

SUPER HI-CAT: Survey of Underwater Plastic and Ecosystem Response between Hawaii and California



Tara M. Clemente, Allison A. Fong, Brett D. Updyke, Donn A. Viviani, Kimberley A. Weersing, Benjamin R. Wheeler II, Angel E. White and David M. Karl



Objectives and Methods

The objective of the SUPER HI-CAT cruise was to locate and sample the microbial communities and biogeochemical properties associated with the Pacific plastic patch between Honolulu, HI and Port Hueneme, CA. Sampling was conducted from the R/V *Kilo Moana* between August 25th - Sept. 5th, 2008 (Figure 1a). During the transit we occupied a total of 15 CTD/Trawl/Optics stations and 15 underway (UW) stations to look at various biogeochemical parameters en-route to CA (Figure 2).

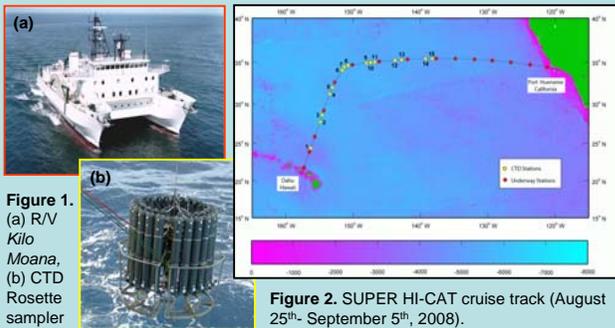


Figure 1. (a) R/V *Kilo Moana*, (b) CTD Rosette sampler

Figure 2. SUPER HI-CAT cruise track (August 25th - September 5th, 2008).

Hydrographic and biogeochemical data was collected to characterize the upper 150m water column at discrete depths (5m, 15m, 25m, 45m, 75m, and Deep Chlorophyll Maxima or DCM) using a CTD rosette sampler (Figure 1b, Table 1). UW stations were sampled using the ships uncontaminated seawater system. A Manta Trawl was used to map the surface horizontal distribution of plastic (Figure 3a). Plastic samples were then size fractionated into the following size classes; 5mm and larger, 2 - <5 mm and 0.2 - <2mm (Figure 4). All three size fractions were then sub-sampled to measure Chlorophyll a, ATP, and DNA/RNA. A LISST and HYPERPRO radiometer were used to characterize particle size distribution and optical properties of the upper water column (Figure 3b).

Event	Parameter Measured
CTD and Underway Stations	DO, DIC, DOC, Nutrients (N, P, Si), Flow Cytometry, Chlorophyll a, ATP, HPLC, Particulate C, N, P & Si, DNA/RNA, and CH ₄ /NO ₂ (CTD Only)
Manta Trawl	Chlorophyll a, ATP, and DNA/RNA

Table 1. Biogeochemical parameters measured during the SUPER HI-CAT cruise.



Figure 3. Research scientists deploying (a) Manta Trawl and (b) HYPERPRO Radiometer.



Figure 4. Size-fractionated plastic pieces collected from the Manta Trawl.

Preliminary Results

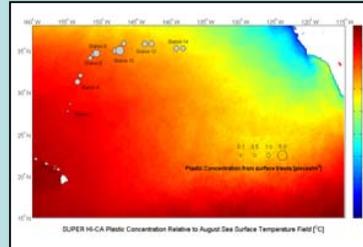


Figure 5 (left). Super HI-CAT plastic concentrations from surface Manta trawls (pieces/m³) relative to the August sea surface temperature field (C^o).

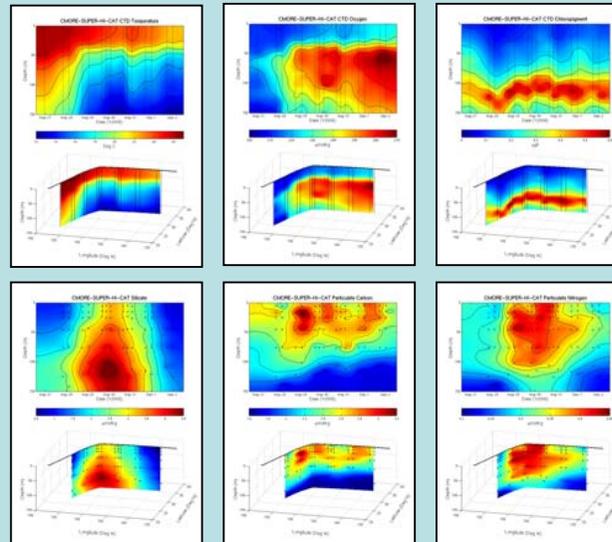


Figure 6. Depth contour plots of various hydrographic and biogeochemical parameters shown in both time and space.

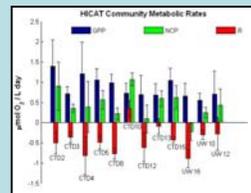


Figure 7. Gross Primary Production (GPP), Net Community Production (NCP) and Respiration (R) rates for near surface waters along the transit. GPP represents the total oxygen evolved, R represents the amount of oxygen consumed by metabolic processes, and NCP represents the net oxygen production per unit volume, per unit time. Oxygen concentration was measured by Winkler titration.

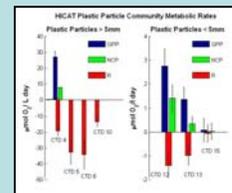


Figure 8. GPP, NCP and R rates from plastic particles. Measurements represent the difference in oxygen evolution rates between plastic particles incubating in seawater and seawater without plastic additions. For stations 12 and 13, plastic pieces between 2 and 5mm were used. Station 15 plastic pieces were in the 0.2-2mm size range.

Education and Outreach

As well as providing an exciting opportunity to launch new research initiatives, the SUPER cruise also afforded numerous opportunities for education and outreach. In addition to communicating our science with major international media outlets such as Radio Australia and the Daily Telegraph, we also created outreach and education products including a short film, a daily weblog, and a set of classroom lessons on marine debris.

Film

Lucy Marcus, a science videographer, joined the crew to create a mini-documentary about the expedition. The 12-minute film, entitled *SUPER*, weaves interviews with David Karl (Figure 9), Charles Moore, and Kimberley Weersing into video footage of on-deck operations, sample processing, and marine landscapes. The film is freely accessible online (http://cmore.soest.hawaii.edu/cruises/super/marcus_film.htm) and will be screened at the BLUE Ocean Film Festival this summer in Savannah, Georgia as well as be distributed through the C-MORE Marine Debris Science Kit.



Figure 9. Screen shot of an interview with David Karl in *SUPER*, a mini-documentary about the science and rationale behind the cruise.



Figure 10. Lucy Marcus maintained a daily weblog of our experiences and research at sea.

Blog

While at sea, a daily weblog of our experiences and research activities was maintained (http://cmore.soest.hawaii.edu/cruises/super/marcus_blog.htm) (Figure 10). The blog, photos and video were aimed at providing students and the general public with meaningful, scientific, and occasionally entertaining commentary about the materials, methods, and basic results of the expedition, as well as an introduction to daily ship life and the personnel involved with the cruise.

Science Kit

Using ideas developed during the cruise, we created a Marine Debris Science Kit, which includes lesson plans and materials in a portable, self-contained format. This three-lesson unit introduces 8th to 12th grade students to the sources, distribution, and consequences of plastics and other marine debris through hands-on activities, a computer modeling exercise, and multimedia presentations.



Figure 11. Kim Weersing uses a microscope to sort and examine plastic obtain by the Manta Trawl.



Figure 12. Large pieces of plastic debris seen floating by the R/V *Kilo Moana* during the cruise.



Figure 13. Brett Updyke and Jeffery Ernst examine a plastic buoy covered with barnacles creating a new habitat for marine organisms.

Acknowledgements

Thanks to all the SUPER HI-CAT participants for their hard work and assistance with sample collection and data analysis. Thanks to the officers and crew of the R/V *Kilo Moana* for providing a safe and comfortable work place. Thanks to Dave Karl and the HOT staff for providing both on land and at-sea support. Thanks to Lance Fujieki, for preparation of graphical figures. Funding provided by C-MORE, the Moore Foundation and the National Science Foundation.



Figure 14. SUPER HI-CAT cruise participants.