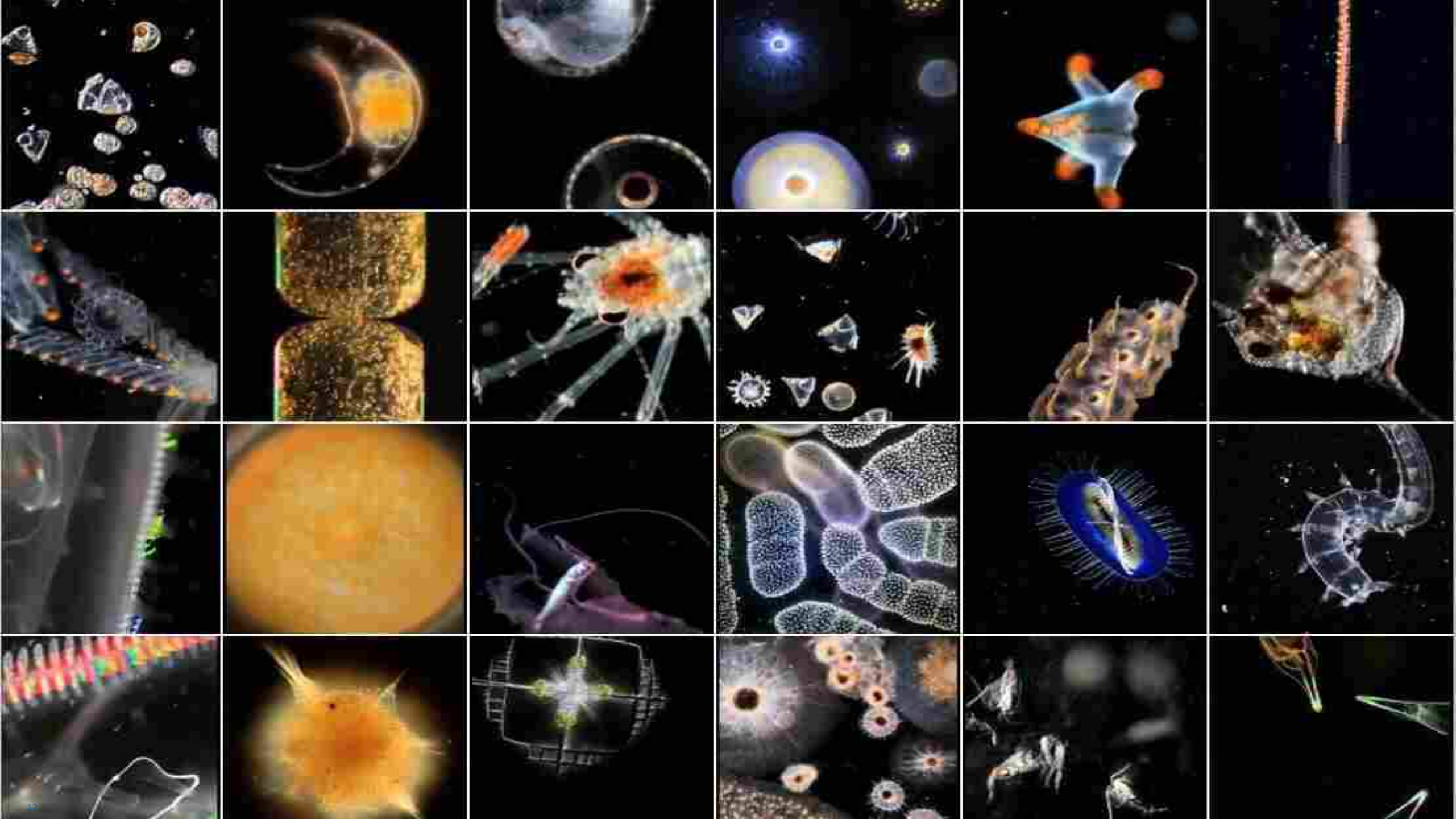
Microplastic particle pollution may be viewed as a new media of concern, perhaps the equivalent of a "marine smog"

- **Marine snow is comprised of dead and decomposing animals, fecal matter, silt and items washed into the sea from land.**
- **This marine snow is an important food source for the base of the food chain (zooplankton) and for organisms in the very deep ocean, and it plays a vital role in the global carbon cycle.**

Microplastic impacts to the food chain and public health

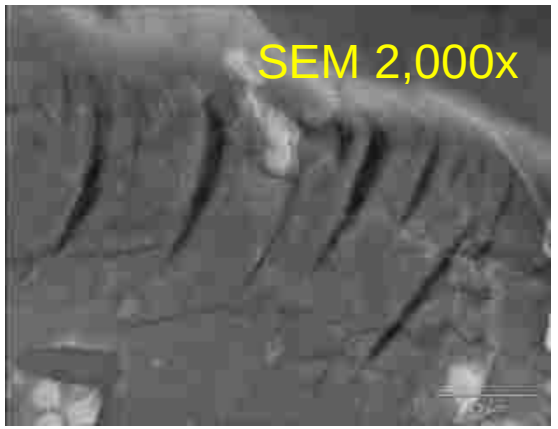
We hypothesize that when micro-plastic particles are ingested as food by marine organisms, sorbed contaminants bioaccumulate and biomagnify within and up the food chain, resulting in potential impacts to public health.





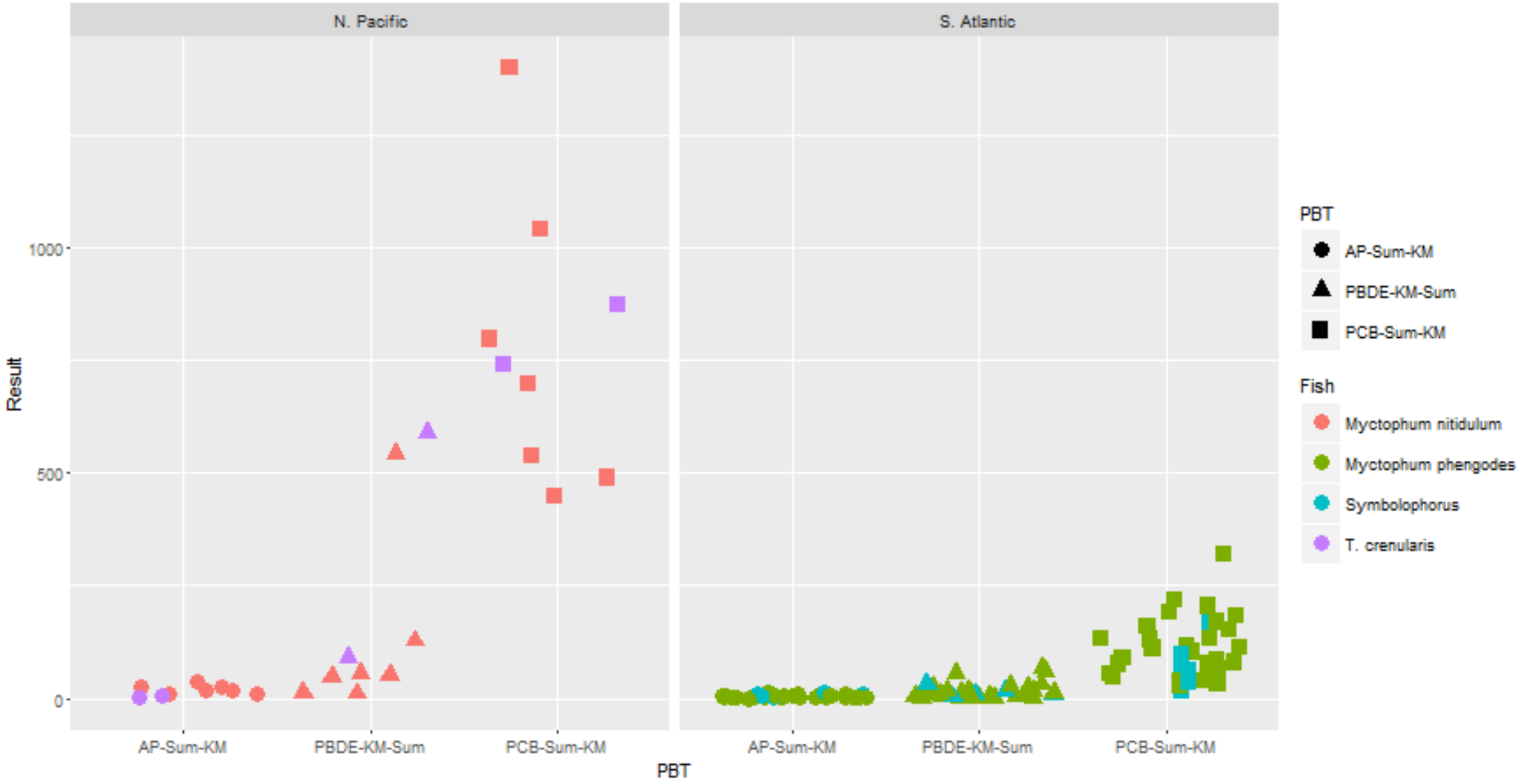
Low-trophic level in the food chain: Microplastic fiber identified in the stomach of a lantern fish in the South Atlantic Ocean

Stereozoom (STZ), SEM, and FTIR images and spectra of 13 x 0.2 mm PE microplastic fiber extracted from South Atlantic Ocean Myctophid stomach BB14A



Sutapa Ghosal, Jeff Wagner, Zhong-Min Wang, and Stephen Wall
California Department of Public Health

Persistent Organic Pollutants in Oceanic Myctophid (lanternfish) samples



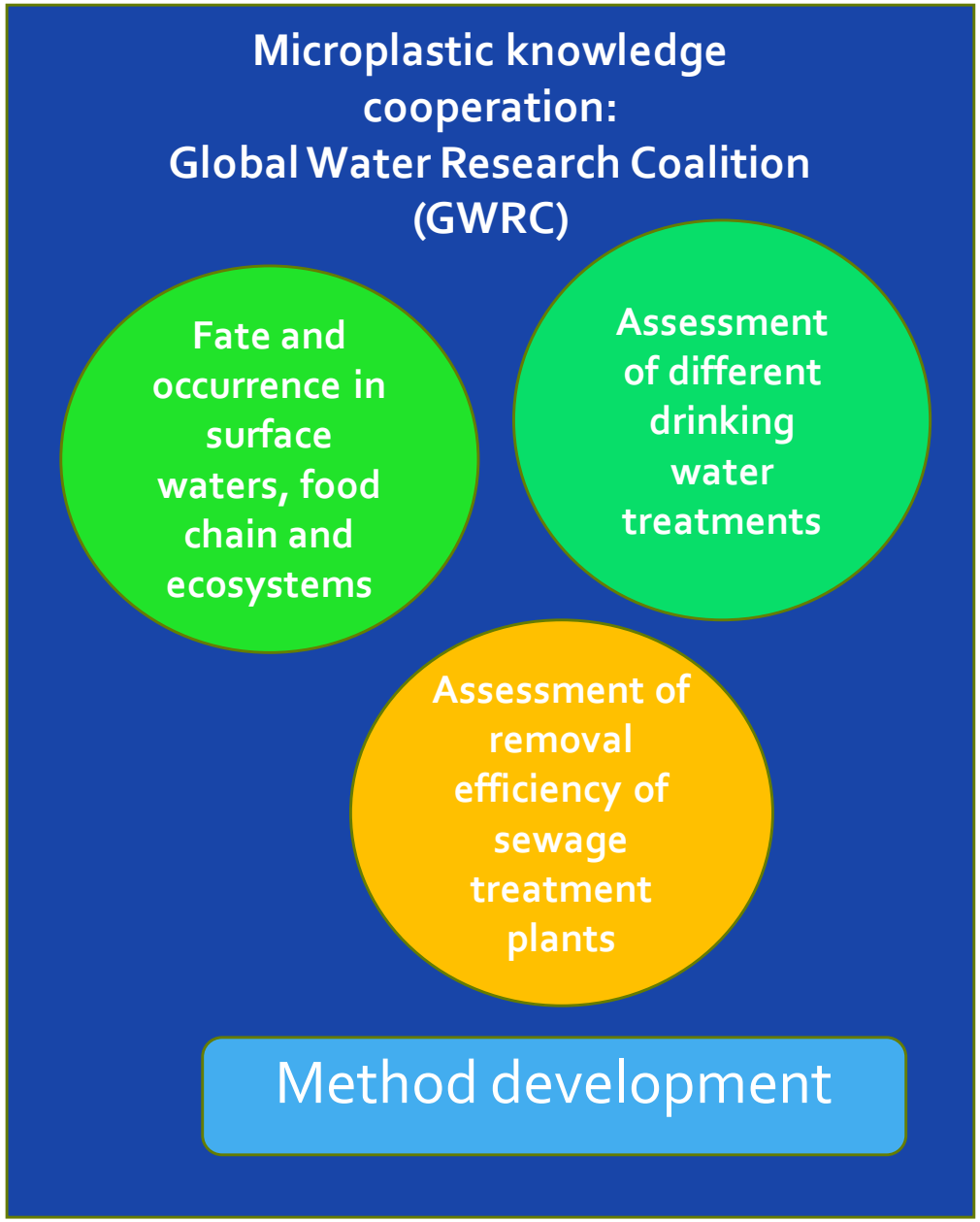
Responding to State of HI Requests and Center for Biological Diversity Petition

- What role does plastic particle pollution play in transporting PCBs from a known contaminated site into the surrounding food chain, including mammals such as the HI Monk Seal?
- Can potential impacts be extrapolated to humans?

Research Needs

"You can't manage what you can't measure"

Standardized identification methods are needed to assist international, national, regional, State and local scientists and organizations answer increasing public concerns associated with microplastics.




2 mm

Initial Method Development: Lab Analytical Methods

- Organism: microplastics in fish gut - completed 2017
- Water Column: in process - completion in February 2019
- Waste Water: in process - expected completion December 2018
  - Influent
  - Effluent
    - Primary
    - Secondary
    - Tertiary
- Sediment: in process - expected completion January 2019
- Drinking Water: yet to start

But what about measuring “in-situ” without taking samples back to the lab?

Volvo Ocean Race 2017-18

Microplastics Data

Meteorological data

Since the amount of data currently available on the oceans is scarce, additional information from remote areas can greatly improve weather forecasts.

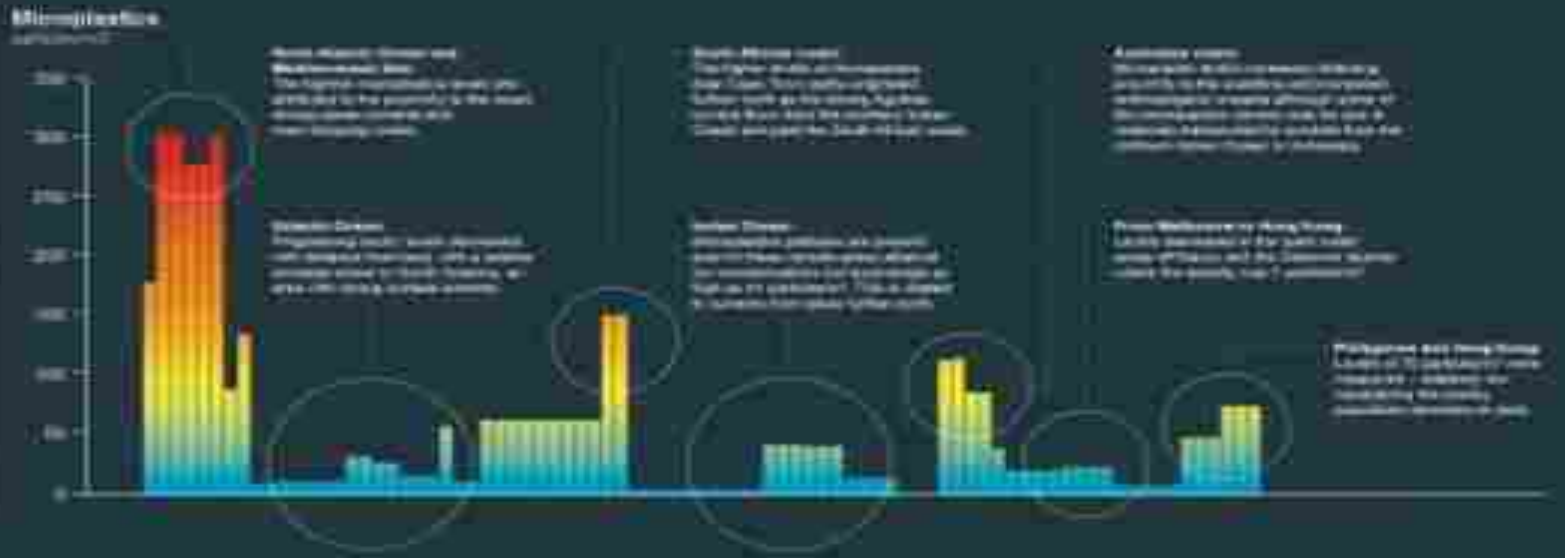
Scientific surface drifters

Drifting buoys are the primary source of surface temperature and current measurements.

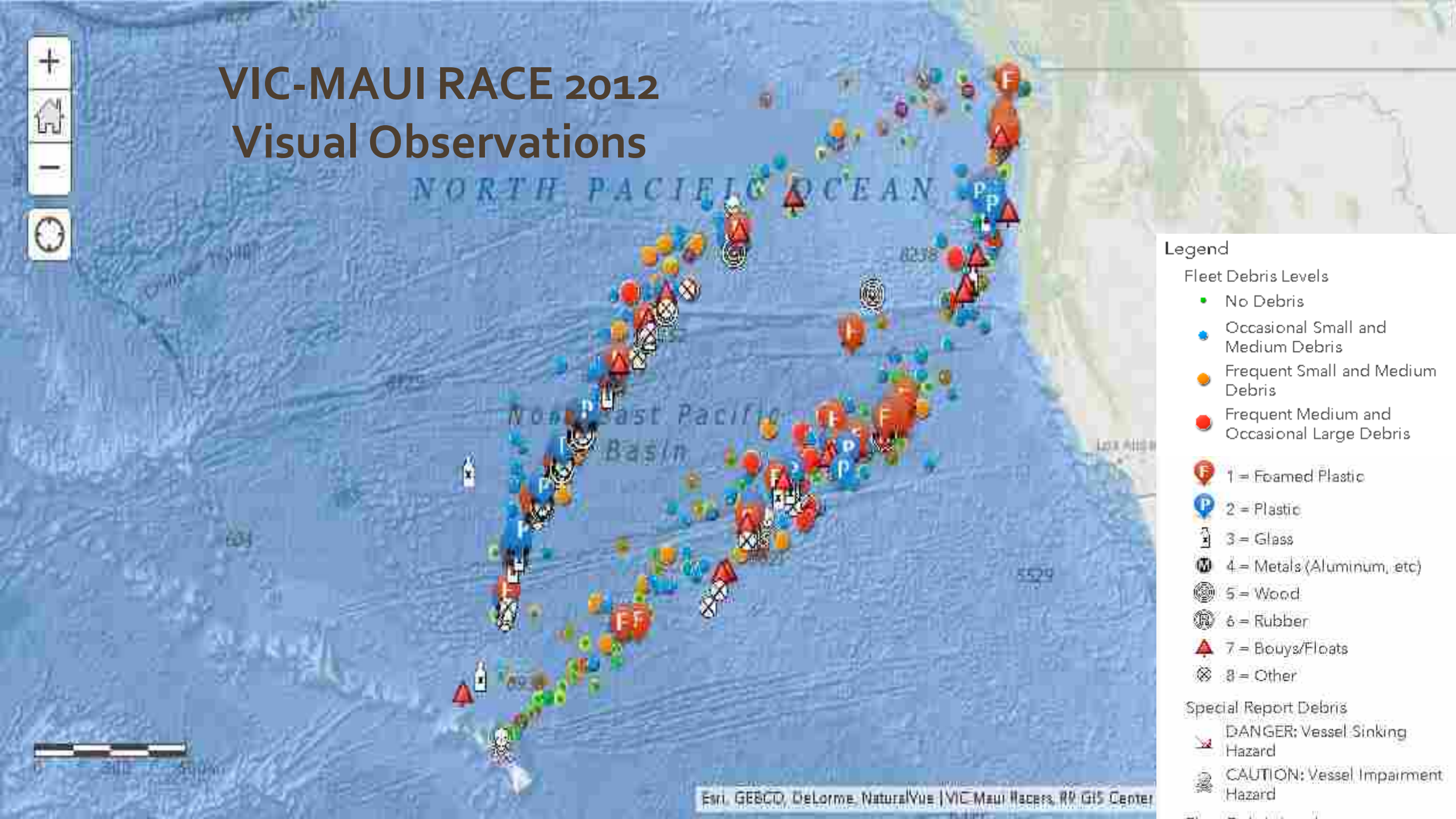
This data is transmitted in near real time for improved marine forecasts, and is especially valuable in predicting rapidly intensifying storms that could otherwise catch mariners off-guard.

The boats collect data on:

1. Sea Surface Temperature (SST)
2. Sea Surface Salinity (SSS)
3. Partial pressure of CO_2. It's estimated that the ocean absorbs 33% of human made CO_2 emissions, but it's important to quantify this accurately
4. Measurements of Chlorophyll a
5. Microplastics. As current data accounts for only 1% of plastic estimated to enter the ocean every year, groundbreaking scientific information will provide a benchmark for further studies.



VIC-MAUI RACE 2012
Visual Observations



Legend

Fleet Debris Levels

- No Debris
- Occasional Small and Medium Debris
- Frequent Small and Medium Debris
- Frequent Medium and Occasional Large Debris

- 1 = Foamed Plastic
- 2 = Plastic
- 3 = Glass
- 4 = Metals (Aluminum, etc)
- 5 = Wood
- 6 = Rubber
- 7 = Bouys/Floats
- 8 = Other

Special Report Debris

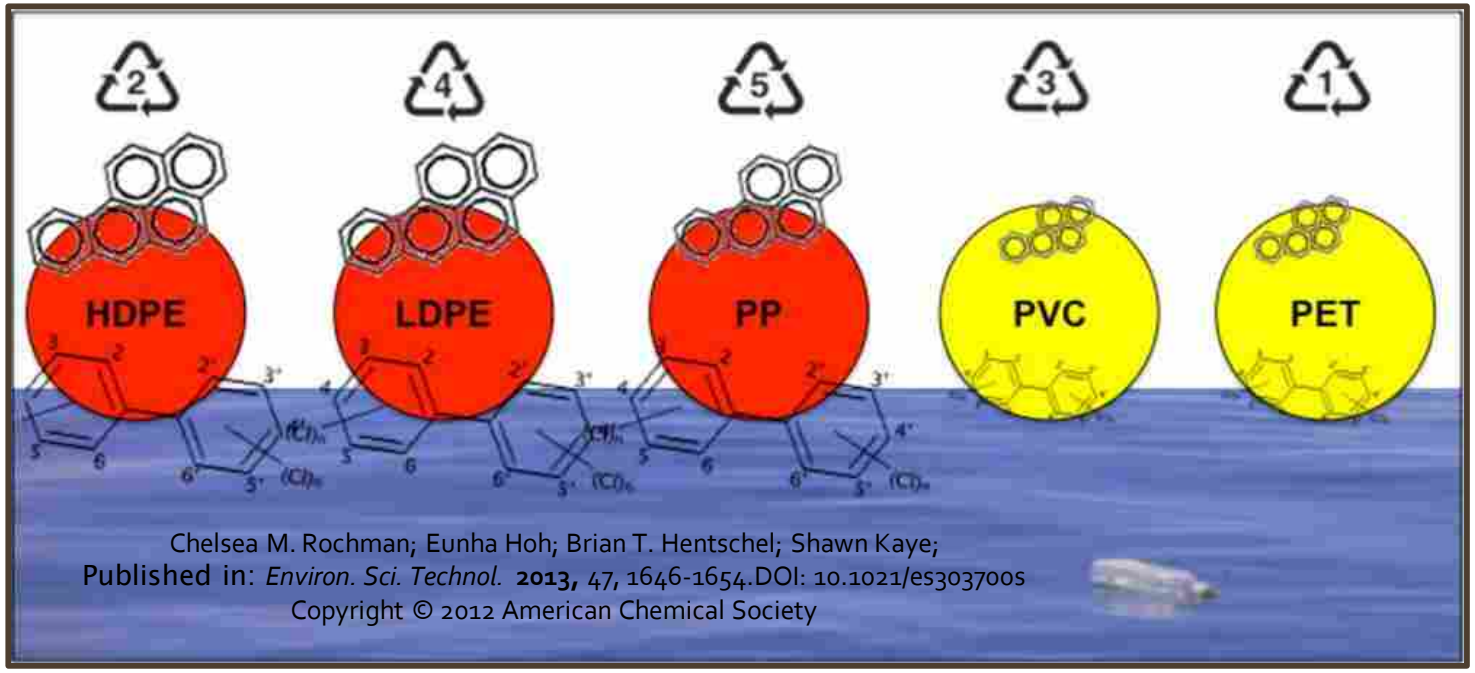
- DANGER: Vessel Sinking Hazard
- CAUTION: Vessel Impairment Hazard

VIC-MAUI RACE 2012
Visual Observations

Adventure Scientists - Grab Samples

Adventure Scientists - Grab Samples

Measuring POPs from the transoms of Pacific Cup Participants



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Dr. Sylvia Earle and friends!

Pacific Cup Volunteers Wanted!