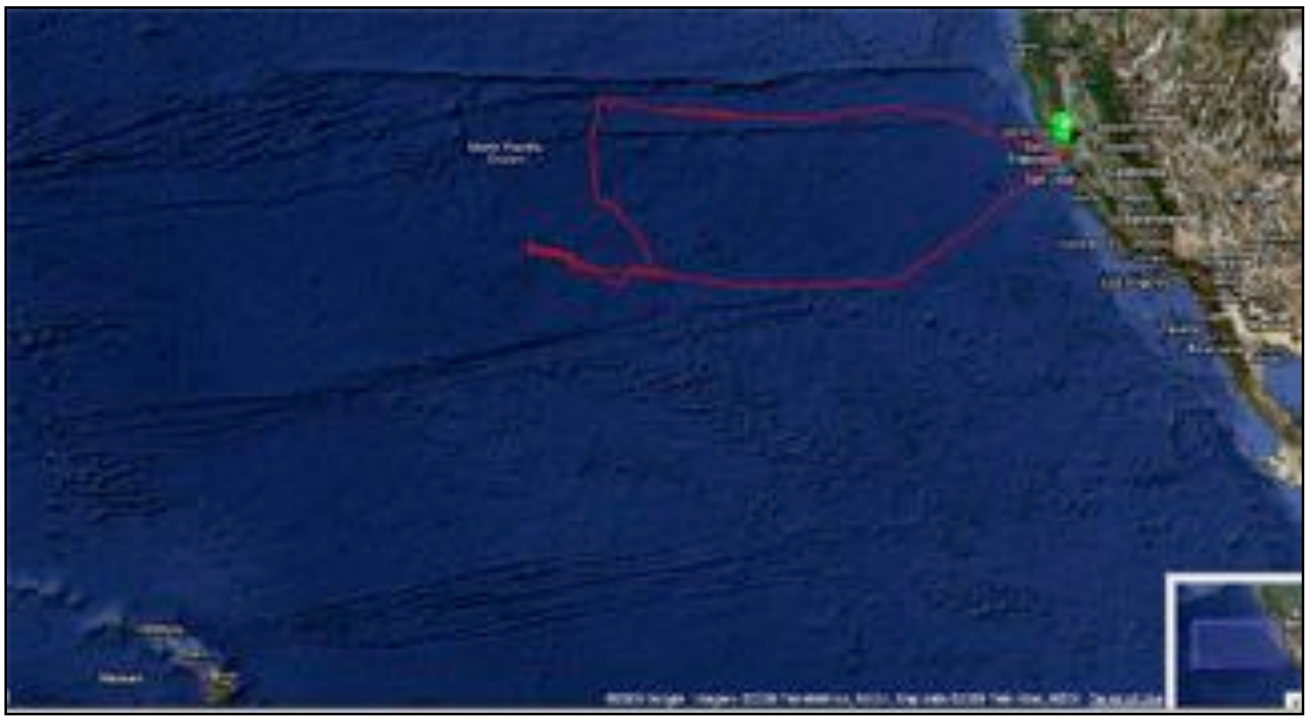
Marine Debris Observations in the North Pacific Gyre aboard *S/V Kaisei*

August 4 – August 31, 2009

On August 4, 2009, 25 people including the Project Kaisei Science Team, crew and volunteers departed on the *S/V Kaisei,* a 151- foot brigantine sailing ship, from the San Francisco Bay area heading in a southwesterly direction to the Subtropical Convergence Zone of the North Pacific Gyre. The expedition returned to the San Francisco Bay area on August 31, 2009, having covered over 3,000 nautical miles and conducted studies throughout the journey.



Route followed by S/V Kaisei in the North Pacific Ocean August 4 – 31, 2009

The team of researchers from the Project Kaisei expedition included:

Principle Investigator:

- ***Andrea Neal, Ph.D.,*** Jean-Michel Cousteau's Ocean Futures Society

Co-principle Investigators:

- ***Michael Gonsior, Ph.D.***, Urban Water Research Center, University of California at Irvine
- ***Margy Gassel, Ph.D.,*** Office of Environmental Health Hazard Assessment, California Environmental Protection Agency
- ***Heather Coleman***, Bren School of Environmental Science and Management, University of California at Santa Barbara
- ***Nicole Argyropoulos***, Jean-Michel Cousteau's Ocean Futures Society
- ***Corinne Hume***, Natural Sciences graduate, University of California at Davis

The Science team traveled to the Subtropical Convergence Zone of the North Pacific Gyre to investigate the possible environmental impacts on marine debris. Our goal of the first Project Kaisei mission was to produce solid baseline data on marine debris accumulation, examine it's potential effects on the food web, and then use the knowledge gained to produce educational outreach materials. In the Subtropical Convergence Zone of the North Pacific Gyre, we observed a deep-blue expanse of ocean with dispersed floating debris. The largest pieces of debris were buoys and derelict nets of various types and sizes encrusted with barnacles, crabs, and at times, other marine organisms including sea anemones, sponges, algae, shrimps, oysters, mussels, limpets, and marine insects. This derelict fishing gear consisted of masses of tangled webs of numerous individual nets and ropes, often twisted around other pieces of marine debris and wildlife (Figure 1). Derelict fishing gear is one of the foremost hazards in the ocean, posing a navigation danger to boats and ships and entrapping a multitude of fish and other wildlife. One of the largest derelict nets we encountered was comprised of several different fishing nets, ropes, weights, and other forms of debris. We estimated its size to be approximately ten meters in length and two meters deep. Other forms of floating debris consisted of specks of particulate plastic pieces, partial lids from plastic buckets, pieces of unidentified objects, detergent and other bottles, crates, and a few metal drums (Figure 2).

NOTE: *Drs. Neal and Gonsior observed similar patterns of accumulation of marine debris related to current lines earlier this summer in the Sargasso Sea (western Atlantic Ocean) while working with Woods Hole Professor Maureen Conte on the Ocean Flux Program.*

We conducted two surface trawls per day for one hour with a 333 μm mesh net sampling the top 15 cm of the water column. Traveling at speeds ranging from approximately 2.5 to 3.8 knots, we filtered over 102,000 m^3 of water during the expedition. Beginning on the third day of the trip, at approximately 565 kilometers (305 nautical miles) from Richmond, California, we conducted a total of 33 daytime and 18 nighttime trawls during the next 26 days. The accumulated material from each trawl was rinsed off the collection net and filtered through a 20.32-cm diameter, 0.333 mm mesh sieve. Each one-hour trawl filtered approximately 2,000 m^3 of water. Our night trawls targeted the collection of fish from the Myctophidae (lanternfish) family. Myctophids are small fish (up to 30 cm, but usually less than 15 cm) that dwell between 200 and 1000 meters in depth during the day and feed at the surface at night. The Myctophid family is widely distributed throughout the world oceans and is major component in the marine food web.

The contents of every surface trawl made during the expedition contained polymer debris that ranged in size from 20 μm to 40 cm. The amount of debris in the samples is yet to be quantified, but based on visual inspections, the samples appeared to be more concentrated with debris as the *Kaisei* approached and sailed within the Subtropical Convergence Zone of the North Pacific Gyre. In general, the trawl samples included numerous multi-colored "microplastic" pieces (fragments less than five millimeters). At times, larger pieces of debris up to ten centimeters or more of various colors (e.g., green, brown, red, blue, purple) were also collected in the surface trawls, including pieces of rope and broken fragments of plastic items. Larger plastic pieces were usually covered in epiphytic growth of bryozoans and various algal forms. In this debris mix, we often collected small fishes in the range of 20 to 50 millimeters, and invertebrate animals (e.g., ctenophores, tunicates, euphausiaceans). The relative proportions of debris and marine organisms varied widely among trawl samples.

A sample obtained early in the expedition (Figure 3) was collected on August 7, 2009, the second of the daytime surface trawls, beginning approximately 830 kilometers (450 nautical miles) from Richmond, California. In addition to several invertebrate organisms and juvenile fishes, Pacific saury (*Cololabis saira*), the debris consisted of strands of monofilament and nylon lines, numerous microplastic fragments, and several larger pieces of plastic that ranged in sizes up to five cm long (Figure 3). The daytime surface trawl conducted on August 11, 2009, beginning approximately 1590 kilometers (860 nautical miles) from Richmond, California, produced the sample shown in Figure 4. This sample contained a greater volume of gelatinous tissue, presumably from unidentifiable invertebrate organisms, and a larger quantity of microplastic fragments compared to the sample shown in Figure 3. In many areas within the Convergence Zone, our trawl sample contents covered the entire surface of the 20.32-cm sieve in a thick layer comprised of various forms of debris and biota. A representative sample collected on August 22, beginning about 1600 km (870 nautical miles) from Richmond, California, is shown in Figure 5.

In our studies conducted in the Subtropical Convergence Zone of the North Pacific Ocean, we did not observe a continuous floating mass of debris the size of the "Lone Star State." Our trawl samples revealed a more insidious distribution of small fragments of debris resulting from the breakdown of larger plastic items. Further studies are planned to investigate ingestion of debris particles by fishes, concentrations of chemical contaminants adsorbed to polymer debris, and accumulation of chemical contaminants in fish tissues. Project Kaisei also plans to study various methods of harvesting smaller scattered debris on a large scale without harming marine life.

Figure 1. Close-up view of tangled ropes and nets in derelict fishing gear encountered on August 19, 2009 at 36° 13.49N, 140° 25.43W.

Figure 2. Debris collected using a hand net from an inflatable boat off the S/V Kaisei *during a two-hour period on August 19, 2009 in the vicinity of 36° 15 N, 140° 22W.*

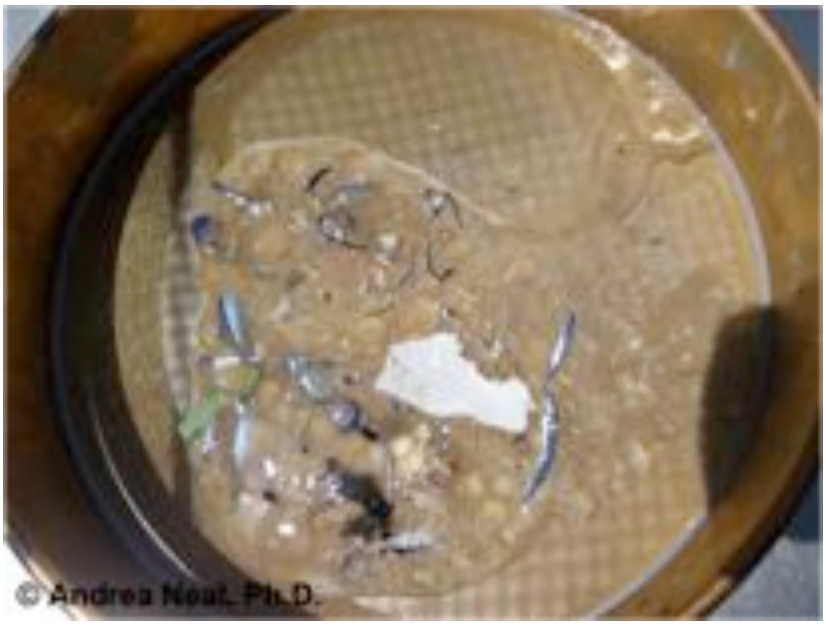


Figure 3. Surface trawl contents from 33° 34.35N, 129° 49.72W to 33° 39.52N, 129° 52.80W collected on August 7, 2009. The amount of water filtered was 2,023 m^3.

Figure 4. Surface trawl contents from 34° 05.81N, 139° 22.31W to 34° 06.49N, 139° 24.71W collected on August 11, 2009. The amount of water filtered was 1,784 m^3.

Figure 5. Surface trawl contents from August 22, 2009 collected from 39° 05.13N, 140° 43.66W to 39° 10.93N, 140° 42.81W. The amount of water filtered was 3962 m^3.