Cruise Report

Scripps Environmental Accumulation of Plastic Expedition (SEAPLEX)
UC Ship Funds Student Cruise in Collaboration with Project Kaisei
SEAPLEX-0908?
R/V New Horizon: August 2-21, 2009

Compiled and submitted by Miriam Goldstein, Chief Scientist
Scripps Institution of Oceanography, University of California San Diego

Cruise ID: SEAPLEX
Depart San Diego, CA: 2 August 2009 at 0800 PST
Return Newport, OR: 21 August 2009 at 0700 PST
Vessel: R/V New Horizon
Operator: SIO
Master: Captain Wes Hill
Chief Scientist: Miriam Goldstein
SIO Resident Technician: Matt Durham

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Scientific Objectives

The purpose of this cruise was to provide quantitative measurements of the plastic debris purported to be accumulating in the North Pacific Central Gyre, and to perform the first study on interactions of pelagic plastic debris with the lower tropic levels.

General Overview of the Science Plan

SEAPLEX had two main objectives: 1) To survey plastic abundance along a transect of the California Current, transition zone, and North Pacific Central Gyre (NPG); 2) Assess biological interactions with marine debris in one reference site in the California Current and three high-plastic sites within the North Pacific Gyre. Past research suggests that debris accumulates in the North Pacific Subtropical Convergence Zone (STCZ), which moves seasonally between 30° and 42° N, and that a significant amount of neustonic debris had been found between Hawaii and California at approximately 140° W. Our cruise track was therefore designed to transect as much of the STCZ as possible given time constraints.

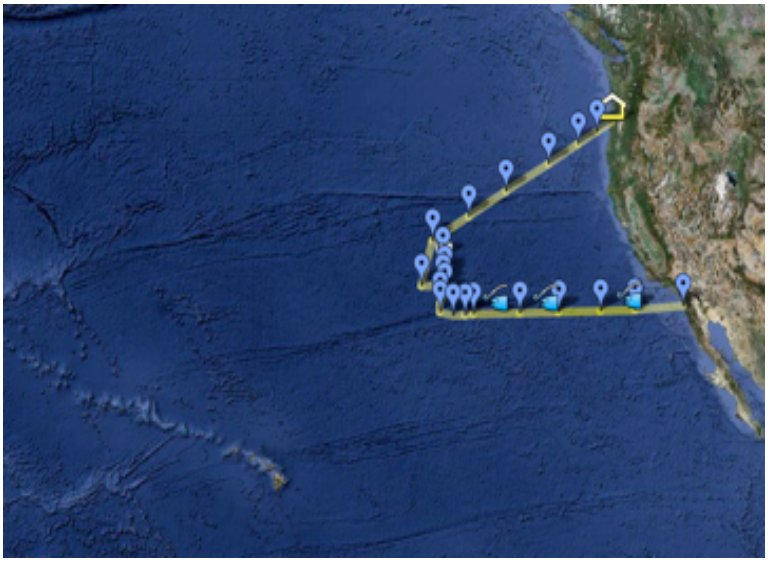

Fig. 1. SEAPLEX cruise track and daily positions.

SEAPLEX sampled all size classes of plastic debris as defined by Gregory (1996), including microdebris (200 to 500 µm), mesodebris (500 to 5000 µm), and macrodebris (> 5000 µm). Microdebris was sampled with a manta tow (333 µm mesh), and subsurface microplastic with an oblique bongo tow (333 µm mesh). Mesodebris was collected using dipnets deployed over the size of the ship and from a small inflatable boat. Macrodebris and conspicuous mesodebris were quantified using visual detection. Net tow and dipnet samples were discrete, while visual observations were continuous during daylight hours. However, net tows collected all debris, while visual observations were limited by debris size, color, and the sea state.

Biota was also sampled on a variety of scales. Marine mammals and seabirds were detected by visual observations. In addition, marine mammal vocalizations were monitored by a passive acoustic array towed behind the ship. Mesopelagic fishes and zooplankton were sampled by Oozeki trawl to 800 meters. Neustonic zooplankton were sampled by manta tow, and subsurface zooplankton by bongo tow. Water samples for phytoplankton and microbial community analysis were collected by CTD and by the onboard seawater flow-through system. Plastic-associated fouling communities were collected by dipnet.

To measure the abundance of plastic along our cruise track, we surveyed debris visually during all daylight hours, and collected neustonic debris with manta tows every six hours (mesh size, tow frequency was increased to every 3 hours when in the NPG). A daily CTD cast at 0330 measured hydrography and took water samples for microbial and phytoplankton community studies. Measured variables included: temperature, conductivity, density, nutrients, fluorometric Chl-a, PAR/irradiance, and oxygen.

Biological interactions were assessed at four intensive sampling sites. CALCOFI Line 90 Station 60 was selected as a low-plastic reference station. High-plastic stations were selected in the NPG based upon visual detection (15-minute quantitative counts from bird and whale observers) and manta tows. Once a high-plastic area was detected, a 27-hour sampling sequence provided replicate measurements of the physical and biological communities, as well as plastic abundance. The sequence included CTD casts for hydrography and phytoplankton studies, manta tows for neustonic plankton and plastic, bongo tows for subsurface plankton and plastic, Oozeki trawls for midwater fish communities and plastic ingestion, and small boat operations for debris collections for fouling community and bacterial studies. Sampling was performed as close to the station's coordinates as possible.

After completing the CA Current reference station (Station 1), transit to the NPG, and two intensive NPG sampling stations (Stations 2 and 3), we added a 30 by 30 km grid to assess mesoscale variation in plastic microdebris abundance. The grid included 16 manta net tows and 4 CTD casts. After completing our third and final intensive sampling station (Station 4) in the NPG, we added a 190 km line transect to estimate mesoscale variation in plastic abundance and to quantitatively compare the size and abundance of debris detected in visual observations with debris sampled by manta net. The line transect consisted of four sets of five back-to-back manta tows. The sets were approximately 9 nautical miles (16.6 km) apart.

Ship and Technical Support

The SEAPLEX cruise was largely exploratory, requiring flexibility and adaptive sampling. The cruise also had unusual logistical issues due to the last-minute collaboration with Project Kaisei. This new collaborative element added seven days of ship time a month before the cruise, as well as an extensive media component. We are grateful to Jim and Rose Dufour for setting up the collaboration that greatly increased the amount of time we were able to spend in the gyre. The Ship Scheduling Office was also extremely helpful in facilitating the last-minute addition of the extra seven days.

Thanks in large part to excellent weather for the majority of the cruise, we were able to meet and exceed our scientific objectives. There were no significant technical problems. There was a minor issue with the ADCP settings (set to "coastal" instead of "deep") that the resident technician was able to quickly correct on Day 3 of the cruise (August 5). Another minor issue occurred when the manta net frame cracked in two places from a combination of wear and a science party member over-tightening the ratchet straps. The loss of the manta net would have seriously damaged the scientific mission so we are extremely grateful to the engineers who were able to bolt the frame back together.

The officers and crew were professional and helpful. Their skill and flexibility allowed us to make efficient use of our ship time and adapt our sampling to local conditions. Matt Durham, the marine technician, was extremely knowledgeable, helpful, and skilled at aiding a relatively inexperienced science party. His diligence and work was a major contribution to the success of this cruise. The Shipboard Technical Support Computer Resources Group was also extraordinarily helpful in setting up and monitoring internet access. Tom Pugh and Gary Lain of Environmental Health and Safety were key in helping us find safe and cost-effective ways to get our samples back from Newport.

Science Operations and Issues

Prior to the SEAPLEX cruise, little data existed on the nature of the plastic accumulation in the NPG. However, identifying high-plastic areas proved easier than expected due to the homogeneity and high density of debris. The ease of locating debris both visually and with the manta tows, combined with excellent support from the captain and crew, good weather, and lack of technical difficulties, allowed us to add two additional sampling locations. Other additions to the science plan included collection of a large dead squid found floating on the surface and a rendezvous with the sailing vessel Kaisei as part of the collaboration with Project Kaisei.

Predictions of heavy weather off Newport, OR resulted in the loss of some sampling (6 manta tows and 2 CTD casts) on August 18th and 19th. This was a direct result of our choice to spend more time in the NPG. In final analysis, we met and exceeded our scientific objectives.

SEAPLEX Activity Schedule - Actual

2nd August

08:00	Depart San Diego Bay
12:00	CTD test cast
15:00	Manta tow
2100	Manta tow

3rd August

2:30	Begin CA Current Reference Station (S1), CTD cast

3:30	Bongo tow
4:30	CTD cast
5:30	Manta tow
6:00	Oozeki midwater trawl - Deep
9:00	Manta tow
9:30	CTD cast
10:30	Manta tow
11:00	Bongo tow
12:00	CTD cast
13:00	Manta tow
13:30	Bongo tow
14:30	Oozeki midwater trawl - Deep
17:30	Manta tow
18:00	Bongo tow
19:00	Manta tow
19:30	Bongo tow
20:30	Manta tow
21:00	CTD cast
22:00	Oozeki midwater trawl - Deep

4th August

1:00	Manta
1:30	Oozeki midwater trawl - Shallow
2:30	Bongo tow
3;30	Begin transit to gyre
09:00	Manta tow
15:00	Manta tow
21:00	Manta tow

5th August

03:00	Manta tow
03:30	CTD cast
08:00	ADCP adjusted from “coastal” to “open sea”
09:00	Manta tow
15:00	Manta tow
21:00	Manta tow

6th August

03:00	Manta tow
03:30	CTD cast

09:00 Manta tow
15:00 Manta tow
21:00 Manta tow

7th August

0300 Manta tow
0330 CTD cast
0900 Manta tow
1500 Manta tow
2100 Manta tow

8th August

03:00 Manta tow
03:30 CTD cast
09:00 Manta tow
12:00 Manta tow
14:00 Manta tow
14:30 Begin gyre station S2, CTD cast
15:30 Bongo tow
16:30 Oozeki midwater trawl - Deep
19:00 Manta tow
19:30 Bongo tow
20:00 CTD cast
21:00 Oozeki midwater trawl - Deep

9th August

0:30 Bongo tow (2)
2:00 Oozeki midwater trawl - Shallow
3:00 Bongo tow
4:00 CTD cast
5:00 Manta tow
5:30 Manta tow
6:00 Oozeki midwater trawl - Deep
9:00 Manta tow
9:30 Manta tow
11:00 CTD cast
12:00 Manta tow (3)
13:30 Bongo tow
14:00 Manta tow (2), end site S2
18:00 Manta tow

21:00	Manta tow

10th August

00:00	Manta tow
03:00	Manta tow
03:30	CTD cast
06:00	Manta tow
09:00	Manta tow
12:00	Manta tow, begin site S3
14:00	Manta tow
14:30	Launch small boat
15:00	CTD cast
16:00	Bongo tow
16:30	Retrieve small boat
17:00	Oozeki midwater trawl - Deep
20:00	Manta tow (2)
20:30	Bongo tow
21:30	Oozeki midwater trawl - Deep

11th August

1:00	Bongo tow (2)
2:30	Oozeki midwater trawl - Shallow
4:30	CTD cast
5:00	Manta tow (2)
6:00	Oozeki midwater trawl - Deep
9:00	Manta tow (3)
10:30	CTD cast
12:00	Launch small boat
12:30	Bongo tow (2)
13:15	Manta tow (3)
14:30	CTD cast, end site S3
21:30	Rendezvous with vessel Kaisei
23:00	Manta tow

12th August

00:00	Manta tow
3:00	CTD cast
3:30	Manta tow
6:00	Manta tow
9:00	Manta tow

12:00	Manta tow
15:00	Manta tow
16:00	Begin grid sampling pattern, manta tow
16:30	CTD cast
18:00	Manta tow
19:00	Manta tow
20:00	Manta tow
20:30	CTD cast
22:00	Manta tow
23:00	Manta tow

13th August

00:00	Manta tow
01:00	Manta tow
02:00	Manta tow
03:00	Manta tow
03:30	CTD cast
05:00	Manta tow
06:00	Manta tow
07:00	Manta tow
07:30	CTD cast
09:00	Manta tow
10:00	Manta tow
11:00	Manta tow
11:30	CTD cast, end grid sampling pattern
15:00	Manta tow
18:00	Manta tow
21:00	Manta tow

14th August

0:00	Begin site S4, manta tow
0:30	Oozeki midwater trawl - Deep
2:30	CTD cast
4:30	Oozeki midwater trawl - Shallow
6:30	Manta tow (2)
7:00	Oozeki midwater trawl - Deep
10:30	CTD cast
11:00	Launch small boat
11:30	Manta tow (2)
12:30	Deployed *ad hoc* drifter (Powell)
12:40	Bongo tow (2)

13:50	Small boat recovered
14:00	Bongo tow
15:00	CTD cast
16:00	Manta tow (2)
18:00	Oozeki midwater trawl - Deep
21:00	Manta tow
21:30	CTD cast
23:00	Bongo tow (3), end site S4

15th August

3:00	Manta tow
3:30	CTD cast
6:00	Manta tow
9:00	Begin line sampling pattern (4 sets of 5 manta tows)
20:00	End line sampling pattern

16th August

3:00	Manta tow
3:30	CTD cast
9:00	Manta tow
15:00	Manta tow
21:00	Manta tow

17th August

3:00	Manta tow
3:30	CTD cast
9:00	Manta tow
15:00	Manta tow
21:00	Manta tow

18th August

3:00	Manta tow
3:30	CTD cast, sampling ended because of weather off Newport OR
9:00	*Manta tow missed*
15:00	*Manta tow missed*
21:00	*Manta tow missed*

19th August

3:00	*Manta tow missed*
3:30	*CTD cast missed*
9:00	*Manta tow missed*
15:00	*Manta tow missed*
21:00	Manta tow

20th August

3:00	Manta tow
3:30	CTD cast
8:40	Drifter deploy (2) (Niiler)

Cruise Personnel

	Name		Title	Affiliation
1	Miriam	Goldstein	Graduate Student/Chief Scientist	SIO
2	Pete	Davison	Graduate Student	SIO
3	Jesse	Powell	Graduate Student	SIO
4	Megan	Rippy	Graduate Student	SIO
5	Darcy	Taniguchi	Graduate Student	SIO
6	Andrew	Titmus	Graduate Student	Hawaii Pacific University
7	Chelsea	Rochman	Graduate Student	San Diego State University/UC Davis
8	Joshua	Jones	Staff Research Associate	SIO
9	James	Leichter	Associate Professor	SIO
10	Doug	Woodring	Co-Founder	Project Kaisei
11	Annie	Crawley	Filmmaker	Project Kaisei
12	Mario	Aguilera	Communications	SIO
13	Lara	Dickens	Teacher At Sea	Patrick Henry High School, San Diego Unified School District
14	Jesse	Dubler	Volunteer	NA
15	Karin	Malstrom	Volunteer	Project Kaisei
16	Timothy	Stillinger	Volunteer	UC Berkeley
17	Matthew	Durham	Resident Technician	SIO