ECOHAB-PNW 6 CRUISE REPORT

R/V T. G. Thompson TN200
September 11 – October 4, 2006

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Area of Operations

Coastal Waters off Washington State and Vancouver Island

Itinerary

Depart Seattle, WA, September 11, 2006
Arrive Seattle, WA, October 4, 2006

Participating Organizations

NOAA/Northwest Fisheries Science Center
Romberg Tiburon Center, San Francisco State University
University of Maine
University of Washington

Cruise Logistics

Dr. Nancy Kachel, University of Washington

Cruise Personnel

Chief Scientist

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Julie Wright, School of Oceanography, University of Washington

Cruise Objectives and Sampling Scheme

The purpose of this cruise was to determine the physical, chemical and physiological conditions under which diatoms of the genus *Pseudo-nitzschia* (*PN*)

produce the neurotoxin domoic acid (DA), and the ecophysiological conditions which promote cellular release of toxin to the surrounding environment. We attempted to observe the conditions under which toxic cells advect towards the coast of Washington where they are consumed by shellfish. Such occurrences lead to closure of beaches to razor clam collection to avoid outbreaks of amnesic shellfish poisoning.

Sampling was organized around a comprehensive grid of stations, sampled repeatedly as environmental conditions changed. Continuous surface water measurements included: temperature, salinity and *in vivo* fluorescence, discrete surface samples for planktonic community analysis and species identification were collected with net tows. Property profiles were obtained with an instrumented rosette including a CTD (conductivity, temperature, depth) and additional sensors that measured *in vivo* fluorescence, photosynthetically active radiation (PAR), beam attenuation (light transmission), and oxygen concentration. During CTD casts discrete samples were collected with Niskin water samplers for chlorophyll, inorganic and organic nutrients, plankton species and community identification (via FlowCAM and flow cytometer analyses), and particulate and dissolved DA. A trace metal clean, underway sampling system was employed to collect subsurface samples that could be measured on board (e.g. iron), and to collect samples for multi-element determination (including copper) ashore. On-deck incubations of phytoplankton assemblages were conducted for growth, nitrogenous nutrition and grazing experiments, and shipboard analyses of the plankton were routinely conducted using both traditional (microscopic) and advanced (FlowCAM image and flow cytometric analyses) methods. Satellite-tracked drifters were released in and near the Juan de Fuca eddy and off the coast of Washington. The cruise was diverted to Neah Bay on September 22 and 24 to exchange personnel. The overall ship track and CTD stations are shown in Figure 1.

Operations

ADCP lines: ~3000 km
Flow-Through system track with T, S, FL sensors: ~3000 km
CTD casts: 234
Satellite-tracked drifter deployments: >15

Samples Collected

Size-fractionated chlorophyll *a* samples: > all ECOHAB grid stations, Juan de Fuca and Puget Sound stations, anchovy study, dilution experiments and deck-board manipulation experiments (>4500 samples)
Cellular fluorescence capacity samples: (DCMU-mediated F_v/F_m) ~200 samples
Inorganic nutrient samples for phosphate, nitrate + nitrite, and silicate: all grid stations and deck-board experiments (~2000 samples)
^{14}C Uptake (P vs. E) rates: 65 experiments (~1200 samples)

Heterotrophic Bacterial Productivity: 50 experiments (200 samples and controls)
Flow Cytometry samples (nanoplankton, cyanobacteria, bacteria): all grid stations at 5 m and all deckboard incubation experiments.
Dilution growth and grazing experiments: 18 experiments
Microplankton samples (preserved and processed): ~125 survey samples and 128 dilution experiment samples, 54 size-fraction experiment samples, 100 samples from Lefebvre's fish exposure experiment, 20 from Pickell's continuous culture experiments
FlowCAM sample analyses: >1000 survey samples and 100 experiment samples
Nitrogen uptake rate experiments: ~300 N-15 particulate samples (2 size fractions)
Surface (~4 m) samples for Fe determination and samples for analysis of other bioactive trace metals (Zn, Co, Cu, Ni, Cd) ~150 samples
Particulate DA: 818 samples
Dissolved DA: 818 samples
Preserved net tow samples (277) for scanning electron microscopy
Whole water samples (818) for *PN* cell counts
Vibrio samples: 297
Microsatellite analysis/culturing of *P. pungens*: 144 samples
Ammonium samples: >550 discrete samples from profiles and experiments (not including another 400-500 samples from dilution experiments and anchovy experiments)
Urea samples: ~400 discrete samples from vertical profiles and experiments

Cruise Summary

The ECOHAB PNW VI cruise was unique in several ways: first—surface nutrients were extremely high farther offshore and also farther northwestward than we have previously observed. In addition: diatoms of the *Pseudo-nitzschia* (*PN*) genus were the least abundant in the eddy region of all four fall ECOHAB PNW cruises. Finally, domoic acid concentrations were the lowest we have observed in the eddy region. Cell numbers, domoic acid concentrations and chlorophyll were all higher near the Washington (WA) coast than in the eddy, as in September 2005. However, values were much lower this fall than in fall 2005.

This cruise took place during a year with record level upwelling-favorable winds—and these strong winds continued through the early part of our cruise. In contrast, the 2005 fall cruise took place during a summer with anomalously late onset of upwelling-favorable winds (mid July). Community variability from year to year, independent of summertime upwelling, may play a role in the character of the planktonic ecosystem we observe in any given year. Also a major fall storm occurred during the first week of our cruise—winds in this storm were much stronger than in other fall ECOHAB PNW cruises. This storm increased northwestward currents and likely contributed to the along coast lengthening of the area of very high (> 15 µm) nitrate. The observed distributions may represent the beginning of the breakdown of the summertime eddy. We note that this cruise

took place later in the year than the other cruises, thus under lower light levels. The lack of plankton accumulation in the presence of large amounts of nitrate intrigued the PIs and an experiment was conducted on the importance of light to *PN* growth.

The study obtained multi disciplinary data from a large scale grid (Section 1), sampling water properties and plankton while following a drifter (Section 2), deployment of surface drifters (Section 3), satellite imagery (Section 4), and on-board laboratory studies using water/plankton collected at selected sites (Section 5).

The setting of cruise sampling events with respect to wind direction (upwelling or downwelling-favorable) is shown in Figure 2. Winds during the cruise were strong and upwelling-favorable for roughly a week, strong and downwelling-favorable for the next several days, then primarily upwelling-favorable for the remainder of the cruise. The complete grid survey took several more days than usual because the iron sampler could only be towed at a speed of 5 knots. Thus the primary grid sampling occurred during several wind environments. All data sections and maps on the website are grouped into three periods independent of winds: survey 0 includes data prior to the major grid sampling; survey 1 includes data collected on the complete grid survey, including lines LD and LE; survey 2 includes data following the grid survey. Personnel transfers occurred on September 22 and 24.

Over 230 water column profiles were obtained. Satellite imagery [sea surface temperature (SST) and chlorophyll] was limited in the first two weeks of the cruise. However a number of very good surface SST and fluorescence (Chl a) were obtained in the upwelling period beginning September 21. Cruise activities were recorded in a sequential “Event” log (Table 1).

Our cruises to date provide sufficient information to allow a comparative analysis of various environmental factors and their effects on *PN*, growth, grazing, nutrient pathways and DA production in the eddy and WA coast regions. In particular, with the new information obtained during this cruise we have shown that:

- Community structure and the dominant species of *PN* have large interannual variability.
- Domoic acid levels in the eddy region can have large interannual variability.
- Physical transport in the eddy and coast region have much less interannual variability than plankton communities and DA concentrations, thus lending themselves well to numerical modeling.
- Although DA concentrations sufficient to toxify shellfish may be relatively rare, lower levels (obtained using the more sensitive detection ELISA method) may occur commonly in the PNW region.

1. Regional Surveys (ECOHAB PNW team)

Our large scale survey grid was designed to include areas influenced by the Strait of Juan de Fuca, the Juan de Fuca eddy region and the coastal upwelling region off the Washington coast (Fig. 3). Data collected on surveys included conductivity (C), temperature (T), light transmission, PAR, oxygen and fluorescence (Fl) profiles, and bottle samples for size-fractionated phytoplankton biomass (chlorophyll *a*), whole cell fluorescent molecular probe assays, particulate DA, dissolved DA, FlowCAM and Flow cytometry samples, samples for scanning electron microscopy of *PN* species, plankton (including *PN* cell counts) and macronutrients, all at selected depths in the water column. Surface net tows for qualitative community assessment were taken at all survey stations. Water samples containing *PN* were placed in medium for isolation and culturing in the laboratory. Underway data included T, C and Fl pumped from a depth of about 4 m as well as ADCP current profiles from 75 khz broad and narrow band RDI ADCPs.

CTD/nutrient/net transects were made along Puget Sound and along the Strait of Juan de Fuca on September 12 during the transit from Seattle (Fig. 4a). Bucket and net samples were obtained on the return journey.

Lines were sampled in whichever direction made best use of ship time. CTD profiles were taken to 500 m where possible. For modeling purposes and to investigate interannual changes, one station was taken to 1000 m (CTD 197). For the third time in our ECOHAB PNW studies, the northern line LD was sampled. A new line (LE) farther northwest was sampled because of the northwestward spread of the surface eddy water. Note that LE begins at the location of the Institute of Ocean Sciences (IOS) LE line, but is oriented differently than that line and thus stations are not identical to the IOS stations. Another new line (WB, offshore of Willapa Bay) was sampled because an increase in *PN* cell numbers was observed on the beach by ORHAB, our partner program, at Twin Harbors and Long Beach.

Two or three calibration CTDs were taken at each of the four mooring sites.

Chlorophyll *a* (size-fractionated samples: >5 m and GF/F filters), particulate and dissolved DA and plankton samples (for both microscope and occasional molecular probe analysis) were taken near the surface (~0 m), 5 m and 10 m and chlorophyll max. Preserved samples for flow cytometric analysis of nanoplankton, cyanobacteria, and bacterial abundance were taken from 5 m at all grid (survey 2) stations.

DA samples were also taken at 15, 30 and 50 m at other stations, for example, at the drift A stations.

Macronutrients (nitrate + nitrite, phosphate, silicate) were taken generally at the surface, 5 m, 10 m, 15 m, 30 m, 50 m, 100 m, 200 m, 500 m and ~5-10 m above bottom if the bottom was less than 500 m deep. In the Juan de Fuca Strait

survey, samples were taken also at 150 m. Whole water samples (4 L) from these deep stations were concentrated through a 20 micron mesh and plankton and were visualized through the FlowCAM. On transects, macro-nutrients were taken in most cases at the two stations closest to shore on a line and then every other station on each line. On LE only surface nitrate samples were taken, but they were taken at every station. During survey period 2, macronutrients were not generally taken, because the ISUS (see below) was working well. Stations were taken when the ISUS briefly failed, on the LAB line (second pass) where we wanted phosphate for Amy MacFadyen's water mass analysis, for drifter endpoint CTDs and for mooring sensor calibration. Most of the macro nutrient samples were processed onboard ship by Julian Herndon (Cochlan group) to enable future onboard sampling decisions. Data will be quality controlled and remaining samples will be processed by mid January 2007.

The ISUS nitrate sensor data, mounted on the instrumented CTD rosette, can be used for vertical profiling, with appropriate calibration. For the first time, the ISUS worked very well, thanks to the efforts of Nick Adams. Regressions between measured nitrate and ISUS nitrate were obtained with a correlation of 0.99 By Sally Warner and Tom Connolly (Bottle = 0.4075 + 1.0987 *ISUS). The slope and intercept remained constant throughout the cruise. Sections were compared between ISUS and bottle data—in some cases the ISUS provided significantly better structure below 100 m.

Upper water column iron samples were taken at selected stations (Table 1). Samples were obtained by flying the trace-metal sampler “FISH” below the surface (~4 m). Samples were taken as the ship approached station (within 10-min). Water was pumped for roughly 10 minutes (20 min prior to station location) to flush the lines thoroughly before samples were taken. In addition to FISH sampling for trace metals, all physiological measures and growth rates (phytoplankton and bacteria) were obtained from the FISH, as well as samples for deckboard incubation experiments. Physiological studies were made on several stations per grid line during the main survey. On some grid lines (GH, LB and LC), a GoFlo bottle at ~10 m was used instead of the towed package. When using these data with the ~4 m data care should be taken to ensure that a mixed layer was present.

CTD profiles are available in pdf format on the cd of ship's data (note: disregard PAR profiles, which are quite wrong, see below). These were prepared by the ship's marine technician and are unedited, although a good reference. The CTD data were partially edited onboard ship by Nancy Kachel. Shipboard editing included replacing downcast data with upcast data when necessary. The shipboard data were used to construct the preliminary maps and sections appended to the report. Following the cruise, salinity calibration will be performed and more detailed editing completed (Hickey group). Although water property spatial patterns are likely robust, actual values may change slightly following the final editing which we hope to complete this fall. ADCP data were processed onboard ship by Tom Connolly. Preliminary water property maps and sections

obtained from CTD data are given on the ECOHAB PNW website (T, S, O_2, Chl, Fl maps at selected depths; T, S, density, Fl, O_2 transects versus depth for all transects, 0-100 m and 0-500 m scales). Maps of relative abundance of *PN* at the surface are also included.

The CTD data are organized into three groups: Survey 0 (September 12-September 14), Survey 1 (September 14- September 26) and Survey 2 (September 27-October 3). Stations sampled in each period are shown in Figures 4a,b,c. Survey 0 includes the Puget Sound and Strait data. Survey 1, which took place during variable winds, following a period of upwelling winds, was the only complete grid survey (Fig. 4b). Lines sampled in Survey 2 are useful for characterizing changes over the cruise period. In particular, the KB, CB, GH and WB lines include information on a freshwater plume from the Columbia River—this plume developed along the WA coast during the September 16-19 storm.

Underway data should be treated with caution. Water is pumped from about 5 m depth near the bow. As is customary, two temperatures are available. The exterior temperature had a slight offset from 5 m CTD bottle data (5 m bottle = -0.01363+ 1.0033*ext Temp, r^2 = 0.98, data through September 21). The salinometer data from September 12 through September 18 should not be used. After careful analysis we determined that the conductivity cell was biofouled. Numerous regressions between CTD bottle and salinometer salinity and also conductivity were performed (by Sally Warner). Although the conductivity regression was very tight (r^2 = 0.93), the salinity regression was quite poor and offsets were nonlinear. We did not perform new regressions after the cell was cleaned—this should be done before using the later data.

The PAR sensors on the CTD had a variety of problems, and the converted data (in uE) are not usable. This includes profiles plotted in the shipboard pdf files. The PAR sensor on the CTD was a 2pi, which is not appropriate for underwater PAR measurements, and had an unusually narrow voltage range response (0-2 volts). The appropriate 4pi sensor was put on the CTD on September 23, but it also had an unusually low voltage range. An inspection of the connection revealed water entry and corrosion of one of the pins, which most likely accounted for the reduced voltage. The connection was remade, and the voltage range appeared normal. However, the calculated uE values in the CTD data files are not correct; it will be necessary to work with the voltage data to determine extinction coefficients and use the PAR data from deckboard sensors. A comparison of the 2pi data to the 4pi data will hopefully allow a correction to the 2pi sensor data.

One drift study was performed on the cruise—this was a brief drift in the shelf edge jet region during a period of upwelling (September 9-12) in an area with moderate nitrate and low concentrations of *PN* (drifter # 3918, deployed on the front between stations LC 8 and 9). After 1.5 days, 3918 was removed and replaced with drifter #66684. Since it was moving well offshore (and southward) it was not sampled again during the cruise and it was not recovered.

Some Preliminary Results:

This cruise was unique in several ways: surface nutrient concentrations were extremely high farther offshore and also farther northwestward than we have previously observed, and chlorophyll was much lower than usual, in spite of the more than adequate nutrient supply. This was the case in both early and late survey periods. Surface nitrate >15 M was observed from the mouth of the strait northwest well past Barkley Sound and south along the WA coast past Grays Harbor.

Diatoms of the *PN* genus were less abundant in the eddy region than in any of the other three fall ECOHAB PNW cruises. High numbers of *PN* were only observed near the southern WA coast. After 2 weeks working in the eddy region and completing the survey grid, we moved back to the southern coastal region where satellite imagery showed high biomass and the early cruise data showed more *PN* cells present as well as low but measurable toxin levels. The WA coastal region did have more *PN* than the eddy, but much fewer than the preceding year's fall cruise. Chlorophyll was also much higher on the WA coast than in the eddy. Nevertheless only very low levels of toxin were detected. Domoic acid concentrations were the lowest observed in the eddy region in all six survey cruises. All values were below detection limits of the receptor binding assay. However low levels (picomolar) were detected using the ELISA method.

In spite of the macronutrient, DA and plankton differences from other years, the eddy was well defined in temperature, salinity and velocity patterns at the surface and at deeper depths. However it was more elongated along the coast, extending well past Barkley Sound.

Both 2006 and 2005 September cruises had low chlorophyll in the eddy region, although not along the WA coast. The 2006 cruise took place during a year with record level upwelling-favorable winds—and these strong winds continued through the early part of our cruise. In contrast, the 2005 fall cruise took place during a summer with anomalously late onset of upwelling-favorable winds (mid August). The reason for the higher concentrations of *PN* and chlorophyll near the WA coast than in the eddy on these cruises are not immediately apparent.

A major fall storm occurred during the end of the first week of our cruise—winds in this storm were much stronger than in other fall cruises. This storm increased northwestward currents and likely contributed to the along coast lengthening of the area of very high (> 15 M) nitrate. The storm also created a northward plume from the Columbia, as mentioned above, and that plume moved offshore in the upwelling-favorable winds of the survey 2 period. Thus in survey 2 transects we observed high nitrate near the coast in the upwelling zone, lower nitrate farther offshore in the plume, and higher nitrate offshore of the plume in the waters that had originated farther north near the eddy. High nitrate continued throughout the cruise in mid to outer shelf waters in spite of the variable wind conditions—strong upwelling, a strong downwelling-favorable wind period and then weaker but persistent upwelling winds.

It is possible that the observed distributions may represent the beginning of the breakdown of the summertime eddy. We note that this cruise took place later in the year than the other fall cruises.

2. Drift Studies (Amy MacFadyen, Tom Connolly, Barbara Hickey, drifters; whole ECOHAB PNW team for water/nutrient)

One brief (1.5 days) drift study was performed, following a water patch with an ARGOS-tracked Brightwaters drifter (# 3918). Nutrients and CTD profiles were taken in the upper 50 m only at the three stations taken. The drifter moved southward along the major front. When it became evident that the drifter was not going to be entrained by the eddy, the non expendable, lighted drifter was replaced with expendable drifter # 66684. Drifter deployment and recovery times and deployment location are listed in Table 2.

A number of drifters deployed on September 13 (see below) with accompanying bucket samples (#60054 and #60056) were sampled with CTDs on recovery from September 30 to October 3. The goal was to determine whether toxicity or chlorophyll had increased over the initial very low levels and whether species composition had changed over the 3 week interval between deployment and recovery.

3. Drifter Deployments (Amy MacFadyen, Tom Connolly, Barbara Hickey)

Several Brightwaters model drifters (Davis or deep-drogue configurations) were deployed to delineate patterns and speeds of surface flows in the eddy area, as well as to determine the ultimate fate of eddy water. Data were stored at the University of Washington and were also available online on the ship as the ship had web access. Drifter location and water temperatures are available at 30 minute intervals during deployment periods.

Eight drifters were deployed at the beginning of the cruise in a small area over the spur canyon (Table 2). The objective was to characterize vorticity over the canyon and in the central part of the eddy. Three were surface drifters (Fig. 6a); five were drogued at 25 m (Fig. 6b). A fourth surface drifter was deployed just east of the primary array (# 60056) to help characterize the larger eddy circulation (Fig. 6a). Drifters were deployed during strong upwelling-favorable winds (Fig. 2). During the strong downwelling winds of September 16-19 the surface drifters moved rapidly northwestward, passing well north of Barkley Sound (Fig. 6a). When upwelling-favorable winds returned these drifters all moved offshore and turned southeast along the isobaths. The drogued drifters that remained near the eddy center moved at speeds of a few cm/sec, much slower than the surface drifters (Fig. 6b). Two of the drogued drifters appeared to escape the eddy core region. On recovery it was discovered that these drifters had lost their drogues. The other drogued drifters eventually began to turn

counterclockwise following the density contours at 30 m. The surface drifters moved southeastward and returned to the eddy region, following water that still contained high nitrate. Most of the surface drifters eventually moved onshore and then southward along the coastal front. Most had nitrate ~10 M upon recovery on the central WA coast.

Additional drifters were deployed to help describe the circulation. One drifter (#60058) was deployed south of the eddy on September 13. This drifter moved south along the WA midshelf, subsequently moving past Grays Harbor. This drifter was sampled with a CTD on October 1, but was left in the water so that it could interact with the Columbia plume. Two drifters were deployed on September 24: one at LB 13 (#66685); another on the south side of the eddy (#66684). Both of these drifters turned shoreward and then moved southward along the WA shelf. They were subsequently recovered, following a CTD to delineate final conditions.

4. Satellite Imagery (Rick Stumpf, Jack Wekell)

Satellite imagery during the cruise was provided by two groups who sent data to the ECOHAB PNW ftp site—Jack Wekell from the Trainer NOAA group provided SST imagery. Chlorophyll imagery was provided by Rick Stumpf at NOAA. The available imagery and an assessment of its quality are listed in Table 3. Because of delay in imagery sent from R. Stumpf's group, additional imagery was kindly provided by Raphael Kudela at UC Santa Cruz and by Jim Gower at the Institute of Ocean Sciences. Few good images were obtained in the first part of the cruise, particularly during the downwelling wind period. However, clear imagery was obtained after September 21 when upwelling-favorable winds returned.

5. Laboratory Analyses

a) Lessard Group (Evelyn Lessard, Julie Wright, Mike Foy, and Megan Bernhardt)

The main goal of this component of ECOHAB PNW is to determine the role of grazers in *PN* population dynamics and DA production. We used the dilution technique to experimentally alter grazing rate and nutrient recycling to determine the effects of grazers on the net growth rate of the whole and size fractionated phytoplankton community, specific species and groups of phytoplankton, and the production of dissolved and particulate DA. These experiments also provide estimates of the *in situ* growth rates of *PN* compared to other phytoplankton. We also took FlowCAM (an imaging flow cytometer) and fixed samples to follow the in situ spatial and temporal changes in the microphytoplankton and protist grazing community in relation to *PN* and hydrography.

On this cruise, we performed the following:

1. *18 dilution growth and grazing experiments*: In these experiments, we followed changes in <5 μm, >5 μm and total chlorophyll, particulate DA, dissolved DA, *PN* species, and macronutrients (including ammonium). Samples were also preserved and processed onboard for microscopic enumeration of major phytoplankton and microzooplankton species later in the laboratory. Chlorophylls were analyzed onboard as well as macronutrients (measured by Cochlan's group), and dissolved and particulate DA (measured by Trainer's group). Eighteen dilution experiments were conducted during this cruise. One experiment examined light limitation, in conjunction with longer term incubation experiments by Wells and Cochlan. Of the eighteen experiments, only nine had significant *PN* abundance, and none of these were in the eddy region, in strong contrast to September 2004, but similar to September 2005.

2. *High frequency abundance estimates of PN and other plankton with the FlowCAM*: Discrete FlowCAM samples from multiple depths from Niskin bottles were taken from selected transects during the surveys. All initial and final samples from the dilution experiments were also analyzed with the FlowCAM. The data files were stored and will be edited and calibrated in the lab to obtain quantitative counts. At selected stations, replicate fixed samples were taken for microscopic enumerations and calibration of the FlowCAM. During surveys, the FlowCAM proved particularly useful (in addition to the surface net tows) for a quick assessment of *PN* abundance and community composition at the surface and at depth.

3. *Preserved samples for micro- and nanoplankton*: We took preserved plankton samples at 24 stations on the surveys and processed them onboard for microscopic determination of autotrophic and heterotrophic nanoplankton, and heterotrophic/mixotrophic dinoflagellates and ciliates. Separate samples were preserved with glutaraldehyde and Lugol's. The Lugol's samples will be settled and analyzed via inverted microscopy for ciliates and rarer microplankton. The glutaraldehyde samples were stained and filtered onto two separate pore size filters for enumeration of micro and nanoplankton with epifluorescence microscopy. We also preserved processed (made slides) samples for initial and final time points of the continuous culture experiments performed by Lisa Pickell (Well's group), as well as for Kathy Lefebvre's (Trainer group) fish exposure experiments.

4. *Size-fractionated incubation experiments*: We also ran two large volume, long term (9 day) batch experiments to follow the dynamics of polymer gels and DA in the absence of organisms (<0.2 μm), with bacteria only (<1 μm) and with the whole plankton assemblage (whole seawater). A large portion of the organic carbon in the ocean are in the form of polymer gels, hydrated polymers held together by Ca++ ions. Polymer gels have been hypothesized to have many roles, including effecting trace metal and

domoic acid dynamics, but have been little studied. For instance, DA release by *PN* has been hypothesized to be a regulated process involving the exocytosis of polymer gels. These experiments were designed to learn more about the role of bacteria, phytoplankton and microzooplankton in polymer gel production and consumption and whether or not there is a relationship between polymer gel and DA production.

b) RTC/SFSU Research Group (William Cochlan, Maureen Auro, Julia Betts, Julian Herndon, Regina Radan, Elizabeth Moore, and two Teachers-at-Sea: Denis Costello and Christine Muir)

The primary objective of this component of ECOHAB PNW is to examine the relationship between elevated concentrations of the pennate diatom *PN* and its toxin DA, and ambient concentrations of macro-nutrients and phytoplankton biomass. In addition a number of bioassays (grow-out experiments) were conducted in association with the Wells research group to determine the relationship between copper, iron and DA production. At each station of the survey sampling grid, size-fractionated phytoplankton biomass levels were estimated from chlorophyll *a* (Chl *a*) concentrations determined using *in vitro* fluorometry (aboard ship) after extraction for 24 h with 90% acetone. Chl *a* samples generally were collected at three depths (0, 5, 10 m) and, at an additional depth corresponding to the chlorophyll maximum layer, when present. Size-fractionated biomass estimates were conducted as follows: total planktonic community was collected on Whatman GF/F filters (nominal pore-size of 0.7 m), and cells >5 m in size were collected on Poretics polycarbonate membrane filters. At every second station, dissolved inorganic nutrients were collected at 0, 5, 10, 15, 30, 50, 100, 200 m and near bottom) and analyzed using appropriate colorimetric methods for determination of nitrate plus nitrite, phosphate, and silicate with a Lachat Instruments QuickChem 8000 Series Flow Injection Automated Ion Analyzer. Both Chl *a* and nutrients were determined at the two most shoreward stations of each sampling line. Vertical profiles of dissolved inorganic nutrients were also determined at the drifter stations, at six vertical stations in the Strait of Juan de Fuca and six stations in Puget Sound. Samples from the Juan de Fuca and Puget Sound transits and grow-out experiments were also collected for ammonium (analyzed onboard using a sensitive fluorometric method) and urea (90% analyzed onboard using a spectrophotometric method), in addition to the standard inorganic nutrients. Dissolved nutrients were determined at the beginning (time-zero) and end (time-final) of all of the dilution experiments performed by Lessard's research group, daily for the anchovy experiments (Lefebvre group) and, when requested, for graduate student research.

A series of shipboard incubation experiments (conducted in association with the Wells group) were designed to assess the role of trace metal (Cu and Fe) and light availability on the growth of *PN* and DA production. These multi-day experiments were conducted with water collected from the surface mixed layer (~

4-5 m) using the trace-metal clean sampling system (FISH; Wells Group) at stations throughout the sampling grid, with particular emphasis in regions previously found to harbor elevated concentrations of *PN* and DA. During all grow-out experiments, samples were preserved for onshore bacterial and picoplankton abundance determination by the University of Western Ontario team using flow cytometry (Becton Dickinson, FACSCalibur), and will be used to generate specific rates of bacterial productivity from the bacterial protein synthesis estimates (^{3}H-leucine method). Photosynthetic-irradiance (P-E) curves were generated from short-term (1-1.5 h) ^{14}C uptake experiments using photosynthetrons at the initiation of all grow-out experiments, at selected times during the drifter experiments and throughout the large volume grow-out experiments, and at the termination of continuous culture experiments (in association with Lisa Pickell, Univ. Maine); these results will be used to describe the efficiency and capacity of phytoplankton photosynthesis with respect to light intensity. Phytoplankton biomass estimates (as previously described) were determined for all metal and macronutrient treatments at the initiation, throughout and termination of each incubation experiment. These measures, together with draw-down rates of macronutrients, will be used to estimate the growth response (including DA production) of the phytoplankton community to copper and iron bioavailability. Other biological measurements conducted during the grow-out experiments included: microscopic taxonomy (Trick Group), total and dissolved DA (Trainer Group), trace metals (Wells Group), and cellular fluorescence capacity (CFC; as measured using the inhibitor DCMU). Two, large volume (10-L) multi-day grow-out experiments involving sixteen carboys (and one parallel experiment employing 24, 2-L PC bottles) were conducted to elucidate the role of nitrogen source (nitrate, ammonium and urea) in the growth of *PN* species and their production of domoic acid as a function of iron and copper bioavailability. These experiments will discern if anthropogenic nitrate sources, associated with agricultural and human activities, promote either the growth or toxicity of *PN* in the study region and the role of trace metals as a determinant factor in any preferential utilization of nitrogen sources and/or production of DA.

Expected Results:

1. *Dissolved Inorganic and Organic Nutrients:* Approximately 80% of the samples for automated nutrient analysis were conducted onboard and final nutrient concentrations made available. This enabled working maps of inorganic nutrients to be developed that helped guide further sampling strategies and experimentally planning. The remainder of samples should be available by January 15, 2007 using automated (nitrate + nitrite, silicate, and phosphate) methods. All ammonium and 90% of the urea samples were manually analyzed onboard and are currently available.

2. *Phytoplankton Biomass:* All of the survey grid samples, Puget Sound, Juan de Fuca Strait and drifter profiles, and onboard deck experiments were analyzed onboard, and are currently available in draft form. All results are currently available.

3. *Photosynthetic Efficiency:* Radio-isotope samples (^{14}C) were prepared on board for liquid scintillation counting ashore at RTC; P-E curves and photosynthetic parameters should be generated by January15, 2007.

4. *Cellular Fluorescence Capacity*: All samples analyzed onboard and are available in draft form.

5. *Bacterial Productivity:* Radio-isotope samples (^{3}H) were prepared on board for liquid scintillation counting ashore at RTC; rates should be generated by January 15, 2007.

6. *Nitrogen Uptake:* Samples for particulate nitrogen (PN) and (^{15}N) analysis by will be run at RTC during November-December 2006/January 2007, provided adequate mass spectrometry time is available. Nitrogen (nitrate, ammonium urea) uptake rates are expected in early 2007.

c) University of Western Ontario Research Group (Charlie Trick)

Our contribution to the ECOHAB project is two-fold: 1) to provide flow cytometric analysis (FCM) to characterize the community assemblage; and 2) to provide experimental evidence of factors that either increase the competitive ability of *PN* or increase the level of DA per cell. Samples for FCM were collected for our lab at all Puget Sound, Juan de Fuca and grid survey stations at 5 m depth. This will allow for quantitative analysis of bacteria, cyanobacteria, and nanoplankton communities

In our second major contribution to the cruise mandate, the personnel from the Cochlan and Wells labs carried out deckboard incubation growth experiments (see Wells description below). All labs offered their expertise to the common goal of all growth experiments (biomass formation, nutrient drawdown measurements, DA analysis (particulate and dissolved), community structure changes, bacterial and phytoplankton productivity and photosynthetic efficiency and capacity). The overall foundation of these grow-out experiments was aimed at elucidating the factors that influence the initiation, formation and/or maintenance of *PN* blooms or DA levels (either cellular or extracellular). The working hypothesis for this set of experiments was that *PN* benefits from producing DA because DA serves as an iron and/or copper chelator. Thus in the presence of macronutrients (either in upwelling sites or in the areas of high nutrients associated with the Juan de Fuca eddy) DA would act as an iron chelator, ensuring that the cells would have a supply of iron as iron concentrations diminish, either through colloid formation or utilization. Alternatively DA could serve as a copper chelator, reducing the levels of cupric ion to less inhibitory levels, allowing *PN* to fully utilize the macro-nutrients and grow effectively.

d) Trainer Group (Vera Trainer, Keri Baugh, Shelly Nance, Sheryl Day, Brian Bill, Nicolaus Adams, Stephanie Moore, Anthony Odell, Anne Mataia, Shuk Tsui, Lauren Kuehne)

Bucket and net tow (20 m mesh) samples were taken to rapidly assess the presence of cells and DA at a number of stations. At each survey and drift station, samples were routinely taken from CTD rosette bottles at 0, 5, 10 m for measurement of particulate and dissolved levels of DA, whole cell counts of *PN*, enumeration of *PN* size classes, and scanning electron microscopy for species determination in selected samples. A net tow was taken at every station to rapidly determine the presence or absence of *PN* and their relative abundance. At selected coastal stations, depth profiles of cells and toxins were done at some of the following depths: 0, 5, 10, 20, 30, 50 m to determine the role of the Columbia River plume in HAB advection to the coast.

1. *Particulate DA:* Particulate DA was analyzed by filtering 1 L seawater through a Nucleopore HA filter (0.45 micron pore size). Filters were minced in 5 ml distilled water with a thin metal spatula and sonicated for 2 h in a bath sonicator to lyse cells. An aliquot of each sample was analyzed using a receptor binding assay in 96-well plate format using a multiwell harvester and Top Count scintillation counter. The receptor binding assay tests the displacement of [^{3}H]kainate by DA in a sample from a cloned glutamate receptor. Each plate of was compared to known DA standards analyzed on the same plate. Endogenous glutamate was digested prior to sample analysis using glutamate dehydrogenase.

2. *Whole cell hybridization assay:* Whole cell probing was performed to rapidly assess the presence of *PN* species of interest. In particular, *P. pungens* are isolated for continued population studies comparing Juan de Fuca eddy with coastal populations. Approximately 15 ml sample was filtered and fixed with saline-ethanol for 2 hours. Then specific *P. australis* (auD1) *P. multiseries* (muD2) and *P. pungens* (puD1) probes (fluorescein labeled) were incubated with samples from stations with abundant *PN* (assessed by surface net tows) taken at several depths. Fluorescence intensity was compared to uniC (positive universal species control) and uniR (negative control) probes. Positively labeled cells on each filter were counted using fluorescence microscopy. Slides were kept in the dark for cell counting in our land-based laboratory.

3. *Dissolved DA:* These samples were filtered through a 0.45 mm syringe filter and refrigerated until analysis. Selected samples from grow out experiments were tested using a commercially available enzyme-linked immunosorbent assay (ELISA) with picomolar sensitivity (Beacon Analytical System). This ELISA was developed using antibodies produced at NWFSC. Therefore kits can be produced by Beacon at great savings ($100 per kit) over the Biosense ELISA kits (>$300 per plate).

4. *PN culturing*: At stations throughout the cruise where *PN* cells were present, a drop of sample was placed in f/2 medium for isolation and culturing upon return to the lab. *PN* cells will be allowed to grow in artificial seawater medium and growth and toxin production will be determined for several isolates. This will allow us to understand the relative levels of dissolved and particulate toxin each species is contributing to our cruise samples. Monoclonal isolates from the eddy and nearshore regions will be used to assess the genetic diversity among certain *PN* species using microsatellite DNA markers. This information will be used to make a preliminary determination of the relationship between *PN* populations in the eddy and nearshore regions .

5. *Fish exposure studies* (Stephanie Moore, Nick Adams): The goal of this project is to determine if dietary exposure to toxic *PN* causes neurotoxic effects in planktivorous anchovies. Anchovies were brought onboard the research vessel and were exposed to various *PN* blooms collected from ECOHAB PNW sampling stations off the coast of Washington and Canada. Exposure conditions were fully characterized for cell density, community structure, and toxicity. Exposure media was exchanged daily to maintain water quality. The following samples were taken at the beginning and end of each renewal; size-fractionated chlorophyll measurements, glutaraldehyde and Lugol's fixed samples, 0.2 and 0.8 stained slides (prepared by Lessard's group), silicate, nitrate-nitrite, ammonium, urea, particulate DA, and dissolved DA. Daily behavioral observations were also performed throughout the exposure. No neurotoxic symptoms were observed. Control and exposed fish were also sampled from exposure and control tanks every 24 to 48 hours. Tissues were dissected into viscera and muscle for analysis for the presence of DA. After the 10-day continuous exposure experiment, a 24-hour grazing experiment was also performed to quantify grazing rates of anchovies on ecologically realistic algal communities.

6. *Vibrio sample collection* (collaboration with NOAA West coast center in Oceans and Human Health): Surface seawater was filtered onto 0.22 m filters, placed in Petri dishes, and frozen for characterization of potential Vibrio interactions with phytoplankton along our survey lines. This work will be done using PCR techniques at the land-based laboratory by Mark Strom's group at the NOAA OHH center.

e) Wells Group (Peggy Hughes, Lisa Pickell, Kathleen Hardy)

The University of Maine component of the ECOHAB PNW cruise had two primary goals: to collect seawater samples from the study area for trace metal analysis and to optimize, and to conduct deckboard incubation studies (in conjunction with Cochlan/Trick group) testing the effects of trace metals on phytoplankton production, community structure (i.e., *PN* abundance) and cell toxicity.

Approximately 150 surface samples from the survey station grid were collected for trace metal analyses while underway through a trace-metal clean sampling towfish. On some grid lines (GH, LB and LC), a GoFlo bottle at ~10 m was used instead of the towed package. When using these data with the ~4 m data care should be taken to ensure that a mixed layer was present. Vertical profiles also were collected with GoFlo bottles from three sites (offshore, in the eddy core, and a comparatively shallow shelf station in the southern part of the study area. Preliminary analyses of Fe concentrations on a subset of samples were conducted on-board by flow injection chemiluminescence detection. The collected samples will be later analyzed at the University of Maine by high resolution Inductively Coupled Plasma Mass Spectrometry to observe spatial and temporal variability of trace metals, and to serve as means for comparison with the shipboard iron method.

The shipboard method for iron provided preliminary iron concentrations to guide various grow-out experiments conducted by the Wells and Cochlan research teams. The veracity of towfish and shallow GoFlo bottle sampling was tested by collection of surface waters from a small boat away from, and upwind of the vessel. These reference samples will help to demonstrate that sample collections were not affected by metal contamination in either the system (Towfish) or by close proximity to the vessel (GoFlo bottles).

In addition to the large growout studies described above, the Wells group also were logistically responsible for conducting 8 independent batch culture incubation experiments, involving > 350 sample bottles, testing the synergistic effects of trace metals, macronutrients, metal complexing ligands, and light intensity. Two separate continuous culture experiments, each consisting of 14 simultaneous culture vessels, were performed to study how community composition evolves over time as a function of different metal and macronutrient stresses.

f) Jen Boehme (visiting scientist, Smithsonian Environmental Research Center)

Approximately 100 samples were collected from CTD casts along the station grid. Optical properties of chromophoric dissolved organic matter were examined for filtered samples (0.2 µm) using absorbance spectroscopy and excitation emission matrix spectroscopy (EEMS). Samples collected on this cruise will be added to a global database of CDOM fluorescence, with the intention of examining fluorescence variability within different marine biogeochemical provinces. Additional absorbance and EEMS analyses were performed in collaboration with grazer incubations from the Lessard growth and grazing experiments, as well as from selected treatments of the Wells continuous culture and batch culture experiments. Samples were also collected from the ship's underway system for a SERC project relating chemical tracer concentration (CDOM and trace elements) with distance from shore.

6. Outreach

In collaboration with Cochlan (RTC/SFSU), Wells (U. Maine) and Trainer (NOAA NWFSC) two, highly experienced, in-service high school teachers from California were invited to join the final ECOHAB PNW cruise to serve as Teachers-At-Sea (TAS). Christine Muir (Woodside Priory School, Portola Valley, CA) and Denis Costello (North High School, Torrance, CA), both previous participants of San Francisco Bay Educator's 'Coastal Oceanography' Workshops held at the Romberg Tiburon Center, posted daily logs of the ECOHAB PNW research being conducted throughout the three-week cruise. Their detailed journals outline the primary research objectives of ECOHAB PNW, the theory behind the science, how the research is actually conducted, and finally the people and equipment necessary for ECOHAB PNW's scientific objectives to be met. Both TAS also were heavily involved in around-the clock biological sampling and analyses and their scientific contribution to success of ECOHAB PNW VI was significant and very much appreciated by the scientists onboard.

With funding from NOAA's Northwest Fisheries Science Center (NWFSC), Jennifer Maas and Tony Elias (Evil Bunny Films, Seattle, WA) came aboard the vessel for 3 days to film ECOHAB PNW scientists in action as an example of collaborative oceanographic research. Their goal, in collaboration with the two TAS was to create a 3-minute film on ECOHAB PNW science and a 20-minute film for senior high school and freshman college students and the general public on the nature of oceanographic research at sea.

The teachers' journals and short videos are linked to the outreach page on the ECOHAB PNW website, and outline the experimental design and analyses conducted at sea, the lives of scientists onboard the ship and numerous aspects of the science of harmful algal blooms, and how ECOHAB collaborative research is conducted and funded.

Acknowledgements

We would like to thank the captain and crew of the R/V T.G. Thompson for their support during the September 2006 cruise. We also thank our shoreside support team: Jack Wekell, Bich-Thuy Eberhart, and Susan Geier. Nancy Kachel deserves our special thanks for handling cruise leader responsibilities before and after the cruise, and Julian Herndon for handling the chemical issues for all research groups before the cruise. This research was supported through the Ecology and Oceanography of Harmful Algal Blooms program by National Oceanographic and Atmospheric Administration/Coastal Ocean Program Award No. NA17OP2789 and National Science Foundation Award No. 0234587.

List of Tables and Figures with Captions and Appendices (web site only)

Figure 1. Cruise track with sampling stations

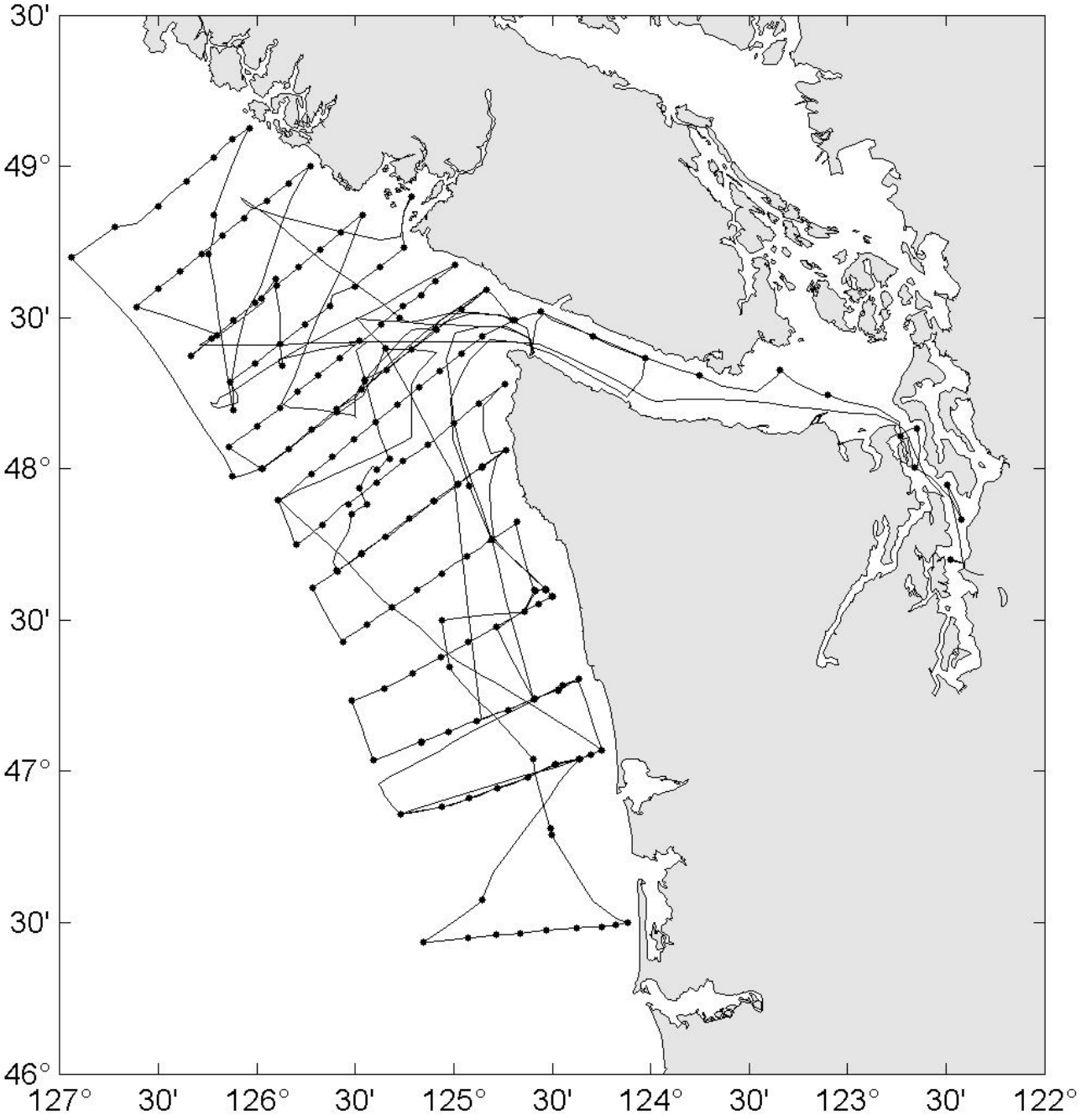

Figure 2. Time series of shipboard vector winds during ECOHAB VI

Sampling events are shown below the x-axis. Vectors show the direction to which the wind is directed; thus, upwelling-favorable below the zero line and downwelling-favorable above it. The three survey periods are differentiated with shading and numbers.

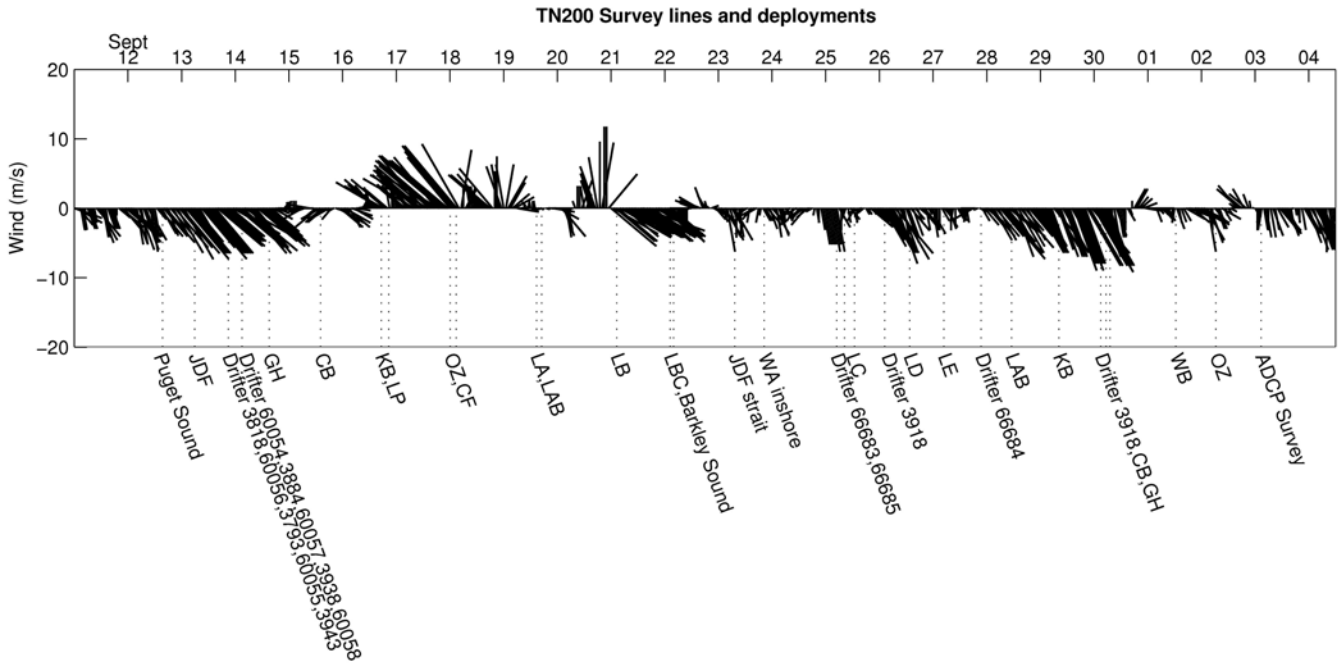

Figure 3. Map showing theoretical survey grid and locations of moored sensor arrays

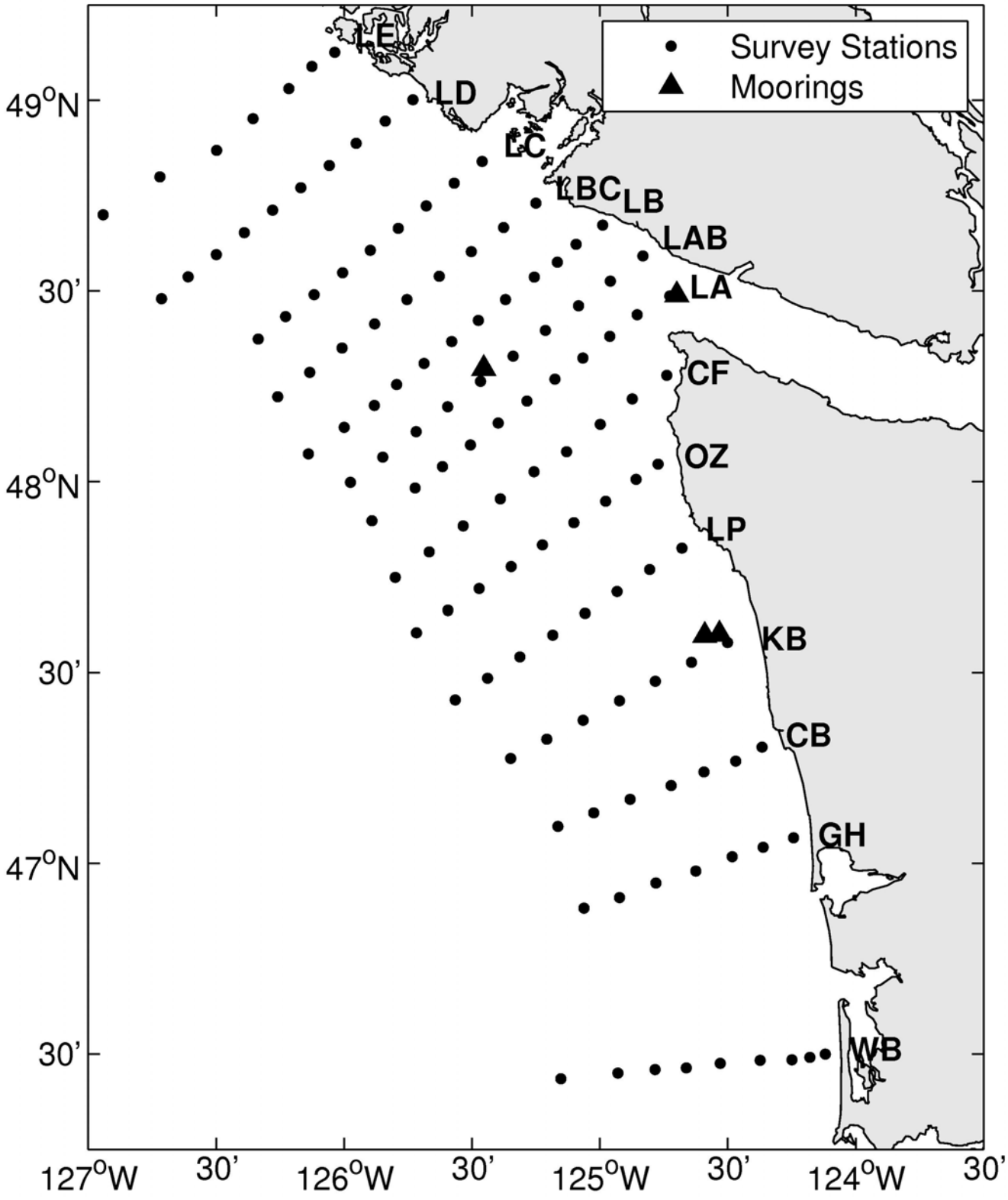

Figure 4a. Map showing CTD station numbers for the survey period 0.

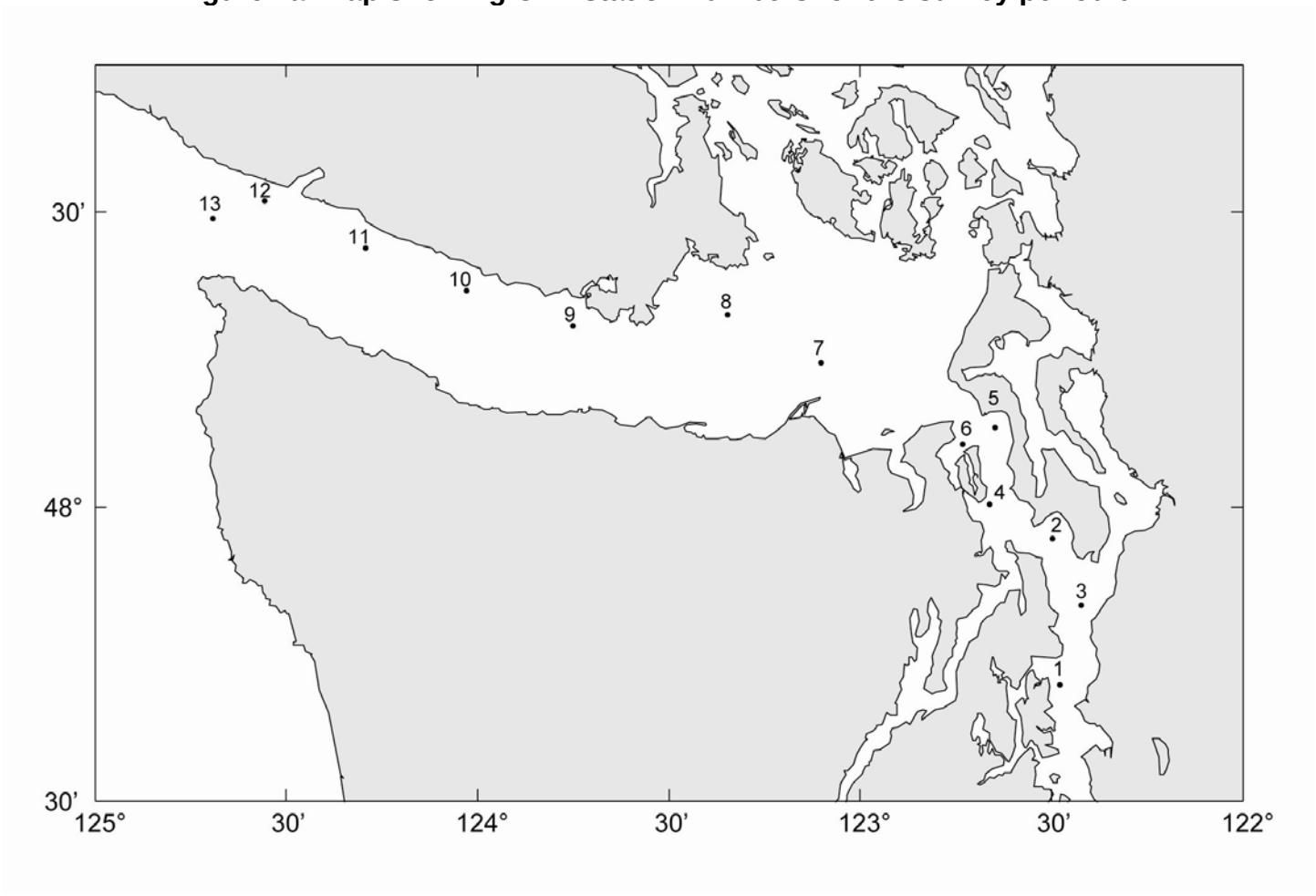

Figure 4b. Map showing CTD station numbers for the survey period 1.

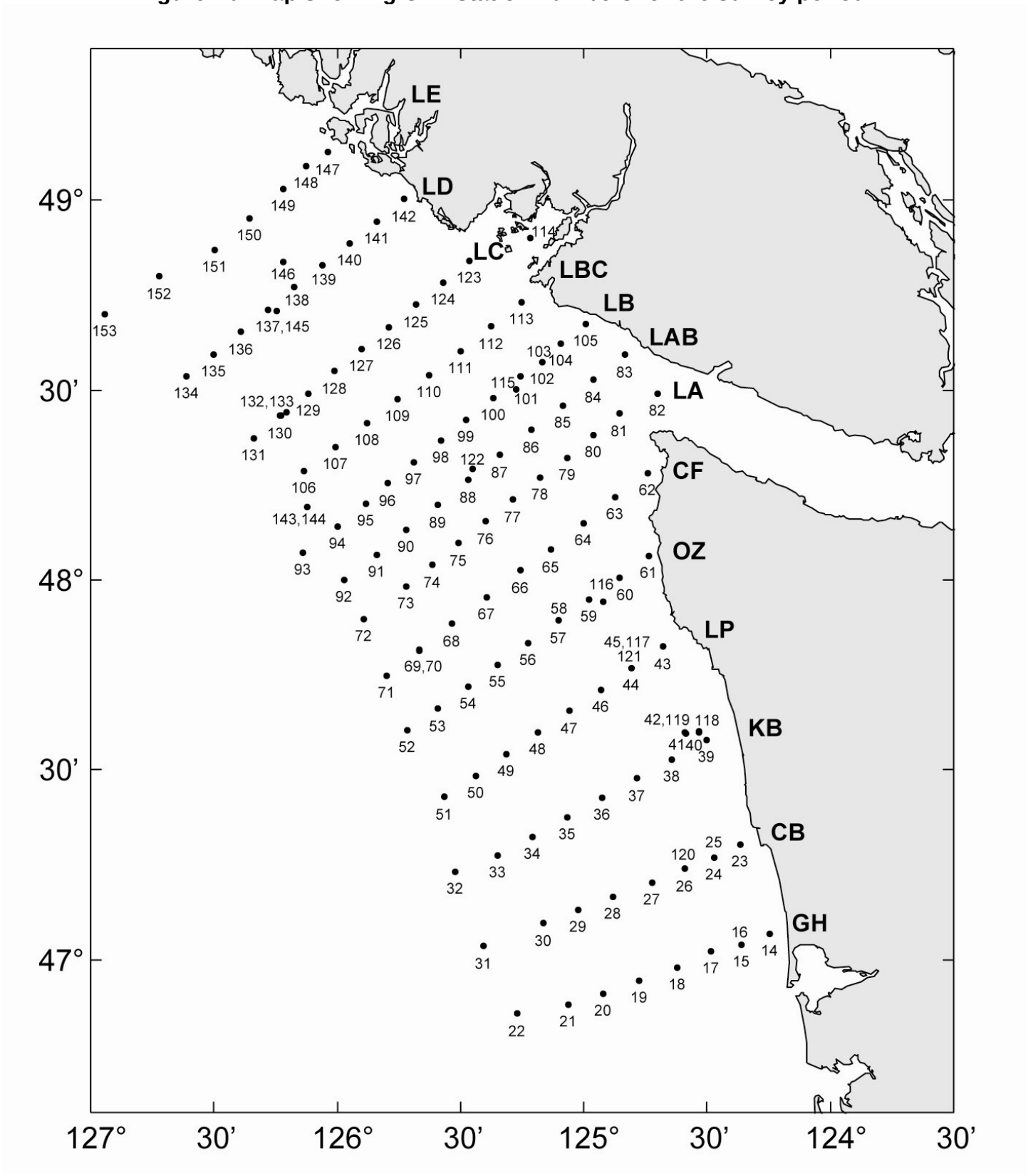

Figure 4c. Map showing CTD station numbers for the survey period 2.

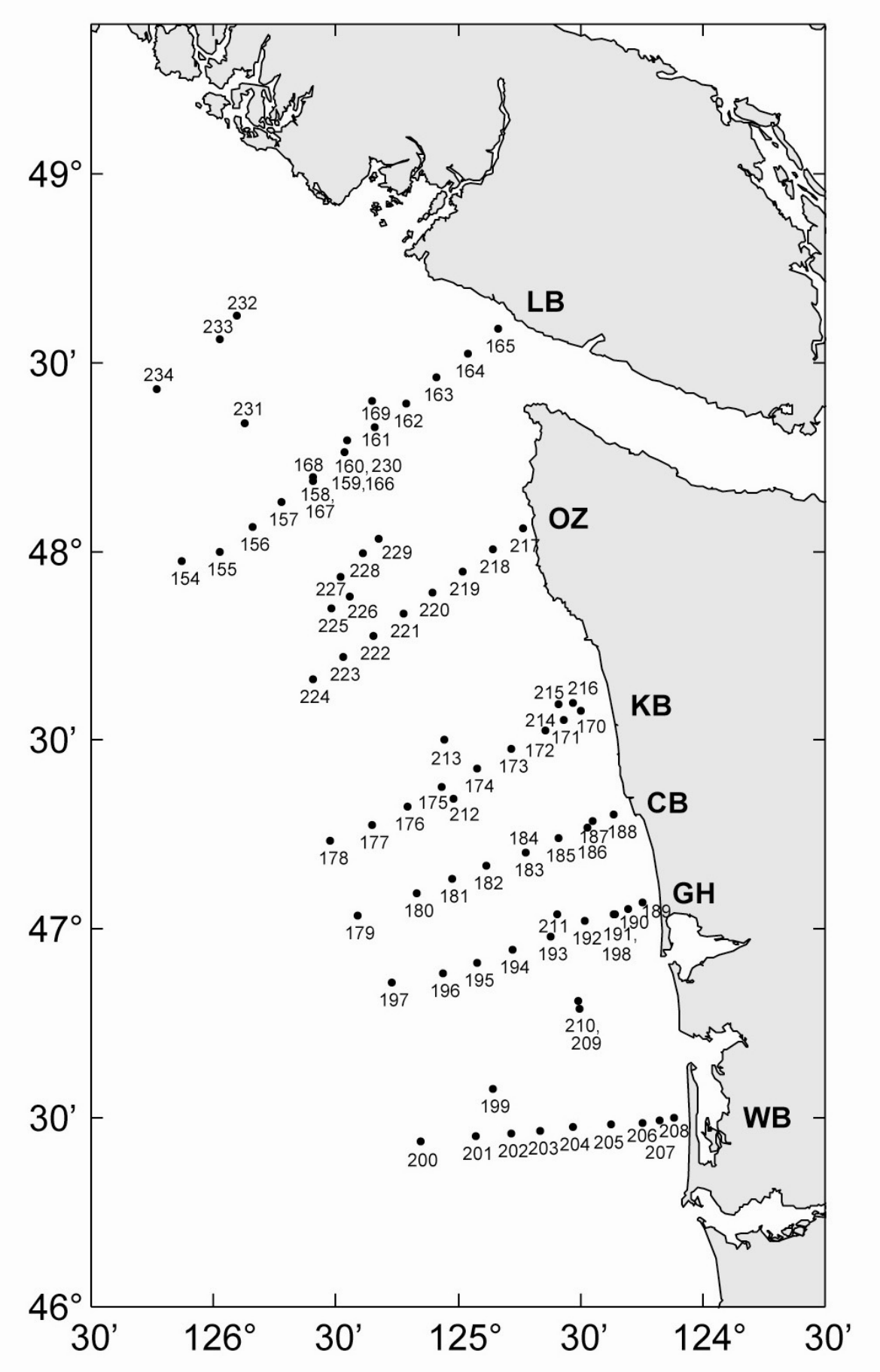

Figure 5. Drifter tracks during drift DA showing CTD stations on the tracks.

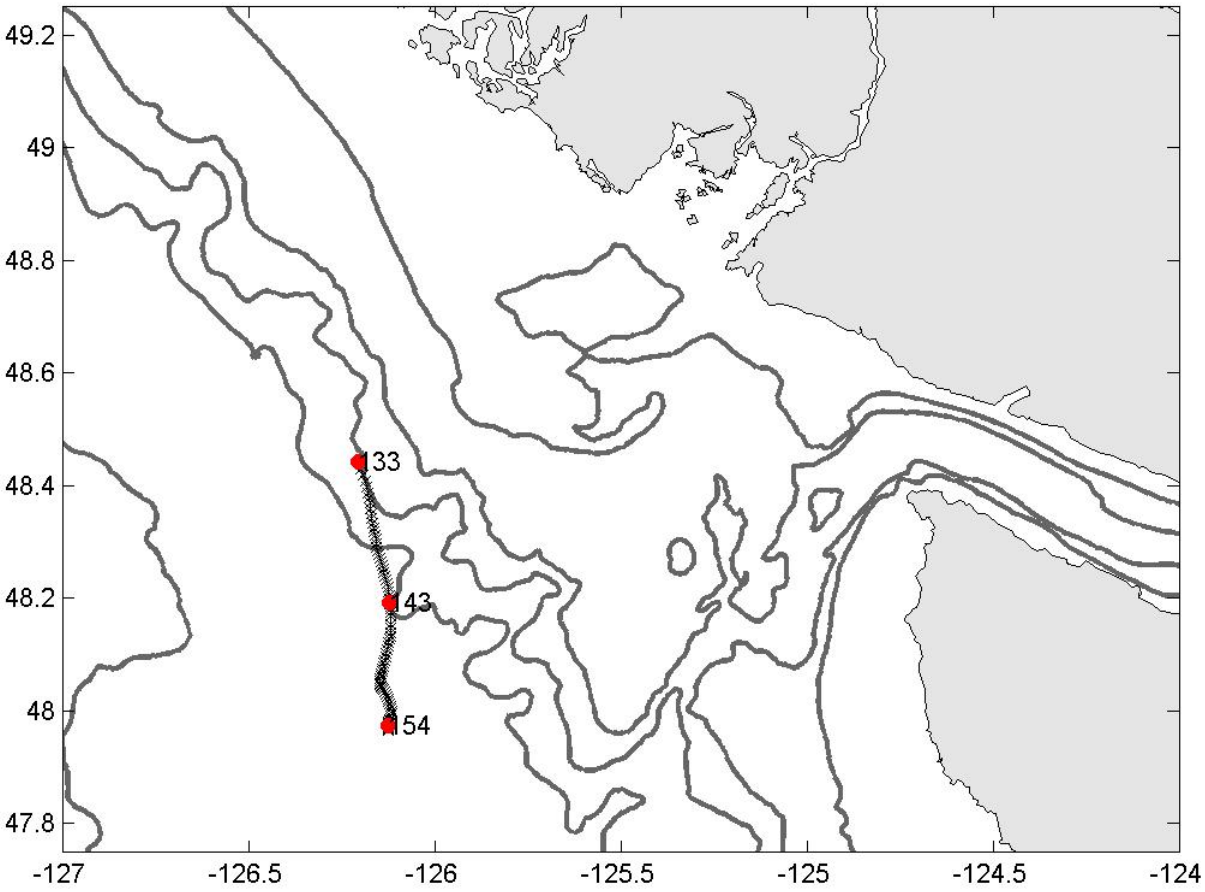

Figure 6a. Drifter tracks – Surface

Drifters deployed during the ECOHAB PNW VI cruise.

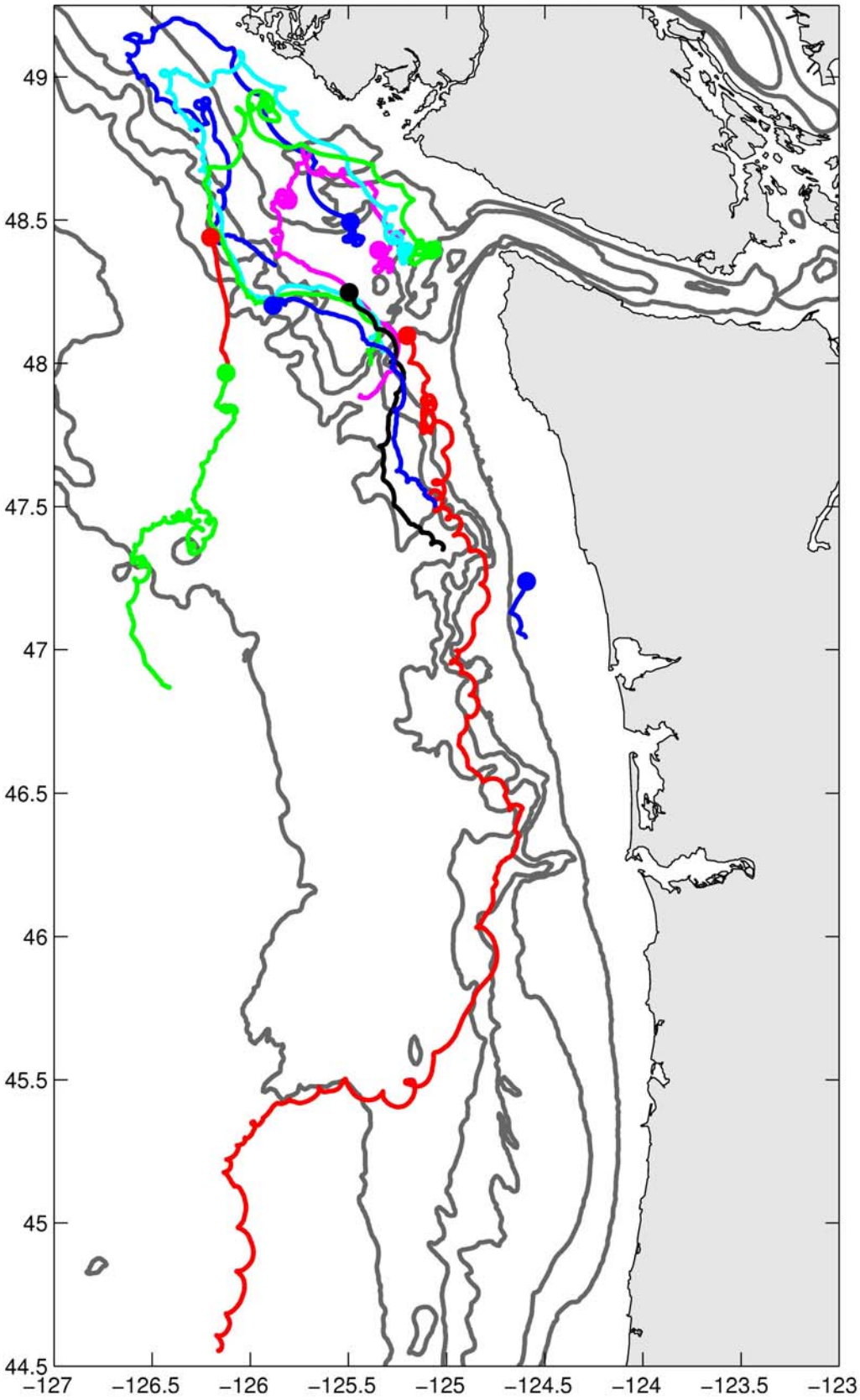

Figure 6b. Drifter tracks – drogued at 25 m

Drifters deployed during the ECOHAB PNW VI cruise. Dots indicate one day intervals.

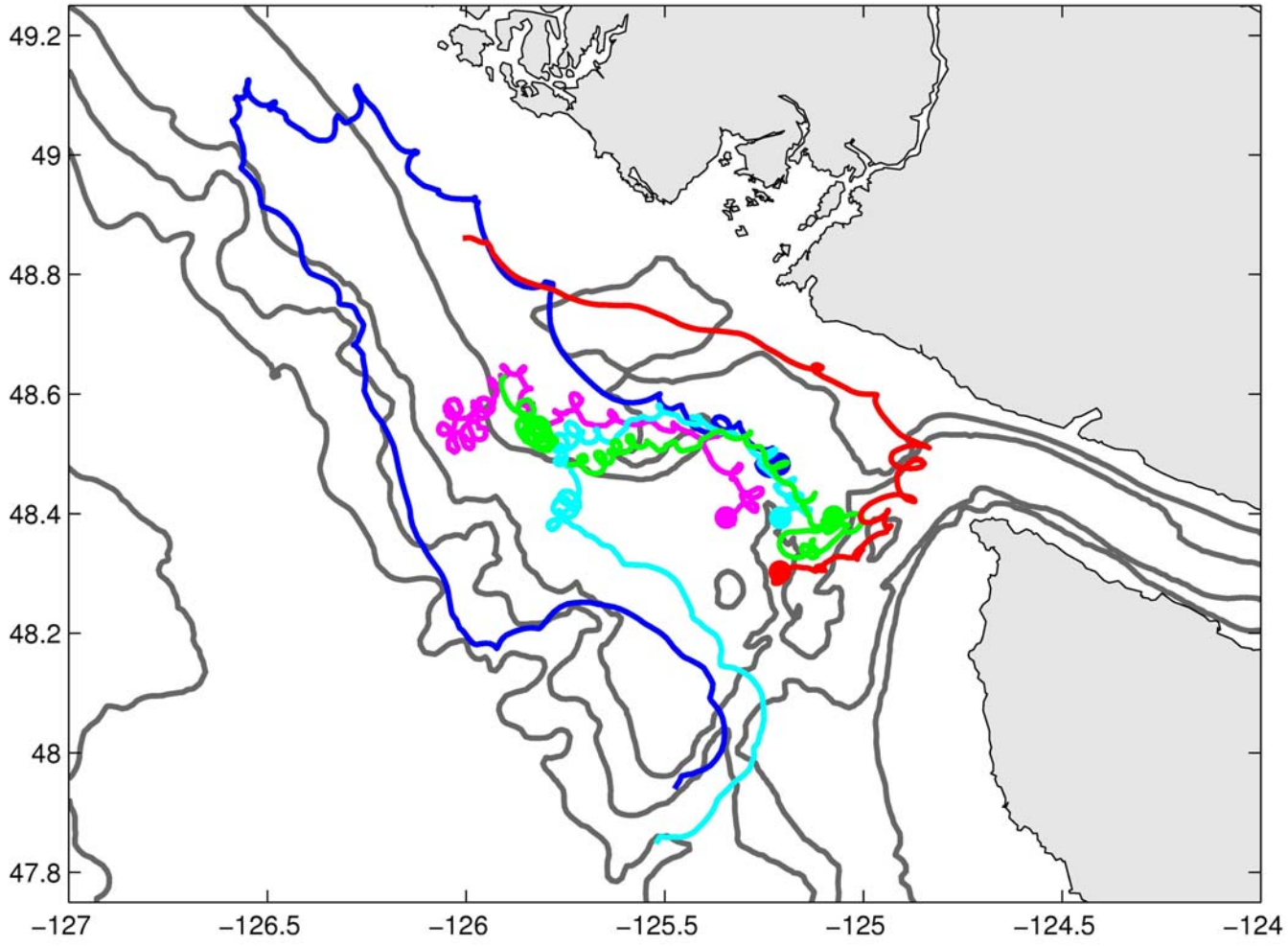

Table 1: Event Log

Event Number	Date (GMT)	Start Time (GMT)	End Time (GMT)	Lat degree (N)	Lat minute	Lon degree (W)	Lon minute	Grid/ Station ID	Event Description	Samples Taken	Water depth (m)	Cast depth (m)	Comments
1	12-Sep-2006	1230							depart UW				
2	12-Sep-2006	1525	1545	47	41.90	122	28.72	PW1	CTD 001/net	phyto, nuts, NH4, urea, chl, microzoo	188	183	
3	12-Sep-2006	1630	1740	47	41.90	122	28.72	PW1	GoFlo weight in water		188		
4	12-Sep-2006	1707	1711	47	41.90	122	28.72	PW1	GoFlo sample bottle rinse		188	20	
5	12-Sep-2006	1720	1728	47	41.90	122	28.72	PW1	GoFlo 001	trace metals at 10 m	188	10	
6	12-Sep-2006	2035	2049	47	56.80	122	28.90	PW2	CTD 002/net	phyto, nuts, NH4, urea, chl, microzoo, salt	94	89	
7	12-Sep-2006	2110	2118	47	56.80	122	28.90	PW2	GoFlo 002	trace metals at 10 m	94	10	
8	12-Sep-2006	2244	2254	47	50.01	122	25.30	PW1.5	CTD 003/net	phyto, nuts, NH4, urea chl, microzoo	174	170	
9	12-Sep-2006	2302	2308	47	50.01	122	25.30	PW1.5	GoFlo 003	trace metals at 10 m	174	10	
10	13-Sep-2006	0036	0045	48	00.29	122	39.77	PW3	CTD 004/net	phyto, nuts, chl, NH4, urea, microzoo, salt	47	43	
11	13-Sep-2006	0045	0055	48	00.29	122	39.77	PW3	GoFlo 004	trace metals at 10 m	47	10	
12	13-Sep-2006	0218	0228	48	08.10	122	38.92	PW4	CTD 005/net	phyto, nuts, NH4, urea, chl, microzoo	38	33	
13	13-Sep-2006	0228	0235	48	08.10	122	38.92	PW4	GoFlo 005	trace metals at 10 m	38	10	
14	13-Sep-2006	0342		48	06.41	122	43.90	PW5	CTD 006/net	phyto, nuts, NH4, urea, chl, microzoo	31	28	
15	13-Sep-2006	0352		48	06.41	122	43.90	PW5	GoFlo 006	trace metals at 10 m	31	10	
16	13-Sep-2006	0552		48	14.62	123	06.07	JDFF	CTD 007/net	phyto, nuts, NH4, urea, chl, microzoo, salt	146	143	
17	13-Sep-2006	0603		48	14.63	123	06.07	JDFF	GoFlo 007	trace metals at 10 m	146	10	
18	13-Sep-2006	0739		48	19.57	123	20.67	JDFN5	CTD 008/net	phyto, nuts, NH4, urea, chl, microzoo	72	67	
19	13-Sep-2006	0805		48	19.57	123	20.67	JDFN5	GoFlo 008	trace metals at 10 m	72	10	
20	13-Sep-2006	1002		48	18.44	123	45.05	JDFN4	CTD 009/net	phyto, nuts, NH4, urea, chl, microzoo	171	167	
21	13-Sep-2006	1020		48	18.44	123	45.05	JDFN4	GoFlo 009	trace metals at 10 m	171	10	
22	13-Sep-2006	1145		48	22.00	124	01.69	JDFN3	CTD 010/net	phyto, nuts, NH4, urea,chl, microzoo	125	120	
23	13-Sep-06	1200	1215	48	22.04	124	01.69	JDFN3	GoFlo 010	trace metals at 10 m	125	10	
24	13-Sep-06	1333	1345	48	26.37	124	17.59	JDFN2	CTD 011/net	phyto, nuts, chl, NH4, urea, microzoo, salt	117	110	
25	13-Sep-06	1345	1355	48	26.37	124	17.59	JDFN2	GoFlo 011	trace metals at 10 m	117	10	
26	13-Sep-06	1525		48	31.21	124	33.43	JDFN1	CTD 012/net	phyto, nuts, chl, NH4, urea, microzoo	143	135	

27	13-Sep-06	1540		48	31.21	124	33.43	JDFN1	GoFlo 012	trace metals at 10 m	143	10	
28	13-Sep-06	1555		48	31.21	124	33.43	JDFN1	test Fa-fish	trace metals	143		
29	13-Sep-06	1803	1826	48	29.39	124	41.51	EH1	CTD 013/net	phyto, DA, nuts, NH4, urea, chl	251	246	
30	13-Sep-06	1828	1835	48	29.39	124	41.51	EH1	GoFlo 013	trace metals at 10 m	251	10	
31	13-Sep-06	2053	2054	48	29.11	125	12.82	WP1	net	phyto		0	
32	13-Sep-06	2055		48	29.11	125	12.82	WP1	drifter deployment	#3818 drogued drifter w/ light		25	
33	13-Sep-06	2226	2228	48	29.95	125	29.94	WP2	net	phyto	100	0	
34	13-Sep-06	2231		48	29.95	125	29.88	WP2	drifter deployment	#60056 surface drifter	100	0	
35	13-Sep-06	2330		48	23.72	125	20.71	WP3	net	phyto	123	0	
36	13-Sep-06	2325		48	23.72	125	20.71	WP3	drifter deployment	#3793 drogued drifter	123	25	
37	13-Sep-06	2327		48	23.72	125	20.71	WP3	drifter deployment	#60055 surface drifter	123	0	
38	14-Sep-06	0006		48	23.71	125	12.83	WP4	net	phyto	180	0	
39	14-Sep-06	0009		48	23.71	125	12.83	WP4	drifter deployment	#3943 drouged drifeter	180	25	
40	14-Sep-06	0010		48	23.71	125	12.83	WP4	drifter deployment	#60054 surface drifter	180	0	
41	14-Sep-06	0055		48	23.63	125	04.82	WP5	net	phyto		0	
42	14-Sep-06	0058		48	23.63	125	04.82	WP5	drifter deployment	#3884 drogued drifter		25	
43	14-Sep-06	0059		48	23.63	125	04.82	WP5	drifter deployment	#60057 surface drifter		0	
44	14-Sep-06	0150		48	17.98	125	12.76	WP6	net	phyto	202	0	
45	14-Sep-06	0154		48	17.98	125	12.76	WP6	drifter deployment	#3938 drogued drifter w/ light	202	25	
46	14-Sep-06	0258		48	06.13	125	12.70	WP7	net	phyto	242	0	
47	14-Sep-06	0301		48	06.13	125	12.70	WP7	drifter deployment	#60058 surface drifter	242	0	
48	14-Sep-06	0424		48	01.08	125	28.74	WP8/VB08	bucket/net	net tow, DA, WW, vibrio		0	
49	14-Sep-06	0520		47	57.60	125	40.44	WP9/VB09	bucket/net	net tow, DA, WW, vibrio		0	
50	14-Sep-06	0625		47	53.92	125	53.43	LA11	bucket/net	net tow, DA, WW, vibrio	261	0	
51	14-Sep-06	0725		47	47.90	125	43.04	VB10	bucket/net	net tow, DA, WW, vibrio	293	0	
52	14-Sep-06	0825		47	41.59	125	32.34	VB11	bucket/net	net tow, DA, WW, vibrio		0	
53	14-Sep-06	0945		47	32.60	125	18.75	VB12	bucket/net	net tow, DA, WW, vibrio	1013	0	
54	14-Sep-	1107		47	23.56	125	02.99	LP06	bucket/net	net tow, DA, WW, vibrio		0	

	06												
55	14-Sep-06	1207		47	18.51	124	50.28	VB13	bucket/net	net tow, DA, WW, vibrio	618	0	
56	14-Sep-06	1306		47	14.09	124	38.54	VB14	bucket/net	net tow, DA, WW, vibrio	93	0	
57	14-Sep-06	1404		47	09.49	124	27.37	VB15	bucket/net	net tow, DA, WW, vibrio	56	0	
58	14-Sep-06	1512		47	04.15	124	14.88	GH01	CTD 014/net	phyto, nuts, NH4, urea, chl, microzoo, gels, cdom	25	20	
59	14-Sep-06	1520		47	04.15	124	14.88	GH01	GoFlo 014	trace metals	25	10	
60	14-Sep-06	1640		47	02.41	124	21.70	GH02	CTD 015/net	phyto, nuts, chl, microzoo	47	42	
61	14-Sep-06	1650		47	02.41	124	21.70	GH02	CTD 016	Lessard/microzoo	49	3.1	
62	14-Sep-06	1705		47	02.41	124	21.70	GH02	GoFlo	trace metals	47	10	
63	14-Sep-06	1801		47	01.41	124	28.87	GH03	CTD 017/net	phyto, chl, microzoo	68	63	
64	14-Sep-06	1810		47	01.41	124	28.87	GH03	GoFlo	trace metals	68	10	
65	14-Sep-06	1820	1840	47	01.41	124	28.87	GH03	fill tanks for fish experiment		68		
66	14-Sep-06	1932		46	58.82	124	37.38	GH04	CTD018/net	phyto, nuts, chl, cdom, salt	99	94	
67	14-Sep-06	1940		46	58.82	124	37.38	GH04	GoFlo	trace metals	99	10	
68	14-Sep-06	2057		46	56.71	124	46.60	GH05	CTD019/net	phyto, chl, microzooplankgon,	147	172	
69	14-Sep-06	2110		46	56.71	124	46.60	GH05	GoFlo	trace metals	147	10	
70	14-Sep-06	2218		46	54.62	124	55.27	GH06	CTD020/net	phyto, nuts, chl, microzoo	417	412	
71	14-Sep-06	2225		46	54.62	124	55.27	GH06	GOFlo	trace metals	417	10	
72	14-Sep-06	2345		46	52.92	125	03.69	GH07	CTD021/net	phyto, chl, microzoo, salt	814	500	
73	14-Sep-06	2345		46	52.92	125	03.69	GH07	GoFlo	trace metals	814	10	
74	15-Sep-06	0125		46	51.51	125	16.22	GH08	CTD022/net	phyto, nuts, chl, microzoo	1450	500	
75	15-Sep-06	0135		46	51.51	125	16.22	GH08	GoFlo	trace metals	1450	10	
76	15-Sep-06	0205		46	51.51	125	16.22	GH08	FeFish enters water	pumps water to be tested for trace metals	1450	4.5	
77	15-Sep-06	0936		47	04.33	125	04.01	VB16	bucket/net	phyto	1290	0	
78	15-Sep-06	1045		47	09.65	124	49.46	VB17	bucket/net	phyto	147	0	
79	15-Sep-06	1100	1215	47	09.65	124	49.46	VB17	GoFlos	cells for growth experiment	147	8	
80	15-Sep-06	1115	1145	47	09.65	124	49.46	VB17	fish pump	pump water for fish	147	0	
81	09.15.06	1300		on deck					experiment CC_1 started	continuous culture experiment			

82	15-Sep-06	1410		47	18.30	124	22.03	CB01	CTD 023/net tow	phyto, nuts, chl, salt	35	30	
83	15-Sep-06	1453		47	18.30	124	22.03	CB01	FeFish enters water	trace metals	35	5	
84	15-Sep-06	1584		47	16.11	124	28.20	CB02	CTD 024/net tow	phyto, nuts, chl	50	45	
85	15-Sep-06	1605	1625	47	16.11	124	28.20	CB02	FeFish picked up and redeployed		50	8	
86	15-Sep-06	1634		47	16.12	124	28.20	CB02	CTD 025	Lessard/microzoo	50	3	
87	15-Sep-06	1758	1808	47	14.37	124	35.51	CB03	CTD 026/net tow	phyto, chl, cdom, Betts	80	75	
88	15-Sep-06	1915	1929	47	12.22	124	43.26	CB04	CTD 027/net tow	phyto, nuts, chl, salt	115	110	
89	15-Sep-06	2000		on deck					experiment BC_1 started	Cu and Cu ligand experiment			
90	15-Sep-06	2053	2108	47	10.03	124	52.97	CB05	CTD 028/net tow	phyto, chl, microzoo	155	150	
91	15-Sep-06	2250	2312	47	07.88	125	01.50	CB06	CTD 029/net tow	phyto, nuts, chl, cdom, salt	820	815	
92	16-Sep-06	0036	0056	47	05.79	125	09.97	CB07	CTD 030/net tow	phyto, chl	1500	500	
93	16-Sep-06	0250	0310	47	02.18	125	24.52	CB08	CTD 031/net tow	phyto, nuts, chl, microzoo	1900	500	
94	16-Sep-06	0528	0538	47	14.00	125	31.20	KB08	CTD 032 /net tow	phyto, nuts, chl, microzoo	1529	500	
95	16-Sep-06	0719		47	16.48	125	21.04	KB07	CTD 033/net tow	phyto, nuts, chl, microzoo	1712	500	
96	16-Sep-06	0909		47	19.51	125	12.53	KB06	CTD 034/net tow	phyto, nuts, chl, microzoo	1678	500	
97	16-Sep-06	1101		47	22.52	125	04.00	KB05	CTD 035/net tow	phyto, nuts, chl, microzoo	1447	500	
98	16-Sep-06	1241		47	25.61	124	55.51	KB04	CTD 036/net tow	phyto, nuts, chl, microzoo	1063	500	
99	16-Sep-06	1425		47	28.65	124	47.00	KB03	CTD 037/net tow	phyto, nuts, chl, microzoo			
100	16-Sep-06	1557		47	31.69	124	38.51	KB02	CTD 038/net tow	phyto, nuts, chl, microzoo	69	65	
101	16-Sep-06	1615		47	31.69	124	38.51	KB02	remove FeFish from water				
102	16-Sep-06	1717	1726	47	34.72	124	29.99	KB01	CTD 039/net tow	phyto, nuts, chl, cdom	30	25	
103	16-Sep-06	1728	1740	47	34.72	124	29.99	KB01	GoFlo	trace metals	30	10	
104	16-Sep-06	1803	1809	47	36.00	124	31.97	EH4	CTD 040/net tow	phyto, chl	35	31	
105	16-Sep-06	1842	1850	47	36.00	124	35.49	EH2	CTD 041/net tow	bottle 2 did not fire	47	42	
106	16-Sep-06	1906	1915	47	36.00	124	35.40	EH2	CTD 042	phyto, nuts, chl	47	42	
107	16-Sep-06	2037	2045	47	49.45	124	40.29	LP01	CTD 043/net tow	phyto, chl, microzoo	37	32	
108	16-Sep-06	2045	2055	47	49.45	124	40.29	LP01	GoFlo	trace metals	37	10	

109	16-Sep-06	2145		47	46.06	124	48.41	LP02	CTD 044/net tow	phyto, nuts, chl	83	78	
110	16-Sep-06	2218		47	46.06	124	48.40	LP02	CTD 045	Lessard/microzoo	83	5	
111	16-Sep-06	2230		47	46.06	124	48.40	LP02	FeFish enters water	trace metals	83	4	
112	16-Sep-06	2300		on deck					start experiment BC_2	nitrogen source experiment			
113	17-Sep-06	0115	0125	47	42.03	124	55.94	LP03	CTD 046/net tow	phyto, chl	120	115	
114	17-Sep-06	0237		47	39.30	125	03.50	LP04	CTD 047/net tow	phyto, nuts, chl, cdom, salt	180	170	
115	17-Sep-06	0411		47	35.91	125	11.14	LP05	CTD 048/net tow	phyto, chl, microzoo	591	500	
116	17-Sep-06	0549		47	33.51	125	18.74	LP06	CTD 049/net tow	phyto, nuts, chl, salt	1026	500	
117	17-Sep-06	0731		47	29.11	125	25.37	LP07	CTD 050/net tow	phyto, chl, microzoo, salt	439	430	
118	17-Sep-06	0918		47	25.72	125	33.87	LP08	CTD 051/net tow	phyto, nuts, chl, microzoo	1474	500	rain
119	17-Sep-06	1015		47	25.72	125	33.87	LP08	remove FeFish from water				rain
120	17-Sep-06	1153		47	36.36	125	42.97	OZ09	CTD 052/net tow	phyto, chl, microzoo	1441	500	rain
121	17-Sep-06	1318		47	39.65	125	35.54	OZ08	CTD 053/net tow	phyto, nuts, chl, microzoo		500	rain & 30 kt wind
122	17-Sep-06	1444		47	43.07	125	28.12	OZ07	CTD 054/net tow	phyto, chl, microzoo	1007	500	rain & 30 kt wind
123	17-Sep-06	1621		47	46.61	125	20.87	OZ06	CTD 055/net tow	phyto, nuts, chl, microzoo	813	500	rain & 35 ktwind
124	17-Sep-06	1811		47	50.06	125	13.47	OZ05	CTD 056/net tow	phyto, chl, microzoo	445	440	rain & 35 kt wind
125	17-Sep-06	1943		47	53.57	125	06.05	OZ04	CTD 057/net tow	phyto, nuts, chl	150	145	rain & 35 kt wind
126	17-Sep-06	2026		47	53.57	125	06.16	OZ04	CTD 058	Lessard/microzoo	150	3	rain & 30 kt wind
127	17-Sep-06	2141		47	56.97	124	58.71	OZ03	CTD 059/net tow	phyto, chl, cdom	110	115	rain & 25 kt wind
128	17-Sep-06	2258		48	00.28	124	51.31	OZ02	CTD 060/net tow	phyto, nuts, chl	60	55	rain & 25 ktwind
129	18-Sep-06	0006		48	03.80	124	44.05	OZ01	CTD 061/net tow	phyto, nuts, chl, cdom	32	32	rain & 20 kt wind
130	18-Sep-06	0245		48	16.82	124	44.34	CF01	CTD 062/net tow	phyto, nuts, chl, salt	34	30	rain & wind
131	18-Sep-06	0255		48	16.82	124	44.34	CF01	GoFlo	trace metals	34	10	rain & wind
132	18-Sep-06	0406		48	13.05	124	52.33	CF02	CTD 063/net tow	phyto, nuts, chl, microzoo	59	51	
133	18-Sep-06	0602		48	09.03	124	59.95	CF03	CTD 064/net tow	phyto, chl, microzoo, salt	341	327	
134	18-Sep-06	0801		48	04.73	125	07.94	CF04	CTD 065/net tow	phyto, nuts, chl, microzoo	132	125	
135	18-Sep-06	0946		48	01.48	125	15.50	CF05	CTD 066/net tow	phyto, chl, microzoo	160	155	
136	18-Sep-	1138		47	57.24	125	23.51	CF06	CTD 067/net	phyto, nuts, chl, microzoo	704	500	

	06								tow				
137	18-Sep-06	1345		47	53.04	125	32.01	CF07	CTD 068/net tow	phyto, chl, microzoo	768	500	
138	18-Sep-06	1626		47	48.96	125	39.98	CF08	CTD 069/net tow	phyto, nuts, chl, microzoo, salt	1067	500	
139	18-Sep-06	1712		47	48.90	125	40.00	CF08	CTD 070	Lessard/microzoo	1067	40	
140	18-Sep-06	1850		47	44.91	125	47.97	CF09	CTD 071/net tow	phyto, chl, microzoo	1300	500	
141	18-Sep-06	2115		47	53.79	125	53.47	LA11	CTD 072/net tow	phyto, chl, microzoo,cdoms	1350	500	
142	18-Sep-06	2313		47	59.03	125	43.33	LA10	CTD 073/net tow	phyto, nuts, chl, microzoo,cdoms, salt	917	500	
143	19-Sep-06	0101		48	02.34	125	36.90	LA09	CTD 074/net tow	phyto, chl, Lessard cast at 5 m	360	355	
144	19-Sep-06	0108		on deck					Cu titration experiment started	effect of trace metals			
145	19-Sep-06	0354		48	05.78	125	30.43	LA08	CTD 075/net tow	phyto, nuts, chl, salt	142	137	
146	19-Sep-06	0522		48	09.20	125	23.84	LA07	CTD 075/net tow	phyto, chl	116	110	
147	19-Sep-06	0648		48	12.65	125	17.16	LA06	CTD 077/net tow	phyto, nuts, chl, microzoo	115	110	
148	19-Sep-06	0820		48	16.12	125	10.56	LA05	CTD 078/net tow	phyto, chl, microzoo, salt	125	118	
149	19-Sep-06	0945		48	19.35	125	04.14	LA04	CTD 079/net tow	phyto, nuts, chl, microzoo,cdoms	193	185	
150	19-Sep-06	1100							conductivity sensors cleaned on underway				
151	19-Sep-06	1118		48	22.85	124	57.72	LA03	CTD 080/net tow	phyto, chl, microzoo	111	105	
152	19-Sep-06	1245		48	26.25	124	51.37	LA02	CTD 081/net tow	phyto, nuts, chl, microzoo	310	305	
153	19-Sep-06	1444		48	29.43	124	42.04	EH1	CTD 082/net tow	phyto, nuts, chl, microzoo	253	245	
154	19-Sep-06	1700		48	35.51	124	50.05	LAB1	CTD 083/net tow	phyto, nuts, chl, microzoo,cdoms	62	55	
155	19-Sep-06	1833		48	31.56	124	57.57	LAB02	CTD 084/net tow	phyto, nuts, chl, microzoo, salt	64	60	
156	19-Sep-06	2003		48	27.60	125	05.20	LAB03	CTD 085/net tow	phyto, chl	170	165	
157	19-Sep-06	2136		48	23.67	125	12.78	LAB04	CTD 086/net tow	phyto, nuts, chl, microzoo,cdoms, salt	184	180	
158	19-Sep-06	2317		48	19.69	125	20.39	LAB05	CTD 087/net tow	phyto, chl	114	109	
159	20-Sep-06	0048		48	15.74	125	27.99	LAB06	CTD 088/net tow	phyto, nuts, chl, salt	138	133	
160	20-Sep-06	0223		48	11.81	125	35.58	LAB07	CTD 089/net tow	phyto, chl	161	156	
161	20-Sep-06	0354		48	07.87	125	43.16	LAB08	CTD 090/net tow	phyto, nuts, chl, microzoo, salt	320	315	
162	20-Sep-06	0533		48	03.92	125	50.40	LAB09	CTD 091/net tow	phyto, chl, microzoo	767	500	

163	20-Sep-06	0720		47	59.95	125	58.32	LAB10	CTD 092/net tow	phyto, nuts, chl, microzoo	1423	500	
164	20-Sep-06	0930		48	04.31	126	08.46	LB15	CTD 093/net tow	phyto, nuts, chl, microzoo	1551	500	
165	20-Sep-06	1131		48	08.49	125	59.98	LB14	CTD 094/net tow	phyto, chl, microzoo	1195	500	
166	20-Sep-06	1314		48	12.01	125	53.00	LB13	CTD 095/net tow	phyto, nuts, chl, microzoo	596	500	
167	20-Sep-06	1441		48	15.22	125	47.74	LB11	CTD 096/net tow	phyto, chl, microzoo	206	200	
168	20-Sep-06	1602		48	18.59	125	41.34	LB10	CTD 097/net tow	phyto, nuts, chl, microzoo	153	150	
169	20-Sep-06	1732		48	22.00	125	34.71	LB09	CTD 098/net tow	phyto, chl	151	145	20 knot winds
170	20-Sep-06	1857		48	25.34	125	28.62	LB08	CTD 099/net tow	phyto, nuts, chl	146	140	20 knot winds
171	20-Sep-06	1905		48	25.34	125	28.62	LB08	Steph net tow (too windy to work well)	zooplankton	146		20 knot winds
172	20-Sep-06	2037		48	28.70	125	21.98	LB07	CTD 100/net tow	phyto, chl	157	150	
173	20-Sep-06	2208		48	32.23	125	15.49	LB06	CTD 101/net tow	phyto, nuts, chl, salt	116	110	
174	20-Sep-06	2333		48	34.47	125	09.99	LB05	CTD 102/net tow	phyto, chl	105	100	
175	20-Sep-06	2354		48	34.46	125	09.99	LB05	CTD 103	Lessard/microzoo	105	4	
176	21-Sep-06	0103		48	37.29	125	05.60	LB03	CTD 104/net tow	phyto, nuts, chl, salt	95	90	
177	21-Sep-06	0230		48	40.40	124	59.52	LB01	CTD 105/net tow	phyto, chl	35	30	
178	21-Sep-06	0243		48	40.40	124	59.52	LB01	remove FeFish from water		35		
179	21-Sep-06	0300	1600						Transit, then Operations closed down	gale			
180	21-Sep-06	1618		48	17.18	126	08.06	LBC08	CTD 106/net tow	phyto, nuts, chl, microzoo,cdoms, salt	1089	500	
181	21-Sep-06	1640		48	17.18	126	08.06	LBC08	GoFlo	trace metals	1089	10	
182	21-Sep-06	1815		48	20.96	126	00.40	LBC07	CTD 107/net tow	phyto, chl	650	500	
183	21-Sep-06	1825		48	20.96	126	00.40	LBC07	GoFlo	trace metals	650	10	
184	21-Sep-06	1933		48	24.76	125	52.81	LBC06	CTD 108/net tow	phyto, nuts, chl	157	150	
185	21-Sep-06	1955		48	24.76	125	52.81	LBC06	GoFlo	trace metals	157	10	
186	21-Sep-06	2101		48	28.58	125	45.28	LBC05	CTD 109/net tow	phyto, chl	109	100	
187	21-Sep-06	2120		48	28.58	125	45.28	LBC05	GoFlo	trace metals	109	10	
188	21-Sep-06	2215		48	32.34	125	37.70	LBC04	CTD 110/net tow	phyto, nuts, chl	80	75	CTD surfaced covered in kelp

189	21-Sep-06	2225		48	32.34	125	37.70	LBC04	GoFlo	trace metals	80	10	
190	21-Sep-06	2355		48	36.18	125	30.09	LBC03	CTD 111/net tow	phyto, chl, microzoo	120	110	
191	22-Sep-06	0005		48	36.18	125	30.09	LBC03	GoFlo	trace metals	120	10	
192	22-Sep-06	0110		48	40.02	125	22.59	LBC02	CTD 112/net tow	phyto, chl	68	60	
193	22-Sep-06	0120		48	40.02	125	22.59	LBC02	GoFlo	trace metals	68	10	
194	22-Sep-06	0223		48	43.82	125	15.12	LBC01	CTD 113/net tow	phyto, nuts, chl	72	65	
195	22-Sep-06	0235		48	43.82	125	15.12	LBC01	GoFlo	trace metals	72	10	
196	22-Sep-06							BS01	bucket/net				
197	22-Sep-06	0453		48	54.00	125	13.01	BS02	CTD114/net tow	phyto	110	10	
198	22-Sep-06	0935		48	52.80	126	00.72		Drifter 3938 Recovery Failed	Wire tangled in Port A-Drive			
199	22-Sep-06	1750		48	30.09	125	16.57	EL1	CTD115	Lessard-micro-zooplankton expt., NOT a full CTD cast	147	3	
200	22-Sep-06	2355		48	0:57	124	03.68	Neah Bay	Embark/Debark Science Personnel				
201	23-Sep-06	0045		48	0:57	124	03.68	Neah Bay		phyto		0	
202	23-Sep-06	0100	0430	48	1:57	124	03.68	Neah Bay	Diving Op to detangle wire rope from Z-Drive				
203	23-Sep-06	0630		48	2:57	124	03.68	Neah Bay	Depart Neah Bay- resume ops				
204	23-Sep-06	0720		48	31.20	124	33.51	JDN1	net	phyto		0	
205	23-Sep-06	0830		48	26.40	124	17.6	JDN2	net	phyto		0	
206	23-Sep-06	0945		48	21.97	124	01.78	JDN3	net	phyto		0	
207	23-Sep-06	1109		48	13.99	124	08.33	JDS3	net	phyto		0	
208	23-Sep-06	1217		48	19.69	124	21.48	JDS2	net	phyto		0	
209	23-Sep-06	1320		48	23.86	124	34.96	JDS1	net	phyto		0	
210	23-Sep-06	1507		48	20.52	124	55.95	VT01	net	phyto		0	
211	23-Sep-06	1530								Thermosalinogrphy and sea-shest fluorometer cleaned			
212	23-Sep-06	1545								New PAR sensor installed on CTD. New battery terminal for ISUS NO2 meter			
213	23-Sep-06	1615		48	12.35	125	00.63	VT02	net	phyto			

214	23-Sep-06	1700		48	04.82	124	59.49	VT03	net	phyto			
215	23-Sep-06	1817		47	56.67	124	55.34	SITE 116/ NT01	CTD116/ net	phyto, cdom	94		
216	23-Sep-06	1830		47	56.67	124	55.34	SITE 116/ NT01	ZP net tow 02	S.Moore- zooplankton	94		
217	23-Sep-06	1840		47	56.67	124	55.34	SITE 116/ NT01	ZP net tow 03	S.Moore- zooplankton	94		
218	23-Sep-06	1850		47	56.67	124	55.34	SITE 116/ NT01	ZP net tow 04	S.Moore- zooplankton	94		
219	23-Sep-06	1910		47	56.67	124	55.34	SITE 116/ NT01	ZP net tow 04	S.Moore- zooplankton	94		
220	23-Sep-06	2031		47	46.11	124	21.31	LP02	CTD117/net	phyto/ Lessard microzoo	84	3	
221	23-Sep-06	2055		47	46.11	124	21.31	LP02	drifter 6668 deployed	demonstration for film crew			
222	23-Sep-06	2104		47	46.11	124	21.31	LP02	drifter 6668 recovered	demonstration for film crew			
223	23-Sep-06	2200		47	45.95	124	48.20	LP02	CC2 Fe fish pumping starts for Continuous Culture Expt.	Lisa M cClintock's expt. BC-4	83		
224	24-Sep-06	0545		47	45.95	124	48.20	LP02	Fe fish pumping ends	Lisa M cClintock's expt. BC-4	84		
225	24-Sep-06	0724		47	36.09	124	32.08	EH4	CTD118/NET	phyto,chl,nuts,microzoo	35	32	
226	24-Sep-06	0807		47	36.84	124	46.29	EH2	CTDF119/NET	phyto,chl,nuts,microzoo	47	43	
227	24-Sep-06	0903		47	32.55	124	38.59	KB02	VB18 net/bucket station	phyto/DA			
228	24-Sep-06	0950		47	28.55	124	47.05	KB03	VB19 net/bucket station	phyto/DA			
229	24-Sep-06	1130		47	14.41	124	35.52	CB03	CTD120/net	phyto,chl,nuts,microzoo	80	75	
230	24-Sep-06	1436		47	46.09	124	58.31	LP02	CTD121/net	Lessard micro-zooplankton expt.	82	40	
231	24-Sep-06	2030	2130	48	1:57	124	03.68	Neah Bay		Debark Film Crew			
232	24-Sep-06	2350		48	27.63	125	05.31	DA1	net/bucket	phyto/DA	168	0	
233	25-Sep-06	0050		48	2763	125	12.99	DA2	net/bucket	phyto/DA	157	0	
234	25-Sep-06	0230		48	22.54	125	20.38	DA3	net/bucket	phyto/DA	121	0	
235	25-Sep-06	0348		48	17.56	125	27.14	EH3	CTD122/net	phyto,DA,chl,nuts	128		
236	25-Sep-06	0450		48	15.03	125	29.98	VB23	net/bucket and Dr 66683 deployed	phyto,DA	140		T 12.97,S 32.28
237	25-Sep-06	0549		48	10.03	125	29.84	VB24	net/bucket	phyto,DA		0	
238	25-Sep-06	0716		48	11.72	125	41.79	VB25	net/bucket	phyto,DA		0	
239	25-Sep-	0814		48	12.05	125	53.09	LB13	VB 26	phyto,DA	609	0	

	06								net/bucket				
240	25-Sep-06	0821		48	12.06	125	53.08	LB13	DR 66685	phyto,DA			
241	25-Sep-06	0920		48	12.05	125	46.79	VB27	net/bucket	phyto,DA	156	0	
242	25-Sep-06	1020		48	29.79	125	41.43	VB28	net/bucket	phyto,DA	100	0	
243	25-Sep-06	1120		48	38.94	125	34.87	VB29	net/bucket	phyto,DA	77	0	
244	25-Sep-06	1220		48	47.52	125	29.57	VB30	net/bucket	phyto,DA	110	0	
245	25-Sep-06	1255		48	50.44	125	27.75	LC01	CTD 123/net	phyto,chl,nuts,microzoo	97	92	
246	25-Sep-06			48	50.44	125	27.75	LC01	GoFlo	trace metals	97		
247	25-Sep-06	1421		48	46.95	125	34.24	LC03	CTD 124/net	phyto,chl,nuts,microzoo, nuts,salt	135	130	
248	25-Sep-06	1435		48	46.95	125	34.24	LC03	GoFlo	trace metals	135	8	
249	25-Sep-06	1527		48	43.45	125	40.81	LC04	CTD 125/net	phyto, chl, microzoo	165	160	
250	25-Sep-06	1540		48	43.45	125	40.81	LC04	GoFlo	trace metals	165	8	
251	25-Sep-06	1646		48	39.97	125	47.39	LC05	CTD 126/net	phyto,chl,nuts,microzoo, cdom	65	60	
252	25-Sep-06	1700		48	39.97	125	47.39	LC05	GoFlo	trace metals	65	8	
253	25-Sep-06	1754		48	36.46	125	53.95	LC06	CTD 127/net	phyto, chl, microzoo	92	97	
254	25-Sep-06	1810		48	36.46	125	53.95	LC06	GoFlo	trace metals	92	10	
255	25-Sep-06	1901		48	32.94	126	00.61	LC07	CTD 128/net	phyto, chl, microzoo, nuts	130	125	
256	25-Sep-06	1920		48	32.94	126	00.61	LC07	GoFlo	trace metals	130	10	
257	25-Sep-06	2010		48	29.42	126	07.14	LC08	CTD 129/net	phyto, chl, microzoo	202	198	pine cones and pine needles abundant on surface
258	25-Sep-06	2025		48	29.42	126	07.14	LC08	GoFlo	trace metals	202	10	
259	25-Sep-06	2115		48	25.90	126	13.84	LC09	CTD130/net	phyto/DA, chl, nuts, salt, cdom	625	500	
260	25-Sep-06	2145		48	25.90	126	13.84	LC09	Fe-Fish pumping	fill tanks	625		
261	25-Sep-06	2145		48	25.90	126	13.84	LC09	GoFlo	trace metals	625	10	
262	25-Sep-06	2152		48	25.90	126	13.84	LC09	3 net tows	S.Moore zooplankton	625	100	
263	25-Sep-06	2202		48	25.90	126	13.84	LC09	3 net tows	S.Moore zooplankton	625	100	
264	25-Sep-06	2212		48	25.90	126	13.84	LC09	3 net tows	S.Moore zooplankton	625	30	
265	25-Sep-	2239		48	22.39	126	22.20	LC10	CTD131/net	phyto/DA, chl, nuts	1254	500	

	06												
266	25-Sep-06	2239		48	22.39	126	22.20	LC10	Go	trace metals	1254	500	
267	26-Sep-06	0045		48	25.92	126	13.69	LC09	CTD132/net	Lessard microzooplankton expt.	1236	40	
268	26-Sep-06	0143		48	26.80	126	19.34	VT04	VT04 NET	phyto +			
269	26-Sep-06	0213		48	26.55	126	12.27	LC8.5	CTD133		576	30	
270	26-Sep-06	0225		48	26.55	126	12.27	LC8.5	DR 3918 deployed	with light			
271	26-Sep-06	0409		48	32.19	126	36.58	LD10	CTD134/net	phyto,DA, chl, nuts,microzoo,Trainer deep water	1475	500	
272	26-Sep-06	0545		48	35.68	126	29.97	LD09	CTD135/net	phyto,DA, chl, nuts,microzoo,salt,cdom	1066	500	
273	26-Sep-06	0643		48	39.15	126	23.42	LD08	CTD136/net	phyto, chl, microzoo	786	500	
274	26-Sep-06	0752		48	42.70	126	16.76	LD07	CTD137/net	phyto,DA, chl, nuts,microzoo,cdom	1041	500	
275	26-Sep-06	0920		48	46.20	126	10.34	LD06	CTD138/net	phyto, chl, microzoo	138	135	
276	26-Sep-06	1025		48	48.49	126	03.70	LD05	CTD139/net	phyto,DA, chl, nuts,microzoo,cdom	94	88	
277	26-Sep-06	1135		48	52.17	125	52.03	LD04	CTD140/net	phyto, chl, microzoo,salt	64	60	
278	26-Sep-06	1234		48	56.59	125	50.42	LD03	CTD141/net	phyto,DA, chl, nuts,microzoo.	49	45	
279	26-Sep-06	1332		49	00.10	125	43.80	LD01	CTD142/net	phyto,DA, chl, nuts,microzoo.	37	33	
280	26-Sep-06	1832		48	11.56	126	07.26	D3918	CTD143/net	phyto, DA, chl, nuts,microzoo	261	100	
281	26-Sep-06	1901		48	11.56	126	07.25	D3918	CTD144/net	Lessard micro-zooplankton expt.	260	50	
282	26-Sep-06	1919		48	11.56	126	07.25	D3918	Fe fish pumping		260		
283	26-Sep-06	2110		48	11.56	126	07.25	D3918	Fe fish pumping ends		260		
284	27-Sep-06	0019		48	42.55	126	14.60	D60054	CTD145/net	phyto, DA, chl, nuts,microzoo	197	100	
285	27-Sep-06	0035		48	42.55	126	14.60	D60054	drifter 60054	recovered to clear kelp	197		
286	27-Sep-06	0045		48	42.55	126	14.60	D60054	drifter 60054	redployed	197		
287	27-Sep-06	0220		48	50.30	126	13.00	D60056	CTD146/net	phyto, DA, chl, nuts,microzoo	135	100	
288	27-Sep-06	0245		48	50.30	126	13.00	D60056	drifter 60056	recovered to clear kelp	135		
289	27-Sep-06	0255		48	50.30	126	13.00	D60056	drifter 60056	redployed	135		
290	27-Sep-06	0453		49	07.52	126	02.25	LE01	CTD147/net	phyto, DA, chl, surface nuts	48	40	
291	27-Sep-06	0541		49	05.31	126	07.56	LE02	CTD148/net	phyto, DA, chl, surface nuts	59	55	
292	27-Sep-	0631		49	01.82	126	13.00	LE03	CTD149/net	phyto, DA, chl, surface nuts	85	80	

	06												
293	27-Sep-06	0744		48	57.11	126	21.40	LE04	CTD150/net	phyto, DA, chl, surface nuts	144	140	
294	27-Sep-06	0906		48	52.09	126	29.92	LE05	CTD151/net	phyto, DA, chl, surface nuts	183	180	
295	27-Sep-06	1055		48	47.90	126	43.18	LE06	CTD152/net	phyto, DA, chl, surface nuts,salt	1085	500	
296	27-Sep-06	1227		48	41.98	126	56.57	LE07	CTD153/net	phyto, DA, chl, surface nuts,salt	1453	500	
297	27-Sep-06	1752		47	58.49	126	07.54	D3918	CTD154/net	phyto,DA, chl, nuts,microzoo,salt,cdom	1729	500	
298	27-Sep-06	1930	1215	47	58.49	126	07.54	D3918	GoFlo	trace metals	1729	10	
299	27-Sep-06	2125		47	58.05	126	07.45	D3918	drifter 3918	recovered	1729		
300	27-Sep-06	2130		47	58.05	126	07.45	D3918	drifter 66684	deployed	1729		
301	27-Sep-06	2237		47	59.99	126	58.39	LAB10	CTD155/net	phyto,DA, chl, nuts,microzoo,salt	1421	500	
302	27-Sep-06	2354		48	03.90	125	50.40	LAB09	CTD156/net	phyto,DA, chl, microzoo	756	500	
303	28-Sep-06	0109		48	07.84	125	43.17	LAB08	CTD157/net	phyto,DA, chl, nuts,microzoo	320	315	
304	28-Sep-06	0150						in transit	power outage				
305	28-Sep-06	0200						in transit	power restored				
306	28-Sep-06	0247		48	11.79	125	35.61	LAB07	CTD158/net	phyto,DA, chl, microzoo	160	158	
307	28-Sep-06	0403		48	15.73	125	27.97	LAB06	CTD159/net	phyto,DA, chl, nuts,microzoo	138	130	
308	28-Sep-06	0455		48	17.63	125	27.24	EH3	CTD160/net	phyto,DA, chl, microzoo	128	123	
309	28-Sep-06	0602		48	19.69	125	20.44	LAB05	CTD161/net	phyto,chl	113	108	
310	28-Sep-06	0712		48	23.64	125	12.85	LAB04	CTD162/net	phyto,chl,nuts,microzoo	182	175	
311	28-Sep-06	0832		48	27.72	125	05.43	LAB03	CTD163/net	phyto,chl,microzoo	165	160	
312	28-Sep-06	0954		48	21.59	124	57.56	LAB02	CTD164/net	phyto,chl,nuts,microzoo	64	60	
313	28-Sep-06	1102		48	25.52	124	50.08	LAB01	CTD165/net	phyto,chl,nuts,microzoo	63	59	
314	28-Sep-06	1418		48	15.74	125	27.96	LAB06	CTD166/net		138	132	
315	28-Sep-06	1528		48	11.80	125	35.56	LAB07	CTD167/net		161	155	
	28-Sep-06	1600	2030	48	11.80	125	35.56	LAB07	Fe fish pumping	Light Experiments	161		
316	28-Sep-06	2100		48	11.34	125	35.88	LAB07	CTD168				
317	28-Sep-06	2315		48	24.00	125	20.91	EC	Vertical Net Tow #1	S. Moore expt.	125	100	
318	28-Sep-06	2325		48	24.00	125	20.91	EC	Vertical Net Tow #2	S. Moore expt.	125	100	

319	28-Sep-06	2340		48	23.97	125	20.93	EC	CTD169/net		125	120	
320	28-Sep-06	2350	0140	48	23.97	125	20.93	EC	GoFlo	Depth Fe Profile			
321	29-Sep-06	0423		47	56.98	124	58.92	OZ03	VB31 bucket	phyto,DA		0	
322	29-Sep-06	0530		47	50.80	124	55.42	VB32	VB32 bucket	phyto,DA		0	
323	29-Sep-06	0626		47	45.79	124	48.31	LP02	VB33 bucket	phyto, DA		0	
324	29-Sep-06	0816		47	34.69	124	30.03	KB01	CTD170/net	phyto, DA, chl, ,microzoo	28	24	
325	29-Sep-06	0845		47	33.21	124	34.20	KB1.5	CTD171/net	phyto, DA, chl, microzoo	45	41	
326	29-Sep-06	0948		47	31.68	124	38.48	KB02	CTD172/net	phyto, DA, chl, microzoo	68	63	
327	29-Sep-06	1059		47	28.63	124	47.00	KB03	CTD173/net	phyto,DA,chl,microzoo,salt	119	115	
328	29-Sep-06	1215		47	25.60	124	55.50	KB04	CTD174/net	phyto,DA,chl,microzoo	323	320	
329	29-Sep-06	1340		47	23.40	125	04.01	KB05	CTD175/net	phyto,DA,chl,microzoo,salt	1444	500	
330	29-Sep-06	1502		47	19.51	125	12.49	KB06	CTD176/net	phyto,DA,chl,microzoo	1769	500	
331	29-Sep-06	1618		47	16.48	125	20.98	KB07	CTD177/net	phyto,DA,chl,microzoo	1690	500	
332	29-Sep-06	1752		47	13.97	125	31.22	KB08	CTD178/net	phyto,DA,chl,microzoo,cdom	1515	500	
333	29-Sep-06	1938		47	02.14	125	24.48	CB08	CTD179/net	phyto,DA,chl,microzoo	1900	500	
334	29-Sep-06	2128		47	05.69	125	10.03	CB07	CTD180/net	phyto,DA,chl,microzoo	1500	500	Isus battery plug failed, taken off line
335	29-Sep-06	2248		47	07.89	125	01.60	CB06	CTD181/net	phyto,DA,chl,nuts,microzoo	800	500	
336	30-Sep-06	0008		47	16.09	124	53.05	CB05	CTD182/net	phyto,DA,chl,microzoo	157	152	
337	30-Sep-06	0122		47	12.20	124	43.31	CB04	CTD183	no samples	115	110	
338	30-Sep-06	0143		47	12.20	124	43.31	CB04	CTD184/net	phyto,DA,chl,nuts,microzoo	115	110	
339	30-Sep-06	0242		47	14.38	124	35.53	CB03	CTD185/net	phyto,DA,chl,microzoo	80	75	Isus sampling resumed
340	30-Sep-06	0301		47	14.38	124	35.53	CB03	drifter 3918	deployed	80		
341	30-Sep-06	0346		47	16.09	124	28.21	CB02	CTD186/net	phyto,DA,chl,nuts,microzoo	50	45	
342	30-Sep-06	0437		47	17.16	124	27.00	CB01.5	CTD187/net	phyto,DA,chl,microzoo	50	45	
343	30-Sep-06	0517		47	18.25	124	21.98	CB01	CTD188/net	phyto,DA,chl,microzoo,nuts	33	30	
344	30-Sep-06	0704		47	04.14	124	14.93	GH01	CTD189/net	phyto,DA,chl,microzoo	24	20	

345	30-Sep-06	0744		47	03.20	124	18.23	GH01.5	CTD190/net	phyto,DA,chl,microzoo	38	35	
346	30-Sep-06	0833		47	02.40	124	21.74	GH02	CTD191/net	phyto,DA,chl,microzoo	46	40	
347	30-Sep-06	0930		47	01.36	124	30.01	GH03	CTD192/net	phyto,DA,chl,microzoo	69	63	
348	30-Sep-06	1039		46	58.80	124	37.41	GH04	CTD193/net	phyto,DA,chl,microzoo,salt	99	95	
349	30-Sep-06	1146		46	56.70	124	46.64	GH05	CTD194/net	phyto,DA,chl,microzoo	148	143	
350	30-Sep-06	1255		46	54.60	124	55.27	GH06	CTD195/net	phyto,DA,chl,microzoo,salt	420	415	
351	30-Sep-06	1412		46	52.90	125	03.71	GH07	CTD196/net	phyto,DA,chl,microzoo,salt	828	808	
352	30-Sep-06	1555		46	51.50	125	16.19	GH08	CTD197/net	phyto,DA,chl,microzoo	1462	1000	
353	30-Sep-06	2009		47	02.45	124	21.88	GH02	CTD198/net	Lessard micro-zooplankton expt	47	42	
354	1-Oct-06	0012		46	34.42	124	51.27	D60058	CTD199/net	phyto, chl, nuts	645	200	
355	1-Oct-06	0100		46	34.42	124	51.27	D60058	Small Boat Ops	Fe sampling			
356	1-Oct-06	0130	0145	46	34.42	124	51.27	D60059	Fe fish pumping	Fe sampling			
357	1-Oct-06	0327		46	26.11	125	09.17	WB08	CTD200/net	phyto, chl, microzoo			
358	1-Oct-06	0503		46	26.98	124	55.82	WB07	CTD201/net	phyto,chl,microzoo			
359	1-Oct-06	0614		46	27.54	124	47.07	WB06	CTD202/net	phyto,chl,microzoo	920	500	
360	1-Oct-06	0721		46	27.83	124	39.77	WB05	CTD203/net	phyto,chl,microzoo,salt	917	500	
361	1-Oct-06	0835		46	28.53	124	31.82	WB04	CTD204/net	phyto,chl,microzoo	395	390	Trouble with CTD boom
362	1-Oct-06	0930								Sea Chest Cleaned			
363	1-Oct-06	1000		46	29.01	124	22.46	WB03	CTD205/net	phyto,chl,microzoo	86	80	
364	1-Oct-06	1108		46	29.09	124	14.99	WB02	CTD206/net	phyto,chl,microzoo	53	49	
365	1-Oct-06	1149		46	29.49	124	10.77	WB1.5	CTD207/net	phyto,chl,microzoo	36	33	
366	1-Oct-06	1235		46	29.98	124	07.15	WB01	CTD208/net	phyto,chl,microzoo	21	17	
367	1-Oct-06	1404		46	39.14	124	22.33	VT5	VT05 net	phyto			
368	1-Oct-06	1543		46	47.35	124	30.15	EL02	CTD209/net	Lessard	97	40	
369	1-Oct-06	1614		46	48.60	124	30.67	BC01	CTD210/net	nuts + NH4	97	92	
370	1-Oct-06	1759		47	02.35	124	35.68	D3918	CTD211/net	phyto, chl, nuts	87	82	
371	1-Oct-06	1825		47	02.35	124	35.68	D3918	Drifter recovery				
372	1-Oct-	2107		47	20.70	125	01.26	D66683	CTD212/net	phyto,chl,nuts	1430	200	

	06												
373	1-Oct-06	2140		47	20.70	125	01.26	D66683	Drifter recovery				
374	1-Oct-06	2256		47	30	125	3.47	D66685	CTD213/net	phyto,chl,nuts	908	200	
375	1-Oct-06	2300		47	30	125	3.47	D66685	Aussie net tow	zooplankton			
376	1-Oct-06	2310		47	30	125	3.47	D66685	Drifter recovery				
377	2-Oct-06	0046		47	31.66	124	38.49	KB02	CTD214/net	phyto,microzoo	68	63	
378	2-Oct-06	0100	0145	145	31.66	124	38.49	KB02	GoFlo	trace metals	68		
379	2-Oct-06	0224		47	35.79	124	35.28	EH2	CTD215/net	Mooring calibration - nuts,chl	47	142	
380	2-Oct-06	0259		47	36.04	124	32.02	EH4	CTD216/net	Mooring calibration - nuts,chl, O2	36	32	
381	2-Oct-06	0625		48	03.78	124	44.08	OZ01	CTD217/net	phyto,chl	32	28	
382	2-Oct-06	0722		48	00.37	124	51.40	OZ02	CTD218/net	phyto,chl	61	55	
383	2-Oct-06	0819		47	56.87	124	58.84	OZ03	CTD219/net	phyto,chl, salt	110	106	
384	2-Oct-06	0918		47	53.50	125	06.15	OZ04	CTD220/net	phyto,chl, O2	150	145	
385	2-Oct-06	1026		47	50.07	125	13.51	OZ05	CTD221/net	phyto,chl	437	430	
386	2-Oct-06	1140		47	46.60	125	20.86	OZ06	CTD222/net	phyto,chl,O2	820	500	
387	2-Oct-06	1257		47	43.19	125	28.22	OZ07	CTD223/net	phyto,chl,salt	1003	500	
388	2-Oct-06	1412		47	39.75	125	35.60	OZ08	CTD224/net	phyto,chl,O2	1205	500	
389	2-Oct-06	1500		47	39.75	125	35.60	OZ08	Small Boat Ops	Fe sampling			
390	2-Oct-06	1600		47	39.75	125	35.60	OZ08	Fe Fish tow	Fe sampling			
391	2-Oct-06	1802		47	51.05	125	31.08	D3943	CTD225/net	nuts, NH4, chl	1055	200	
392	2-Oct-06	1830		47	51.05	125	31.08	D3943	Drifter recovery				
393	2-Oct-06	1929		47	52.88	125	26.45	D60055	CTD226/net	nuts, chl	817	200	
394	2-Oct-06	2000		47	52.88	125	26.45	D60055	Drifter recovery				
395	2-Oct-06	2034		47	56.08	125	28.64	D3818	CTD227/net	nuts, NH4, chl	332	200	
396	2-Oct-06	2100		47	56.08	125	28.64	D3818	Drifter recovery				Drogue connection failed at drogue shackle
397	2-Oct-06	2233		47	59.80	125	23.37	D60057	CTD228/net	nuts, chl?	556	200	
398	2-Oct-	2300		47	59.80	125	23.37	D60057	Drifter recovery				

	06												
399	2-Oct-06	2335		48	02.07	125	19.58	D60054	CTD229/net	nuts	497	200	
400	3-Oct-06	0000		48	02.07	125	19.58	D60054	Drifter recovery				
401	3-Oct-06	0142		48	17.67	125	27.20	EH3	CTD230/net	Mooring cal - chl,nuts,phyto,O2	129	124	
402	3-Oct-06	0240		48	25.20	125	31.00	B1	ADCP survey	Start of East Transect			
403	3-Oct-06	1030		48	25.20	125	31.00	B1	ADCP survey	End of West Transect			
404	3-Oct-06	1617		48	20.38	125	52.32	D60056	CTD231/net	phyto,nuts	249	244	
405	3-Oct-06	1635		48	20.38	125	52.32	D60056	Drifter recovery				
406	3-Oct-06	1858		48	37.60	125	54.25	D3884	CTD232/net	phyto,nuts	93	89	
407	3-Oct-06	1945		48	37.60	125	54.25	D3884	Drifter recovery				Drogue floating well, one harness strap ripped
408	3-Oct-06	2009		48	33.73	125	58.48	D3793	CTD233/net	phyto,nuts	110	105	
409	3-Oct-06	2030		48	33.73	125	58.48	D3793	Drifter recovery				Drogue tangled, drogue floats submerged, drifter occasionally underwater
410	3-Oct-06	2344		48	25.93	126	13.70	LC09	CTD234/net	O2, Lessard water collection	1493	500	
411	4-Oct-06	0310		48	25.20	125	31.00	B1	ADCP survey	Start of East Transect			
412	4-Oct-06	0600		48	25.20	124	40.80	B2	ADCP survey	End of East Transect			
413	4-Oct-06	0845		48	12.72	124	00.00		bucket				
414	4-Oct-06	1240		48	10.80	123	00.00		bucket				
415	4-Oct-06	1415		48	07.86	122	43.68		bucket				
416	4-Oct-06	1700							arrive UW				

Table 2: Drifter deployment locations and times

Deployment Date (GMT)	Lat Deg	Lat Min	Lon Deg	Lon Min	Stn ID	PTTID	Recovered/Lost	Comments
9/13/06 20:55	48	29.11	125	12.82	EN	3818	10/2/2006	Drogued at 25 m, connection failed at drogue harness, likely early in deployment
9/13/06 22:31	48	29.95	125	29.88		60056	10/3/2006	
9/13/06 23:25	48	23.72	125	20.71	EW	3793	10/3/2006	Drogued at 25 m, drogue floats underwater when recovered, drogue tangled in wire
9/13/06 23:27	48	23.72	125	20.71	EW	60055	10/2/2006	
9/14/06 0:09	48	23.71	125	12.83	EC	3943	10/2/2006	Drogued at 25 m, drogue line severed, drogue lost most likely several days before recovery
9/14/06 0:10	48	23.71	125	12.83	EC	60054	10/2/2006	
9/14/06 0:58	48	23.63	125	4.82	EE	3884	10/3/2006	Drogued at 25 m
9/14/06 0:59	48	23.63	125	4.82	EE	60057	10/2/2006	
9/14/06 1:54	48	17.98	125	12.76	ES	3938	9/22/2006	Drogued at 25 m, drifter and drogue lost during recovery
9/14/06 3:01	48	6.13	125	12.70		60058	-	
9/25/06 4:50	48	15.03	125	29.98	~LAB6	66683	10/1/2006	
9/25/06 8:21	48	12.06	125	53.08	~LB13	66685	10/1/2006	
9/26/06 2:25	48	26.55	126	12.27	LC8.5	3918	9/27/2006	
9/27/06 21:30	47	58.05	126	7.45		66684	-	Replaced 3918
9/30/06 3:01	47	14.38	124	35.53	CB03	3918	10/1/2006	

Table 3: Dates and file name of available satellite imagery

File Name
SWFCWS20062772158WCchlora.jpg
SWFCWS20062762117WCchlora.jpg
SWFCWS20062742135WCchlora.jpg
SWFCWS20062732055WCchlora.jpg
SWFCWS20062692130WCchlora.jpg
SWFCWS20062672148WCchlora.jpg
SWFCWS20062662107WCchlora.jpg
SWFCWS20062622143WCchlora.jpg
2006_0922_1049_n18_wn.jpg
2006_274_1912_n17_wn.jpg
2006_269_2132_n18_wn.jpg
2006_268_1811_n17_wn.jpg
2006_267_1833_n17_wn.jpg
2006_266_1856_n17_wn.jpg