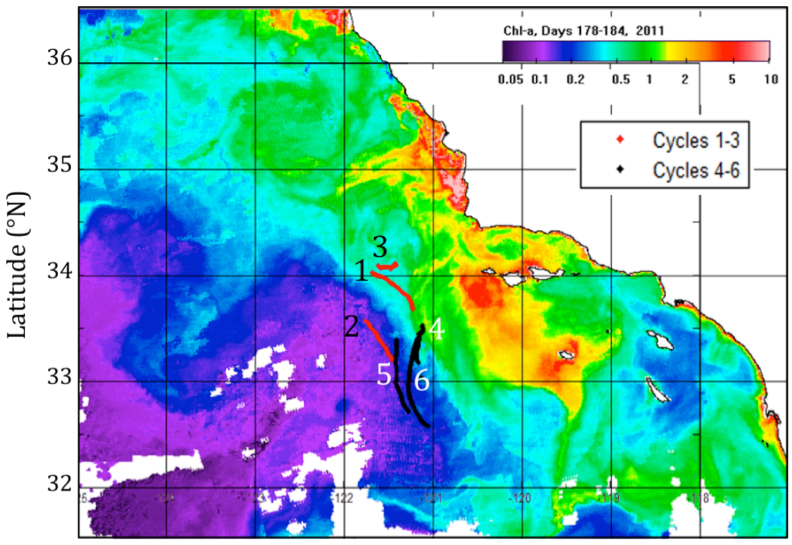
Cruise Report

California Current Ecosystem LTER Program
CCE-P1106, Process Cruise #4
R/V MELVILLE, 18 June - 17 July, 2011

Compiled and submitted by: Michael R. Landry, Chief Scientist
Scripps Institution of Oceanography, Univ. California, San Diego

Cruise ID: CCE-P1106, aka MV1107
Depart: 18 June 2011 at 0800 (PST)
Return: 17 July 2011 at 0700
Vessel: R/V MELVILLE
Operator: Scripps Institution of Oceanography
Master: Captain David Murline
Chief Scientist: Michael R. Landry
Marine Technicians: Brian Rowe, Robert Thombley, Rob Palomares



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SCIENCE OBJECTIVES

This was the fourth Process Cruise of the CCE LTER (California Current Ecosystem, Long-Term Ecological Research) Program, the objective of which is to understand the coupling of physical, chemical and biological dynamics in the California Current ecosystem and, ultimately, the system responses to long-term climate variability. P1106 was the first cruise designed specifically to investigate the effects of ocean frontal systems on composition, biomass and activity of CCE biota. In addition to process-focused experiments, it therefore incorporated large-scale surveys with an undulating towed vehicle (Seasoar, upper 300 m) to sample broad distributional fields of basic variables (temperature, salinity, density, fluorescence, light transmission, oxygen) and rapid cross-front transect sampling at specific locations to assess details of distributions on finer scales.

OVERVIEW OF THE SCIENCE PLAN

The science plan involved three major components: 1) Seasoar surveys were done to assess broad-scale hydrography and circulation characteristics of the study area. 2) Detailed experimental studies were done between these surveys to characterize chemical and biological concentrations and rate relationships at comparative sites/stations in the front axis and in water masses to the east and west of the front. 3) Periodic rapid sampling transects were conducted across the front to get detailed, semisynoptic sections of physical, chemical and biological parameter fields.

Seasoar Surveys

Survey mapping with Seasoar was conducted in a radiator pattern on 3-4 day runs on two occasions (20-23 June and 3-6 July). We used faired cable to reach depths of ~300 m, and achieved 9 E-W transects at ~10-km spacing on each survey. The figures below (Figs. 1 & 2) show the tracks for Seasoar surveys 1 and 2, and the depth contours for salinity, density and chlorophyll fluroescence along the survey transit line closest to the positions of the detailed cross-front sampling transects (shown in red highlight; Up-front #2 in Seasoar #1; Up-front #3 in Seasoar #2).

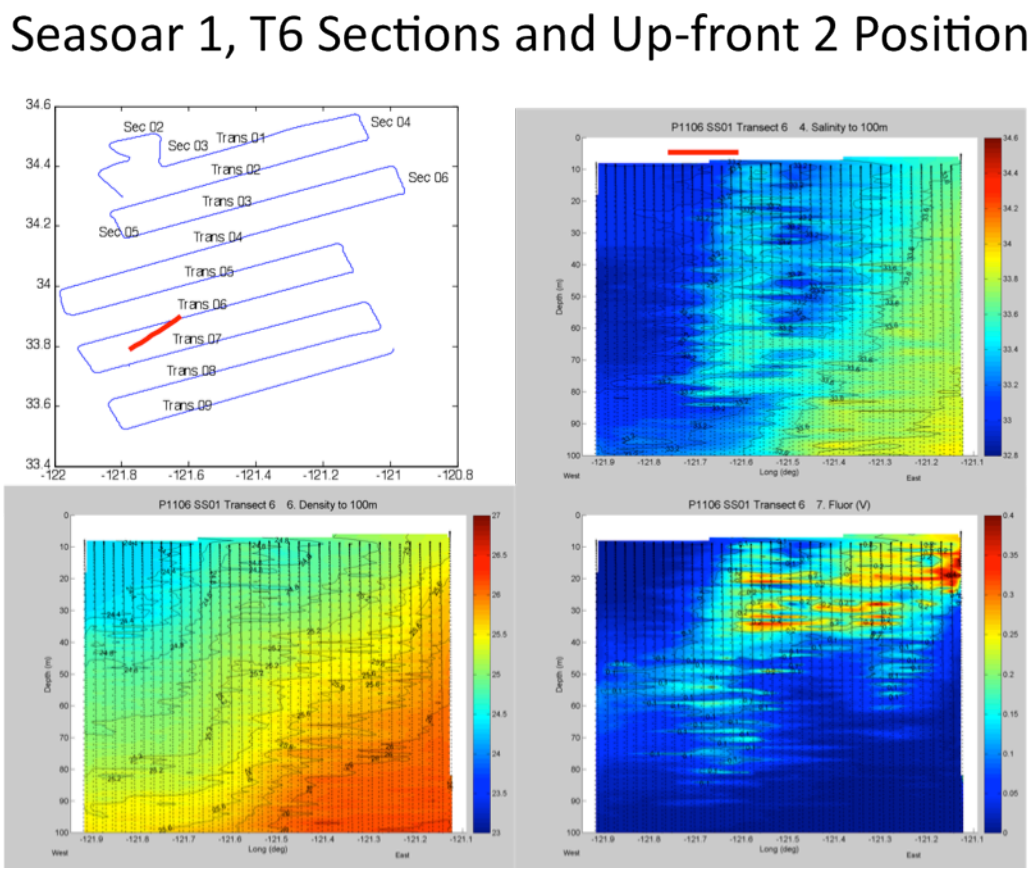


Fig. 1. Map of Seasoar #1 transect lines. Red line shows position of front crossing #2. Sections are salinity, density and fluorescence along Transect line 6.

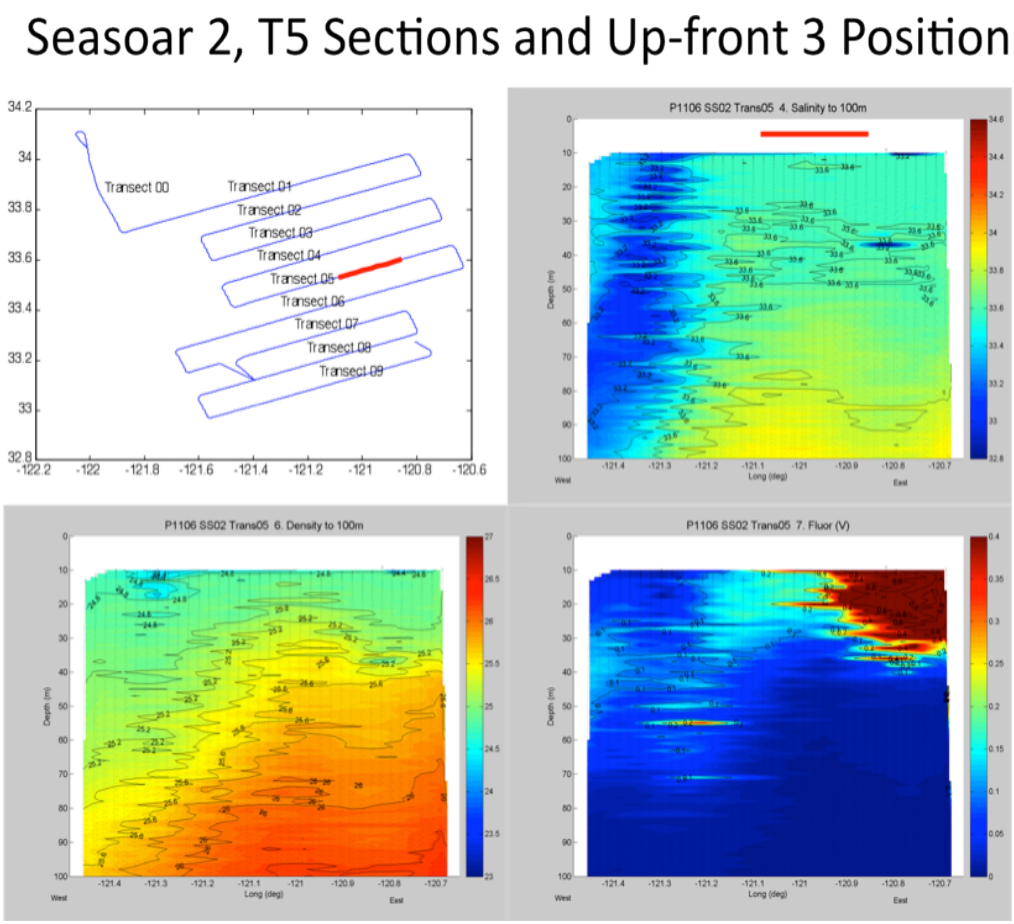


Fig. 2. Map of Seasoar #2 transect lines. Red line shows position of front crossing #3. Sections are salinity, density and fluorescence along Transect line 5.

Process Studies

Experimental studies of 2-days duration were conducted in a semi-Lagrangian style, following a mixed-layer drogued, satellite-tracked drifter. Initial and daily CTD sampling at approximately 0200 were conducted at the drifter position to assess daily changes in water mass characteristics. The same water collection was also used experimentally to assess taxon-specific rates of phytoplankton growth, ^{14}C-primary production and microzooplankton grazing impact by the dilution approach. These incubations were conducted for 24 hours in net bags attached on a line below the drift array (therefore incubated under in situ conditions of temperature and light). A second drifter was deployed with attached sediment traps to measure particle fluxes over the 2-day experiments (initial deployment and final recovery only).

Measured variables on CTD sampling included: temperature, conductivity, density, nutrients (dissolved inorganic N, P, Si), total organic carbon and nitrogen (TOC, TON), particulate carbon and nitrogen (POC, PON), particulate biogenic silica (BSi), thorium-uranium disequilibrium, total and size-fractioned fluorometric Chl*a*, HPLC accessory pigments, microscopical and flow cytometric assessments

of microplankton community composition, and samples for molecular analyses. An ISUS nitrate sensor and an Underwater Vision Profiler system (UVP5) were also integrated into the CTD rosette system to provide continuous measurements nitrate concentration and sizes and abundances of particles (aggregates and organisms) on each cast down to typically 300-500 m.

Using the drift array as a moving frame of reference, additional CTD sampling was conducted at mid-day for bio-optical studies, shipboard assessments of primary production by the ^{14}C-uptake method, microbiological studies (bacterial production, bacteria particle interactions, enzyme activities and viral mortality impact), and typically in the evening for additional shipboard experimental studies of mesozooplankton reproduction. We also had a full round-the-clock schedule of other sampling activities including: a) net sampling of zooplankon and mesopelagic fish with MOCNESS, Oozeki trawls, bongo and ring nets; b) trace-metal rosette or GO-Flo sampling for iron (Fe) analyses and experiments, and c) wire deployments of a McLane pump for sampling C:thorium of suspended particles. Mesozooplankton biomass and grazing estimates will be derived from size-fractioned dry weights, carbon biomass and gut fluorescence analysis of bongo net samples collected at mid-day and mid-night.

MOCNESS net tows were taken at mid-day and mid-night to determine the depth structure and day-night variability of the meso-zooplankton community. Bongo net tows were also taken around mid-day and mid-night to get depth-integrated assessments of the zooplankton biomass structure and gut fluorescence in the euphotic zone. One side of the paired nets from these collections was formalin preserved for species identification. The other was size-fractioned on shipboard for biomass (dry weight, C, N) and gut pigment analyses. Sampling of mesopelagic fishes and invertebrates was conducted with a 5 m^2 mid-water trawl net (MOHT, Matsuda-Oozeki-Hu).

Cross-Front Transect Sampling

Rapid sampling transects across the front were completed on 3 occassions, with 7-10 stations sampled on each in one night (~20:00 - 06:00). The main sampling was done by shallow CTD (300 m) and vertical net tows, and surface (pole) samples for iron analyses at each station. Additional samples were taken at every other station for PvE experiments of phytoplankton photosynthesis and bacterial production and activity. All routine measurements on CTD hydrocasts, including nutrients, full microscropy, flow cytometry, HPLC pigments, POC/PON, BSi and size-fractioned Chl*a*. Net tows were split into analyses for zooplankton composition and sized-fractioned biomass and gut fluorescence.

Site selection for the experimental cycles and sampling locations for intensive front crossings were guided by underway surveys with the flow-through Advanced Laser Fluorometer (ALF) to detect surface features and the Moving Vessel Profiler (MVP) to measure subsurface structure.

Two custom-built ALF instruments (Chekalyuk group) were used for the measurements of underway fluorescence and for discrete sample analysis during the experimental cycles and front samplings. The ALF is a portable benchtop instrument that combines high-resolution spectrally and temporally resolved flow-

through measurements of laser-stimulated emission from seawater, allowing for real-time spectral deconvolution of the signals associated with Chl a, phycobiliprotein pigments associated with different types of *Synechococcus*, chromophoric dissolved organic matter (CDOM), and variable fluorescence, F_v/F_m indicative of phytoplankton photochemical efficiency and photophysiological status. During the underway measurements, ALF was connected to the shipboard uncontaminated seawater system that continuously pumped surface water from 4.5 m at the bow of the ship, and it was integrated with the ship's MET system. It consistenly provided strong signals at the frontal boundaries between adjacent water masses.

The MVP profiles vertically to a depth of 200 m with the vessel moving at up to 12 kts. Its sensors include a Laser Optical Particle Counter (LOPC), Chl-a fluorometer, and fast response CTD. Following initial replacement of a controller interface power supply, the MVP performed admirably. A total of 390 MVP casts was completed, with 326 casts to 200 m on 7 separate frontal crossings (Fig. 3).

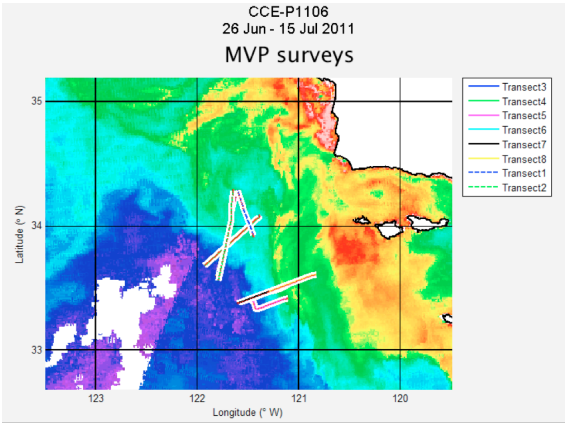
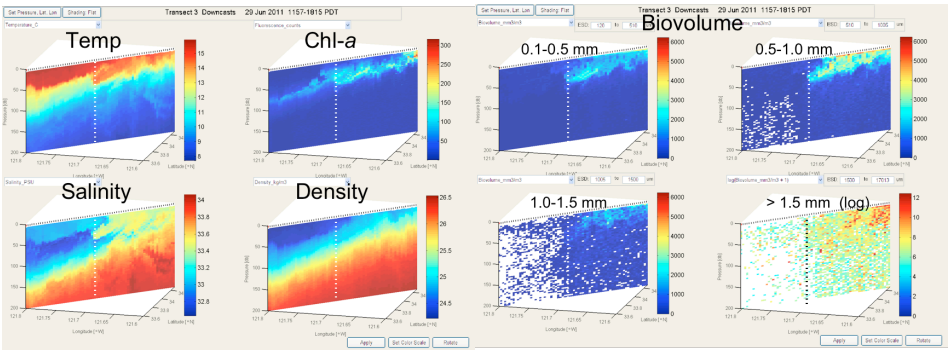


Fig. 3. Above: MVP survey lines. Below: Panels illustrate a SW to NE section across a major front (dotted line) in our study region (M. Ohman).



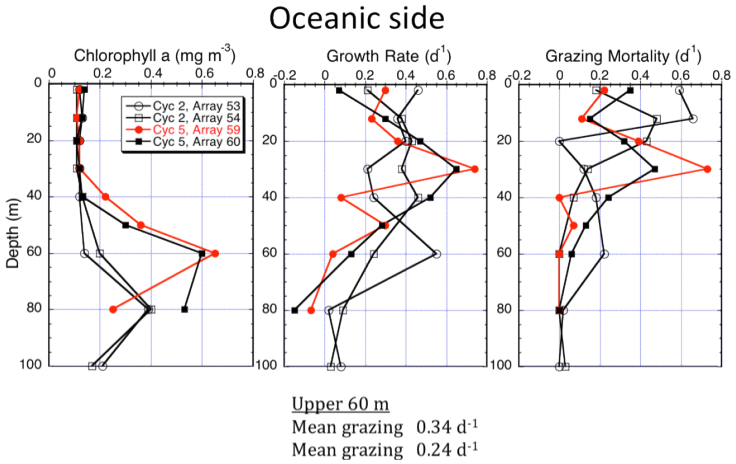
GROUP REPORTS

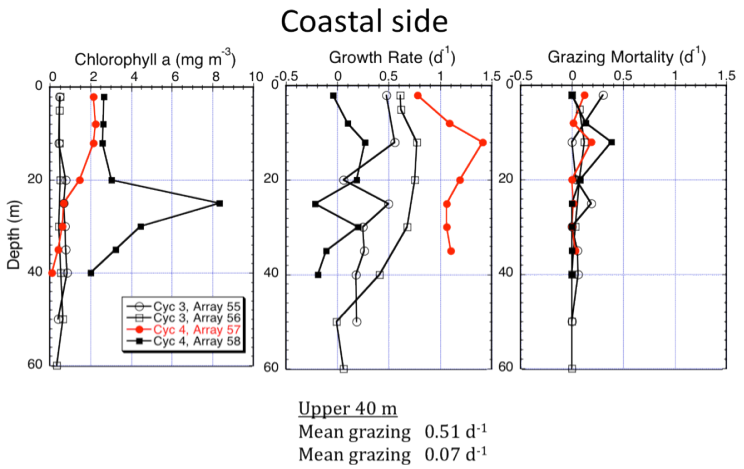
Microplankton Studies – Mike Landry and Ralf Goericke groups

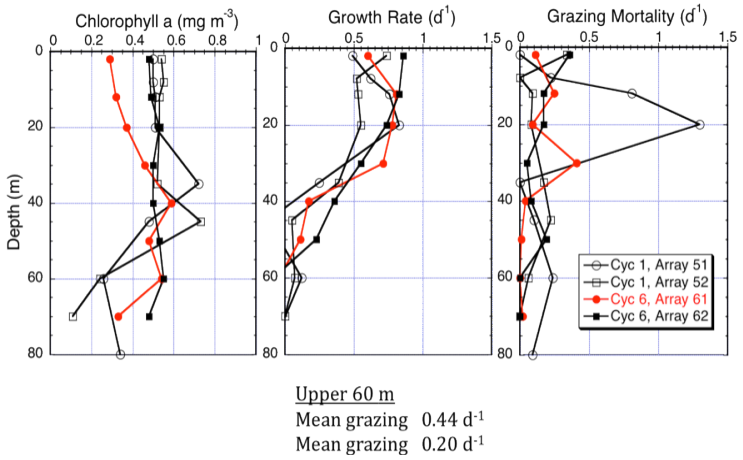
The Landry lab group was responsible for coordinating the drifter experiments, including experimental estimates of phytoplankton growth and microzooplankton grazing rates by the dilution method, initial and final measurements of abundances and biomass of bacteria and picophytoplankton by flow cytometry, and initial and final assessments of composition, biomass and size structure of auto- and heterotrophic protists by epifluorescence and inverted microscopy. The Goericke group was responsible for pigment assessments of phytoplankton standing stocks and composition (total and size-fractioned fluorometric Chl*a*; HPLC accessory pigments), for primary production measurements by ^{14}C uptake, and for basic sampling of nutrients and POC/PON. These various measurements are used together for determining total community and group-specific rate estimates for the incubation studies.

In the figure below (Fig. 4), preliminary Chl*a*-based results from the process experiments on the oceanic side (west) of the frontal area show a well-defined deep Chl maximum, relatively low mean phytoplankton growth rates (μ = 0.34 d^{-1}) for the upper 60 m, and mean microzooplankton grazing impact of ~70% (= 0.24/0.34) of daily primary production On the coastal side (east) of the front, chlorophyll and growth rates were highly variable but higher on average than on the oceanic side (e.g., μ = 0.51 d^{-1}) and microzooplankton grazing was notably very low (~14% of PP). In experiments conducted in waters directly at the front, we see no evidence of enhanced biomass or rates relative to the coastal side; instead they are intermediate in all respects between the oceanic and coastal extremes.

Fig. 4. Preliminary results from dilution incubations from Cycle 1-6 experiments.





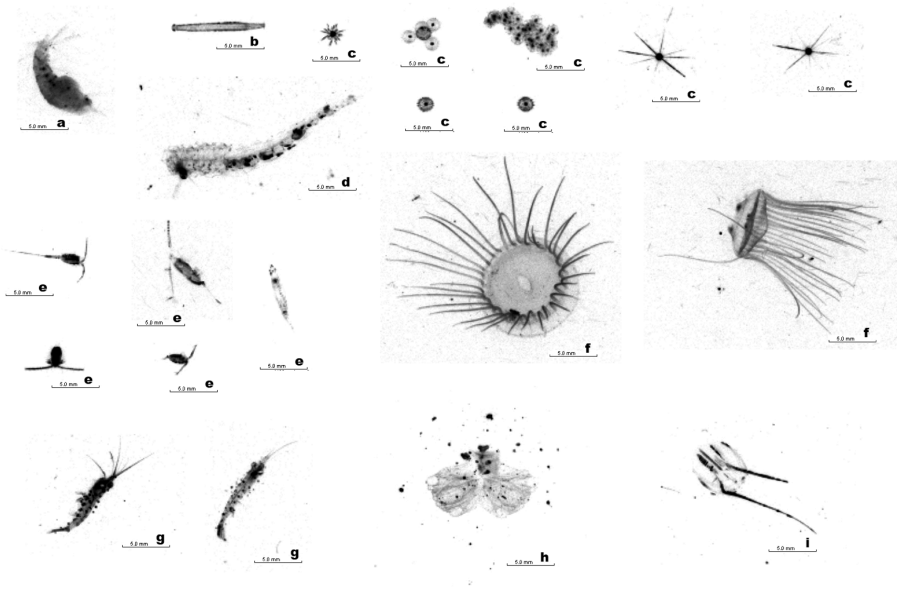


Mesozooplankton Research – Mark Ohman and group

Vertically stratified plankton sampling was carried out with a 1 m^2, 202-µm mesh MOCNESS, deployed at experimental Cycles within a front and on either side of it. The MOCNESS was equipped with sensors for temperature, salinity, O_2, beam attenuation coefficient, and Chl*a* fluorescence. Sampling was conducted to assess changes in mesozooplankton vertical distributions and diel vertical migration behavior in relation to the frontal features. Samples were fixed in 5% buffered Formalin, and in addition, for one day and one night vertical series per cycle, samples were split then 50% fixed in Formalin and 50% fixed in 95% non-denatured Etoh. Ethanol-fixed samples will be used to analyze calcification of thecosome pteropods in relation to aragonite solubility, and for molecular genetics.

Twenty-two MOCNESS tows were completed. Usually 2 day and 2 night vertical series were conducted during each Cycle, although for 2 Cycles a total of 3 series were completed. All sensors on the MOCNESS functioned correctly, apart from an initial lack of response from the net trip indicator, and some intermittency of flow meter response at deeper depths.

We also ran the Underwater Vision Profiler 5 (UVP5), an in situ plankton camera on loan from IFREMER, France. This instrument was mounted inside the CTD-rosette frame so that it imaged a volume of water virtually undisturbed by the frame. The system collected images during the downcast only (sample images below).



The UVP5 collected data from 5 of 6 cycles and from 2 of 3 front-crossings. No data were collected from front-crossing 1 and Cycle 1 due to internal computer crashes and lens issues. The system was fixed and functioned with no additional issues for the rest of the cruise. 58 UVP5 profiles were completed during this cruise; 20 from front-crossings 2 and 3 to 300 m and 38 profiles from Cycles 2-6.

Bongo tows were made with a 71-cm diameter, 202-µm mesh bongo net, for determination of mesozooplankton biomass and grazing rates, the latter by gut fluorescence. At experimental Cycles, samples were taken to a depth of 210 m, with one net sample fixed in 5% buffered Formalin for taxonomic analyses and the other size-fractionated into 5 size categories (0.2, 0.5, 1.0, 2, 5 mm) and frozen in liquid N_2. The latter sample was divided such that 3/8 will be used for biomass determination, 3/8 for mesozooplankton gut fluorescence, and ¼ for other studies. At the front crossings, the bongo frame was modified to be deployed and retrieved vertically, to facilitate more rapid sampling. The net was lowered to 100 m and the samples processed as before upon recovery, except that size fractionation was not carried out. One sample was fixed in Formalin, the other split and frozen in liquid N_2, with half for biomass and half for gut fluorescence. Fourty-four oblique bongo tows were completed, representing replicate day and night sampling at each experimental Cycle. Twenty-seven vertical bongos were completed, on the 3 front crossings.

Incubation experiments were performed with two of the numerically dominant calanoid copepods in our study site (*Calanus pacificus* and *Eucalanus californicus*), to assess mesozooplankton reproductive responses to the frontal

gradients. In some circumstances egg production rate can be used as an index of secondary production. Live copepods were collected in the upper 200-250 m in the daytime and incubated in water from the depth of the chlorophyll maximum. Egg production was recorded at 12 and 24 h, then egg hatching success recorded after a time period corresponding to 1.5X the embryonic duration.

Trace Metal Sampling – Kathy Barbeau and group

The trace metal group completed 19 sampling casts with the new 12-bottle X-Niskin rosette, covering Cycles 1-4. Once initial issues with programming the auto-fire module and cocking the X-Niskins were worked out, the rosette proved to be an effective and time-efficient tool for profiling and sampling at depth. Continuing issues with the line and block resulting in breakage of the Vectran cable prompted us, however, to reconsider our profiling strategy and switch to GO-Flo bottles for Cycles 5 and 6. 8 GO-Flo casts were completed. In terms of iron distributions, 11 depth profiles and 124 samples were taken for total dissolved iron measurements, ranging in maximum depth from 250-500m. Three of the 11 profiles were also sampled for iron organic complexation measurements, and one was sampled for both iron and copper organic complexation. In addition, 2 surface transects across the front were sampled for total iron analyses using a pole sampling method, totaling 16 dissolved iron samples and 4 iron organic complexation samples. Pole sampling (surface samples) was also conducted for the final front crossing. Large volume particulate samples were obtained at four sites for studies of the trace metal content of diatom frustules (for graduate student D. Richter, SIO).

Experiments were performed to examine iron dynamics and biogeochemistry at frontal and end member cycles. Photochemical iron-binding ligand degradation experiments were performed at Cycles 2, 3 and 6 to examine abiotic ligand dynamics in the euphotic zone. Bacterial culture experiments were also carried out at all cycles, along with collection of DNA for studies of the environmental distribution and phylogeny of prokaryotic iron transport genes. Iron addition experiments were performed during Cycles 1, 2, 3, 4 and 6, incorporating $^{15}NO_3$ uptake incubations to determine potential differences in nitrate uptake between +Fe and control treatments. Several experiments, conducted in collaboration with Jeff Krause, also examined the effects of Fe addition on silicate metabolism. An extensive iron addition grow-out was performed over 9 days in Cycle 3, in water collected at 0600 on Day 1 from 30 m, within the upper part of the chlorophyll maximum (Fig. 5). This experiment followed both the biological response as well as the changes in iron speciation resulting from a simulated bloom followed by decline in unamended and +Fe bottles. Bottles were incubated in the light for the first 6 days, until sufficient separation in relative

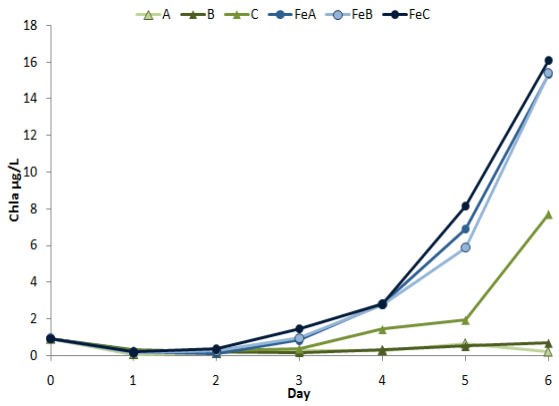


Fig. 5. Results illustrating enhanced growth of Chl*a* with iron (Grow-out experiment from Cycle 3 Day 1, sampled at 30 m).

chlorophyll concentrations was achieved between +Fe and unamended treatments, and then bottles were placed in the dark to stimulate bloom decline. Grow-out results indicate potential for iron limitation of the phytoplankton community at this cycle location.

Export Flux Measurements - Mike Stukel

We assessed carbon export using two different approaches, ^{238}U:^{234}Th disequilibrum and sediment traps. Total ^{234}Th concentrations were measured from 4-L samples at ten depths on two profiles for each Lagrangian cycle experiment. The C: ^{234}Th ratio was assessed for each 2-day cycle at one or two depths using sediment traps and a McLane *in situ* pump. VERTEX-style sediment traps were deployed at 100-m depth and also at the base of the euphotic zone (when the euphotic zone was shallower than 100 m) for the duration of each cycle (~2.25 days). Sediment trap tubes were sorted to remove zooplankton swimmers, split, and used for several different analyses including C/N, C:Th-234, particulate and dissolved Si, $CaCO_3$, pigments, and taxonomic enumeration.

We also measured $^{15}NO_3$uptake as an estimate of new production. $^{15}NO_3$ Uptake was measured *in situ* daily at eight depths during the cycle experiments. Samples were typically spiked with $^{15}NO_3$ at a concentration of 2-10% of ambient nitrate (as assessed spectrophotometrically) and incubated for 24 hours. $^{15}NO_3$ uptake was also measured at a single depth in the mixed layer (incubated onboard at 33% light level) for 6 hours at each of the stations of our front crossing transects. Twice we conducted 24 hour deckboard experiments to assess diel patterns of $^{15}NO_3$ uptake and to test the assumption that ^{15}N was not being recycled in the 24-h *in situ* incubations.

Silicon Biogeochemistry - Jeff Krause (UCSB)

Multiple parameters pertaining to silicon biogeochemistry were measured during the P1106 cruise. Standing stocks of dissolved orthosilicic acid ($[Si(OH)_4]$, were run at sea using a manual spectrophotometric method, and biogenic silica ($bSiO_2$) samples were collected. The rates of $bSiO_2$ production and export flux were measured, respectively, using ^{32}Si tracer and surface-tethered sediment trap arrays (VERTEX style). Like the water-column $bSiO_2$ samples, trap $bSiO_2$ will be analyzed on shore, as will ^{32}Si samples. All parameters were measured during each experimental cycle, but only standing stocks were measured during front transects.

Profiles of $[Si(OH)_4]$ showed typical vertical distributions (Fig. 6), with drawdown in the surface and increasing concentrations with depth. Shallow (e.g. 20 m) gradients were observed in experimental Cycles 3 and 4 with gradients at least twice as deep (e.g. ~40-50 m) during other experimental cycles. Drawdown to ~0.1 µM was observed in the upper 10 m during Cycle 4 and is only among a handful of reports globally observing such low $[Si(OH)_4]$ -- in all previous reports the low concentrations were due to intense diatom drawdown, such low values are below autoanalyzer detection limits.

The flux of biogenic silica due to the in-trap dissolution of particles was also quantified at sea by measuring the increase in $[Si(OH)_4]$ from the pre- and post-

deployment brine solutions (Fig. 7). Higher particle dissolution occurred during experiment Cycles 1, 3 and 4 compared to Cycles 2 and 5, which were areas of presumed lower primary productivity and phytoplankton biomass. For context, the daily silica flux reported in the Santa Barbara Basin (470 m) ranges between 0.7-27 mmol Si m^{-2} d^{-1} with a mean of 4.3 mmol Si m^{-2} d^{-1} (Thunell 1998, Shipe & Brzezinski 2001).

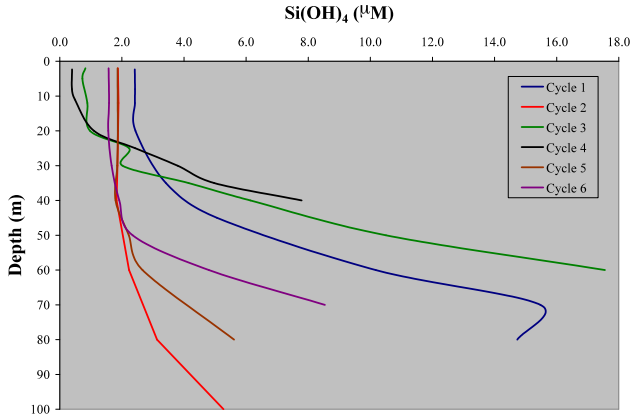


Fig. 6. Average vertical distributions of [$Si(OH)_4$] during experimental cycles (mean of three profiles per cycle).

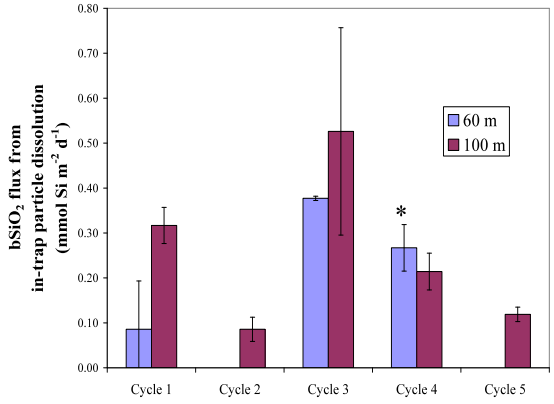


Fig. 7. Flux of bSiO2 due to particle dissolution during deployment. *Indicates trap was at 50 m instead of 60 m. All data are preliminary estimates without accounting for [$Si(OH)_4$] change due to mixing during deployment; however, assuming that mixing occurs at the surface, and given that all initial brine [$Si(OH)_4$] were higher than surface values, these preliminary estimates are likely conservative.

Micronekton – Tony Koslow and group

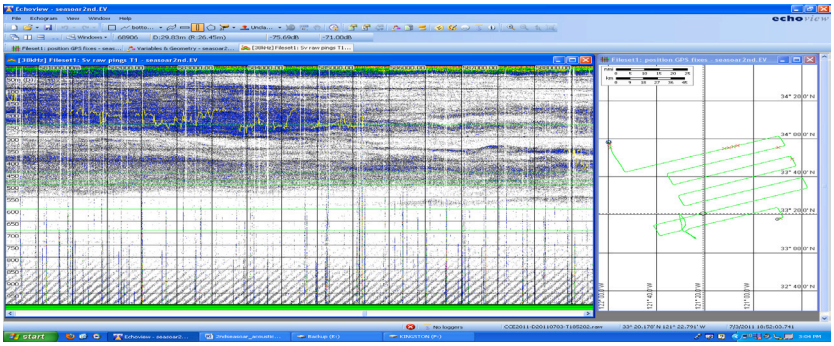
The abundance, vertical and horizontal distribution, size and species composition of the micronekton were examined based on sampling with Simrad EK-60 multifrequency acoustics (38, 70, 120, 200 kHz) system and depth-stratified sampling with a Matsuda-Oozeki-Hu trawl (MOHT) (5-m^2 mouth opening, 1.6-mm mesh). The latter was equipped with a HydroBios 0.25 m^2 mouth opening multinet with five nets serving as an opening/closing cod-end system (MOHTOCS).

This was the first use of the MOHTOCS. Our aim was to sample five strata from 1000 m to the surface: below the oxygen minimum zone (OMZ) (800 - 1000 m); within the OMZ (550 - 800 m); the hypoxic boundary layer above the OMZ (350 - 550 m); the upper mesopelagic zone (100 - 350 m); and the upper 100 m. To assess diel vertical migration patterns, two samples were obtain in daytime at each cycle and one or two at night. While the system was mechanically reliable, the samples often failed to pass through to the cod ends and ended up in the last one.

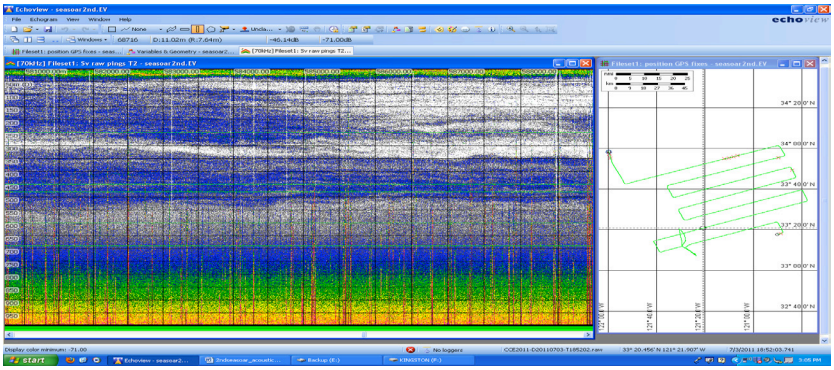
This was partially rectified by the end of the cruise, but the net design requires modification. There were striking differences in the trawl samples between offshore and nearshore water masses.

The acoustic system was mounted on a pole on the port side of the vessel. It was initially mounted too deep leading to collapse of the pole on the first night out. However, the pole was retrieved, and the chief engineer was able to cut off the damaged sections, weld on flanges, and re-configure the pole. The acoustics data were generally excellent, often showing striking changes in faunal biomass and distribution in the vicinity of fronts and at the different cycles (Fig. 8).

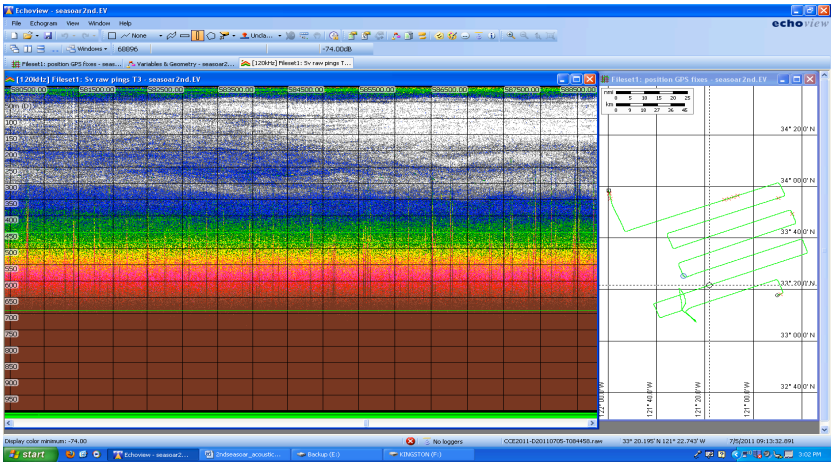
38KHz



70KHz



120KHz



200KHz

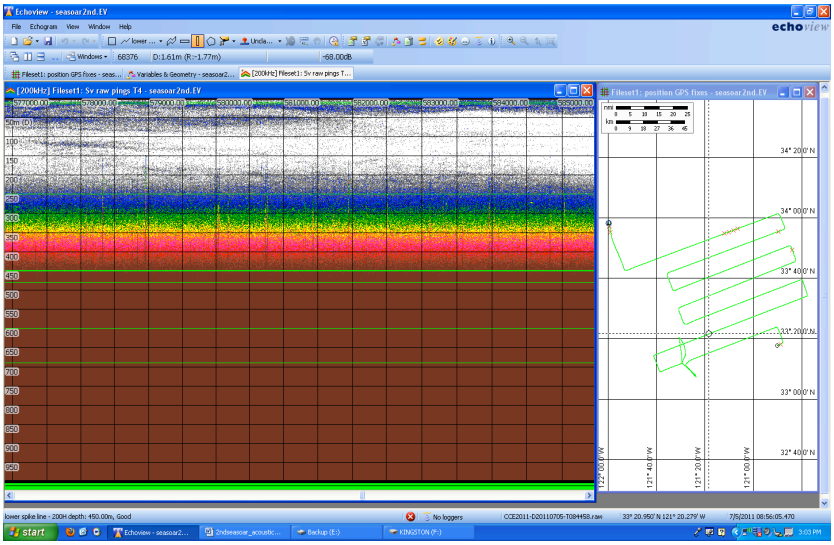


Fig. 8. Acoustic backscattering from the four frequencies (38, 70, 120, 200 kHz) from the second SeaSoar survey, line 6, showing the crossing of the apparent front.

Seabird Surveys - Bill Sydeman

Seabird surveys covering 691 linear kilometers and 207 square kilometers were conducted on P1106 by Megan Sanders (Farallon Institute) over 12 days between 21 June and 16 July. During the survey, 369 individuals from 15 species were observed, the average density was 1.8 birds per km^2, and the peak was 22 birds per km^2. The most abundant taxa were the Storm Petrels and the largest flock observed was for Common Murres. The table below summarizes the recorded observations for each species in terms of the total number of individuals, the number of sightings and the average density for the entire survey. The map and figure below shows the transect maps and the density distributions of all species in birds per km^2 for dates with significant bird observations (Figs. 9 & 10).

Fig. 9. Map of seabird survey transects

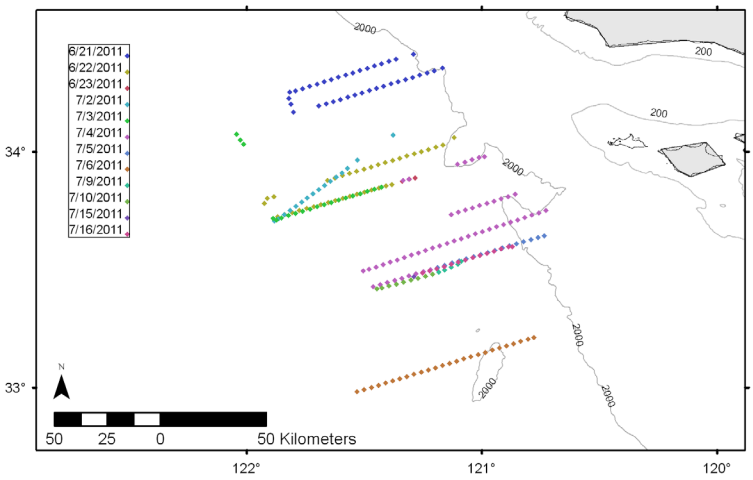
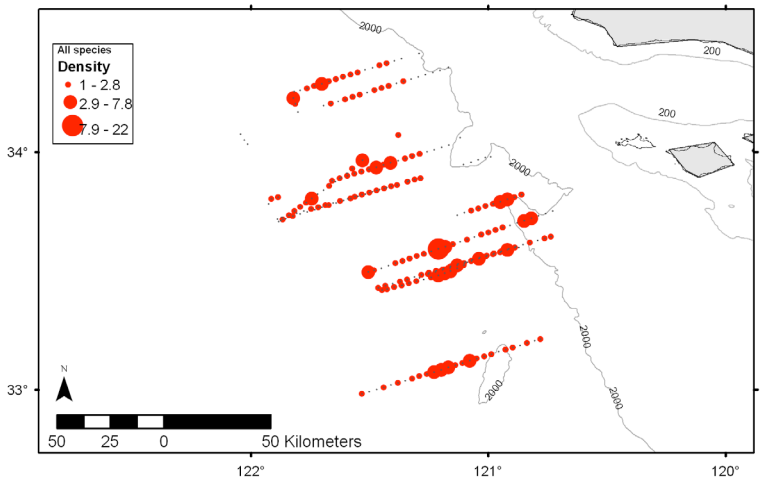


Fig. 10. Seabird distributions. All species, all dates.



Species Summary

Species	Count	Sightings	Density
Black-Footed Albatross	15	15	0.09
Black-Legged Kittiwake	1	1	0.01
Common Murre	45	15	0.17
Cook's Petrel	1	1	0
Dark Shearwater	50	38	0.4
Laysan Albatross	1	1	0
Leach's Storm-Petrel	58	51	0.23
Northern Fulmar	2	2	0.01
Pink-Footed Shearwater	23	13	0.2
Unidentified Auklet	2	1	0.05
Unidentified Cormorant	1	1	0
Unidentified Gull	19	17	0.07
Unidentified Murre	19	10	0.09
Unidentified Shearwater	12	12	0.07
Unidentified Storm-Petrel	139	133	0.66

SHIP AND TECHNICAL SUPPORT

For delicate over-the side operations (drifter and sediment trap deployment/ recovery), ship handling by Captain Murline and the bridge was excellent. Support from the crew, especially engineers and Res Techs, Brian Rowe, Robert Thombley and Rob Palomares, was exceptional. Two major equipment items were largely functional because of their efforts. An acoustics pole broke under stress on the initial run up to the study site, because it had been set too deep (science error). It looked like it was lost for the cruise, but chief engineer Paul Bueren came to the rescue with an inspired job of cutting and re-welding to make the system functional again. Rob Palomares also provided critical electronics help in diagnosing and repairing the MVP (Moving Vessel Profiler) system. Both of these systems were critically important for the success of the cruise.

ADDITIONAL SCIENCE AND SUPPORT OPERATIONS

Mati Kahru provided near real-time satellite imagery from MODIS-Aqua for the duration on the cruise. Clear images of the study area were largely unavailable due to cloud early in the cruise, which increased the difficulty of locating frontal systems for Transect sampling #1 and Seasoar survey #1. Transect sampling #1 was consequently not consider to have been a successful crossing of a defined frontal feature. The cruise greatly benefitted from the context provided by Seasoar surveys, especially due to the extraordinary efforts of Dave Jensen, who produced volumious code on-the-fly to process and display the multi-parameter the survey profiles in real time (Fig. 11). Eventually, clear composite satellite images revealed the large-scale, near-surface expressions of the features in our study area, which provided a valuable semi-synoptic perpsective for our later surveys and process experiments.

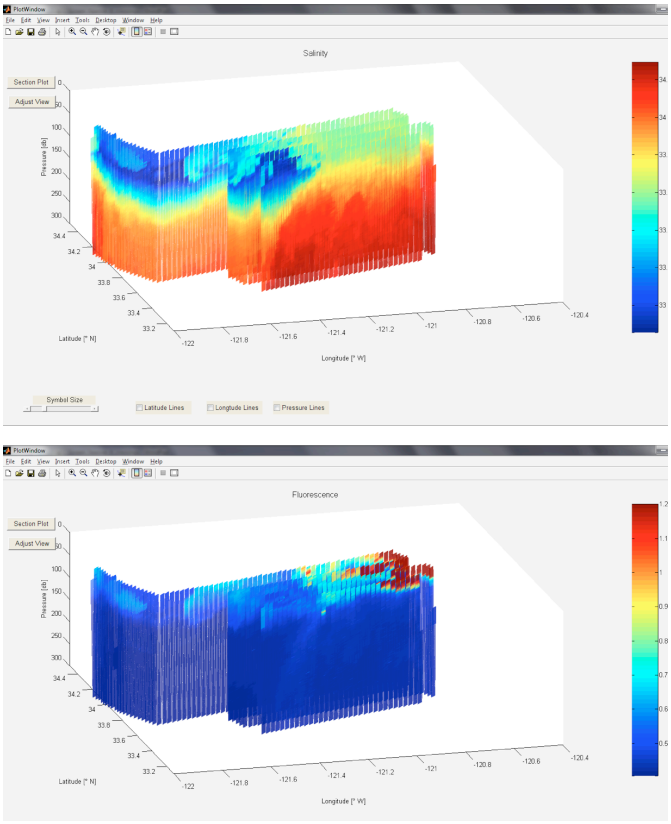


Fig. 11. Computer code was written at sea to display SeaSoar data in real-time, drawn as continually updated 3D plots (D. Jensen).

Top: Salinity.
Bottom: Chl*a* fluorescence.

Spray glider data from CalCOFI line 80 provided helpful insights about frontal structure from a recent crossing of the area early in the cruise. Absent the contemporaneous satellite imagery, however, this information was not sufficient in itself to guide detailed planning of the science experiments.

INFORMATION MANAGEMENT AND EDUCATION

Information Management and Education activities were coordinated, resectively, by Beth Simmons and James Conners.

One of the IM activities is setting up an event logger to provide an authoritative listing of each research activity, with assigned event numbers, date, time and location information. Pre-cruise preparations included incorporation of hardware/software updates on logger laptops, setting up logger stations on the bridge and in the lab, coordination of program decoding with the ship's GPS string, and logger training. A glossary of activity names incorporated as a configuration file serves as a controlled vocabulary list. In contrast to previous CCE cruises, when the event logger worked well, it crashed repeatedly, automatically entered phantom events, and basically required continuous attention and manual correction of each event.

Additional IM activities included input of cruise specifics to the information system study list and participant directory as well as uploading of the cruise data CDs to a project shared disk. Since the event log serves as a key mechanism for post-cruise coordination of datasets, event log cleaning was initiated including checking for consistency and missing data. A web page was set up with cruise information and a dynamic mapper that makes station locations available visually and as a downloadable file.

Education infrastructure and outreach support was provided for one Teacher-at-Sea, Debra Brice, a twenty-year teacher from San Marcos middle school. Ariel Valentino, also from San Marcos middle school, as well as two other teachers Denise Litt and Kim White from Serra High school in the San Diego Unified School District provided land-based assistance in the form of classroom application. Via the CCE LTER Education Outreach webpage, the teachers posted cruise news and thought-provoking questions. They also developed classroom lessons and will have their students create short videos explaining climate change in their local marine ecosystems. These clips and educational resources will be peer-reviewed and posted on a webpage dedicated to climate change within the CCE. The intent is to share resources with the public and other educators who seek a greater understanding of the effects of global climate change on a local marine ecosystem.

On June 8th students from San Marcos Middle School also toured the R/V Melville in anticipation of their teacher's departure. Under the guidance of Bruce Apelgate and Captain Murline, student were introduced to ship dynamics and careers at sea.

CCE-P1106 DAILY ACTIVITY SCHEDULE

17 June

0800 Depart MarFac, calibrate multi-freq acoustics
1030 End acoutics calibration, transit
1500 Test station (TM-rosette, CTD/UVP, MOCNESS, MVP)
2100 Transit to study area

18 June

1300 MVP front survey

19 June – Transect sampling #1

0000 Oozeki trawls, fish acoustics, etc.
2000 Cross-front transect sampling #1 (UP-Front #1/B-Front)

20 June – Seasoar survey #1

0500 End front transect #1
0800 Repair EK60 Sonar pole
1630 Begin SeaSoar survey #1

23 June

0700 End SeaSoar survey #1
0800 Recover SeaSoar
1030 Test MVP system
1100 Transit to study site, 34.04°N, 121.7°W
1330 CTD, 1000 m
1430 MVP front crossing(s)
1800 Reposition pole-mounted acoustics
2000 Oozeki trawl

24 June – Experimental Cycle #1 (central front jet)

0000 Sediment trap deployment, begin CYCLE 1
0100 Wirewalker deployment
0200 CTD cast, CYC 1-1
0300 TM cast, experiments
0430 Deploy drift array #1
0500 CTD, thorium
0600 TM cast, experiments
0930 Net tow, Bongo, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1700 Bongo live tows
1800 McLane pump, C:thorium
1900 TM cast
2000 Oozeki trawl
2300 Zooplankton net tow, Bongo, gut fluor

25 June

0000 MOCNESS
0200 CTD cast, CYC 1-2
0300 TM cast, experiments
0430 Recover #1/deploy drift array #2

0600 TM cast, experiments
0930 Zooplankton net tow, Bongo, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
1700 Bongo live tows
1800 McLane pump, C:thorium
1900 Ring net, plankton isotope size-fractions
2000 Oozeki trawl
2300 Zooplankton net tow, Bongo, gut fluor

26 June

0000 MOCNESS
0300 CTD, CYC 1-3 end
0400 TM cast
0500 Recover drift array #2
0700 Recover sediment trap array
0900 Recover wirewalker

27 June – Experimental Cycle #2 (oceanic/west side)

0000 Sediment trap deployment, begin CYCLE 2
0100 Wirewalker deployment
0200 CTD cast, CYC 2-1
0300 TM cast, experiments
0430 Deploy drift array #53
0500 CTD, thorium
0600 TM cast, experiments
0700 Ring net, plankton isotope size-fractions
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
1800 McLane pump, C:thorium
1900 CTD, full dilution, zoopl experiments
2100 Bongo, Zooplankton net tow, gut fluor
2300 MOCNESS

28 June

0100 CTD, Zoopl experiments
0200 CTD cast, CYC 2-2
0300 TM cast, experiments
0430 Recover #53/deploy drift array #54
0600 TM cast, experiments
0730 Acoustic pole deployment
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl

2000 Bongo, Zooplankton net tow, gut fluor
2100 MOCNESS
2330 Oozeki trawl

29 June

0300 CTD, CYC 2-3 end
0400 TM cast
0500 Recover drift array #54
0730 Recover sediment trap array
0900 Recover wirewalker

30 June – Experimental Cycle #3 (coastal/east side)

0000 Sediment trap deployment, begin CYCLE 3
0100 Wirewalker deployment
0200 CTD cast, CYC 3-1
0300 TM cast, experiments
0430 Deploy drift array #55
0500 CTD, thorium
0600 TM cast, experiments
0700 Ring net, plankton isotope size-fractions
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
1800 McLane pump, C:thorium
1900 CTD, full dilution, zoopl experiments
2100 Bongo, Zooplankton net tow, gut fluor
2300 MOCNESS

1 July

0100 CTD, Zoopl experiments
0200 CTD cast, CYC 3-2
0300 TM cast, experiments
0430 Recover #55/deploy drift array #56
0600 TM cast, experiments
0700 Ring net, plankton isotope size-fractions
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
1800 McLane pump, C:thorium
2000 Bongo, Zooplankton net tow, gut fluor
2100 MOCNESS
2330 Oozeki trawl

2 July – Transect sampling #2

0300 CTD, CYC 3-3 end
0400 TM cast

0500 Recover drift array #56
0730 Recover sediment trap array
0900 Recover wirewalker
0930 Transit north to
2000 Begin Transect sampling #2 (UP-2/C-Front)

3 July – Seasoar Survey #2

0700 End Transect #2
1200 Deploy Seasoar

5 July

1000 Recover & repair Seasoar
1400 Redeploy & resume Seasoar survey

6 July

1400 Recover Seasoar
1600 Transit north to study site

7 July – Experimental Cycle #4 (coastal/east side)

0000 Sediment trap deployment, begin CYCLE 4
0100 Wirewalker deployment
0200 CTD cast, CYC 4-1
0300 TM cast, experiments
0430 Deploy drift array #57
0500 CTD, thorium
0600 TM cast, experiments
0700 Ring net, plankton isotope size-fractions
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030, CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
1800 McLane pump, C:thorium
1900 CTD, full dilution, zoopl experiments
2100 Bongo, Zooplankton net tow, gut fluor
2300 MOCNESS

8 July

0100 CTD, Zoopl experiments
0200 CTD cast, CYC 4-2
0300 TM cast, experiments
0430 Recover #57/deploy drift array #58
0600 TM cast, experiments
0700 Ring net, plankton isotope size-fractions
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
1800 McLane pump, C:thorium
2000 Bongo, Zooplankton net tow, gut fluor

2100 MOCNESS
2330 Oozeki trawl

9 July

0300 CTD, CYC 4-3 end
0400 TM cast
0500 Recover drift array #58
0730 Recover sediment trap array
0900 Recover wirewalker

10 July – Experimental Cycle #5 (oceanic/west side)

0000 Sediment trap deployment, begin CYCLE 5
0200 CTD cast, CYC 5-1
0430 Deploy drift array #59
0500 CTD, thorium
0600 TM cast, experiments
0700 Ring net, plankton isotope size-fractions
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
1800 McLane pump, C:thorium
1900 CTD, full dilution, zoopl experiments
2100 Bongo, Zooplankton net tow, gut fluor
2300 MOCNESS

11 July

0100 CTD, Zoopl experiments
0200 CTD cast, CYC 5-2
0300 GoFlo cast, experiments
0430 Recover #59/deploy drift array #60
0600 GoFlo cast, experiments
0700 Ring net, plankton isotope size-fractions
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
2100 Bongo, Zooplankton net tow, gut fluor
2145 MOCNESS
2330 Oozeki trawl

12 July

0300 CTD (1000 m), CYC 5-3 end
0400 GoFlo cast
0500 Recover drift array #60
0730 Recover sediment trap array
0830 Leave area to South for HARMEX “live fire”

13 July – Experimental Cycle #6 (central front jet)

0000 MVP survey to front site
0330 Sediment trap deployment, begin CYCLE 6
0400 CTD cast, CYC 6-1
0500 GoFlo cast, experiments
0600 Deploy drift array #61
0630 CTD, thorium
0700 GoFlo cast, experiments
0730 Bongo live tows
0830 Bongo, Zooplankton net tow, gut fluor
0930 CTD, 14C-PP, biooptics
1000 VACATE AREA TO NORTH FOR HARMEX "Live Fire"
2100 Bongo, Zooplankton net tow, gut fluor
2300 MOCNESS

14 July

0100 Zoopl experiments
0200 CTD cast, CYC 6-2
0300 GoFlo cast, experiments
0430 Recover #61/deploy drift array #62
0600 GoFlo cast, experiments
0700 Ring net, plankton isotope size-fractions
0830 Bongo live tows
0930 Bongo, Zooplankton net tow, gut fluor
1030 CTD, 14C-PP, biooptics
1130 MOCNESS
1400 Oozeki trawl
1800 McLane pump, C:thorium
2100 Bongo, Zooplankton net tow, gut fluor
2145 MOCNESS
2330 Oozeki trawl

15 July – Transect #3

0300 CTD, CYC 6-3 end
0400 GoFlo cast
0500 Recover drift array #62
0730 Recover sediment trap array
0830 Live bongo tow (zoopl experiments)
0930 Redeploy acoustic pole
1030 Transist to MVP survey site
1400 MVP survey
2000 Begin Transect sampling #3 (UP-3/D-Front)

16 July

0700 End Transect #3
0900 Opportunity sampling

17 July

0700 Return to MarFac