ECOHAB PNW 3 CRUISE REPORT

R/V Atlantis AT11-17
Sep 8 - Sept 28, 2004

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Area of Operations

Coastal Waters off Washington State and Vancouver Island

Itinerary

Depart Seattle, WA, September 8, 2004
Arrive Seattle, WA, September 28, 2003

Participating Organizations

NOAA/Northwest Fisheries Science Center
San Francisco State University
University of Maine
University of Washington
University of Western Ontario

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Personnel

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Teacher At Sea

Herb Bergamini, Northwest School

Cruise Objectives

The purpose of this cruise was to measure the physical, chemical and physiological conditions under which the algae *Pseudo-nitzschia* produce the toxin domoic acid, and when the toxin is released into the 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. Measurements made included continuous surface water properties, temperature, salinity, fluorescence, as well as discrete surface samples for particulate and dissolved domoic acid, chlorophyll concentration, analysis of community assemblage and identification of phytoplankton species. In these surveys profile data taken with the CTD (conductivity, temperature, depth) included extra sensors that measured fluorescence, photosynthetically active radiation (PAR), beam attenuation (light transmission), and oxygen concentration. During CTD casts discrete samples were taken for chlorophyll and nutrient analyses. A trace metal clean underway sampling system was used to measure iron concentrations on board, and to collect samples for later multielement determination. On deck incubations of phytoplankton for growth and grazing experiments, as well as shipboard laboratory analyses of the plankton were conducted. Satellite tracked drifters were released in the strait, near the Juan de Fuca eddy and off the coast of Washington to delineate patterns and speeds of surface flows in the eddy area, as well as to determine the ultimate fate of eddy water. Drift studies were also performed, during which the ship followed strategically placed drifters allowing the same parcels of water to be resampled as they aged, and thus measure in situ changes in the physical, chemical and biologic constituents. The ship track and sampling stations are shown in Figure 1.

Operations

ADCP lines:
Flow-Through system track with T,S,FL sensors:
CTD casts: 213
Satellite-tracked buoy deployments: 9

Samples Collected

Chlorophyll samples: >200 stations and deck-board experiments (~1500 samples)
Nutrient samples: >150 stations and deck-board experiments (~1900 samples)
^{14}C Uptake (P vs. E) samples: 25 experiments (~1700 samples)
Flow Cytometry samples (nanoplankton, cyanobacteria, bacteria): >125 Stations and deckboard incubation experiments (~700 samples)
HPLC Pigment samples: >125 Stations at 5 m depth
Dilution growth and grazing experiments: 24
Microplankton samples (preserved): ~35 stations and 24 dilution experiments
FlowCAM samples: ~ 500 (stations and experiments)
Phytoplankton/Domoic acid samples: 228 stations
Surface (4 m) samples and depth profiles (10 – 100 m) for Fe determination using Flow-Injection Analysis (pumped using a towed trace metal clean sampling fish) and samples
for analysis of other bioactive trace metals (Mn, Zn, Co, Cu, Ni, Cd): ~120 samples
Sinking Rates: 85 stations and deck-board experiments
Exocellular polysaccharides: 85 stations and deck-board experiments
Aggregation measurements: 20 stations and deck-board experiments

Cruise Summary

Introduction

The ECOHAB 3 cruise was highly successful: *Pseudo-nitzschia* (*PN*) blooms of unprecedented high densities and toxicities in the region persisted throughout the cruise. This situation provides an important contrast to the 2003 cruises, in which *PN* were present, but never a dominant species of the phytoplankton assemblage. The longevity and toxicity of the blooms as well as their large spatial extent provided a rare opportunity for studying toxic blooms in situ.

The study included obtaining 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 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. For simplicity we characterize the wind patterns into three periods: predominant downwelling (1), intermittent weak upwelling/downwelling (2) and weak, persistent upwelling (3). In general, the weather conditions were much more downwelling favorable in contrast with both cruises in the prior year. This allowed us to reduce our effort on sampling a large scale grid—no dramatic weather changes occurred to warrant extensive repeat sampling until late in the cruise. Moreover the slower current speeds allowed us to successfully follow and sample at drifters for extensive periods. Thus more emphasis was placed on time changes following patches of water, in particular, following patches with high *PN* density and high particulate domoic acid (DA) concentrations. Upwelling favorable winds occurred briefly near September14 and September 18-20. However winds during these periods were either too weak or too brief to cause significant changes in the density field (although surface drifters did respond to these events). On the other hand, the change to more persistent upwelling after September 23 resulted in higher air temperatures and warming of surface layers. After September 23 weak upwelling winds persisted through the remainder of the cruise—to investigate changes, one coastal and one eddy transect were re-sampled.

Over 200 data profiles were obtained. Satellite imagery [Sea surface temperature (SST) and chlorophyll] was not generally available due to the generally poor weather. However, a collage of three SST images was made to coincide with our grid sampling period. Cruise activities were recorded in a sequential “Event” log (Table 1) from which summary tables discussed below were derived.

The cruise was diverted to Neah Bay on two occasions (September 13 and 20) in order to exchange personnel and re-supply clean water. A malfunctioning clean water system (Millipore) required WHOI to send out additional filters. Carboys of water from the Lessard laboratory were brought to the ship on these exchanges. The shortage of Millipore water during peak usage times delayed nutrient analyses and other studies. This was the largest initial problem on this cruise. The shipboard water shortage was partially resolved by assistance from the ship’s engineering staff and the additional resin cartridges.

1. Regional Surveys (ECOHAB PNW team)

The 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 chlorophyll, sandwich hybridization assays, whole cell fluorescence assays, particulate domoic acid, dissolved domoic acid, FlowCAM samples, samples for scanning electron microscopy of *PN* species, plankton and macronutrients, all at selected depths. 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, S and Fl pumped from a depth of about 4 m as well as ADCP current profiles from a 150 kHz narrowband RDI ADCP. An ISUS nitrate sensor was tested during this cruise.

Underway data should be treated with caution up to about September 16, 2003 GMT. During the first part of the cruise, sensors were mounted in their usual position on Atlantis, forward and near the bow thruster at a depth of about 5 m. Comparison with salinity and temperature data from the CTD indicated two problems: first, salinities were too low by about 1 psu and temperature, although closer to the CTD value, was low by about 0.5^{o}C; second, salinity data had very large (several psu) fluctuations when the ship was on station. The latter were attributed to the use of the bow thruster. Subsequently (September 16, 2030 GMT) all sensors were moved to a position mid ship and a water depth of about 4 m. Although this eliminated the fluctuations it did not eliminate the mean offset problem, nor did use of a different sensor. Sensors are Falmouth Scientific CTDs. Finally, a thorough cleaning of the area in which the sensors were housed was done and salinity and temperature means closely approached those on the CTD. Sensors were left in this position for the remainder of the cruise. We did not perform a systematic evaluation of other underway sensors such as the fluorometer.

The ISUS nitrate sensor, mounted with the other underway sensors, did not function well during this cruise. Its behavior was similar to that on ECOHAB2: large offsets occurred. On ECOHAB2 calibration data were sufficient to compute a regression and recover the data. On this cruise, however, offsets appeared to change frequently so that there is little hope of obtaining useful data from this instrument. Note that calibration prior to installation on the ship was extremely tight. NMFS personnel will continue to work with the manufacturer to address these issues.

A list of CTD stations organized by sample line and including bottle sample types taken is given in Table 2. Lines were sampled in whichever direction made best use of ship time. Note that occasional short (1-4 hours) time gaps occurred due to the necessity of obtaining water/plankton samples for bio-chemical incubations.

CTD profiles were taken to 500 m where possible. Deeper data were taken on the KB and LB lines on repeat line sampling following the main survey (only). Chlorophyll a, particulate and dissolved DA and plankton samples (for both microscope and molecular probe analysis) were taken near the surface, 5 m, and 10 m (and at 15 m at stations after the initial grid survey). DA samples were also taken at 15, 30 and 50 m at many stations, in particular, at drift stations. Flow cytometry and HPLC pigment samples were taken at 5 m depth. Macro nutrients 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 meters above bottom if the bottom was less than 500 m deep. At canyon stations 5 m and 15 m samples were omitted. In the strait survey, samples were taken also at 150 m. 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. Chlorophyll samples were taken at most stations.

Upper water column iron samples were taken at selected stations (Tables 1 and 2). These samples were obtained by weighting the iron “fish” below the surface (~10 m). Samples typically were taken as the ship left station. Water was pumped for roughly 15 minutes to flush the lines thoroughly before samples were taken. Vertical iron profiles were obtained at several stations by lowering the fish to the target depths (typically 10, 15, 30 and 100 m depths).

The CTD data were partially edited onboard ship. Shipboard editing included replacing downcast data with upcast data at several early stations (casts 7-9): at these stations the CTD pump was inadvertently not turned on in the upper water column. The edited 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 require more extensive processing and will be provided later this year (Foreman group).

Preliminary water property maps and sections are included in the PI data section (T, S, O2, Chl, Fl surface maps at selected depths and T, S, density, Fl, O2 transects versus depth for all transects, 0-100 m and 0-500 m scales). Note that contours of fluorescence voltage differ from those in prior years. Maps of relative abundance of *PN* at the surface are also included.

The CTD data are organized into three groups: Survey 1 (September 9-September 16), drifter stations (September 17-26) and re-sampled transects plus canyon and strait transects. Note that the LP line was sampled once prior to the entire grid survey, with the hope of sampling before and after downwelling conditions. Grid stations sampled in each period are shown in Figure 4a,b. Survey 1, which took place during persistent and sometimes strong downwelling favorable winds was the only complete survey (Fig. 4a). The lack of strong or persistent upwelling meant that conditions during the survey as well as following it were unlikely to change significantly. Note however that surface velocities as measured by our drifters always responded to changes from downwelling to upwelling with directional changes onshore or offshore (in the surface Ekman layer). This complete downwelling survey (our first for ECOHAB PNW) allows us to contrast upwelling and downwelling nutrient and flow patterns (although between years). In general, the shelf break coastal jet was weaker than in prior years' surveys, likely because of the unusually persistent downwelling conditions that would allow the seasonal upwelling pattern to weaken prematurely. Consequently, surface flow patterns were generally weaker and the eddy was more retentive than in our prior surveys.

Drift DA started at the start of weather period 2 (intermittent and weak upwelling and downwelling; Fig. 2) and continued through the remainder of the cruise into the third weather period (weak but persistent upwelling). The water for drift DA was taken from the northeast edge of the eddy. This drift lasted for 10 days, with the drifter remaining in the eddy the entire time. Samples were taken as frequently as 3 hr intervals. Drift DB was initiated as an "add on" to a drifter that had been deployed the first day of the cruise with no intention of following it with samples. It proved so interesting that we initiated sampling on September 17, returning to it roughly every 24 hr. Drift DC was also an "afterthought". It was deployed at a location that in subsequent analyses we found to have high domoic acid. This drifter effectively followed a "hot" filament from the eddy down the coast. We sampled it on three occasions distributed throughout the cruise.

The Kalaloch line was sampled twice after the complete grid survey. One the first occasion, winds were downwelling favorable; on the second, winds had been weakly upwelling favorable for about 2 days (Fig.2).

CTD/nutrient transects were made also along the axis and along Juan de Fuca strait during the weak but persistent upwelling period (Fig. 4b). The same canyon section was also sampled in June and September 2003. Deeper nutrients were collected on these sections. The beginning of the strait data collection occurred at the start of flood, continuing through flood and ebb. The canyon data were collected through flood and ebb, with the end of ebb coinciding with the stations near the mouth of the strait. Note that this is the first continuous transect made through the canyon and strait. In 2003 both regions were sampled, but the two sections were not connected in time.

Some Preliminary Results:

The complete survey clearly captured the coastal downwelling that was occurring during most of the sampling period (PI data, surface maps). Fresher water was observed along most of the Washington coast. From Kalaloch south the freshest water was observed slightly offshore of the coast: this is the signature of a plume from the Columbia that has been slightly displaced offshore in the intermittent weak upwelling and downwelling that occurred just prior to these observations.

Fresher water was also observed off the Vancouver Island coast: this is the signature of water emanating from the strait, forming the Vancouver Island Coastal Current that typically hugs the Vancouver Island coast. The Juan de Fuca eddy is evident as a saltier, colder region centered offshore and slightly south of the strait. Both temperature and salinity indicate a tongue of this water extending down the Washington coast.

The surface fluorescence during the first survey period showed high fluorescence in the region corresponding to the eddy and the tongue directed down the Washington coast. This result is best seen by comparing salinity and fluorescence maps—higher fluorescence occurs roughly in the region of slightly higher salinity.

Pseudo-nitzschia cells and particulate DA reached the highest levels observed over the broadest area thus far in any of our cruises. This made sampling for water for experiments much easier. In general highest DA concentration and *PN* counts were observed in the colder water of the eddy and in the filament extending south to the Washington shelf. The numerically abundant diatom is a strain of P. pseudodelicatissima that was not recognized by the specific muD2 molecular probe.

Intermittent and relatively weak winds persisted over much of the cruise (Fig. 2). Hence, in contrast to prior ECOHAB cruises no attempt was made to resample major portions of the grid. Persistence increased after September 18, with a weak upwelling event of about 2 days followed by weak downwelling for about 2 days (weather period 2). The KB line was re-sampled at this point, with the intention of capturing a well developed Columbia plume after the considerable period of downwelling over the prior 2 weeks. The hope was to determine whether the plume had significant DA and *PN* and whether *PN* might be subducted beneath the plume. A longer period of weak upwelling (weather period 3) extended through the end of the cruise (September 23-28). The KB and LB lines were re-sampled and the canyon and strait transects were sampled during this period.

2. Drift Surveys (Amy MacFadyen, Barbara Hickey, drifters; whole team for water samples)

Three drift studies were performed, following water patches with satellite-tracked Brightwaters drifters. To avoid regions of high current shear, no drogues were used—the drifters average the top meter of the flow field. Note that Mark Wells' iron fish samples were taken slightly deeper (~ 8-10 m) due to requirements of the iron pumping fish; Lessard sampled at 2-4 m to obtain ideal light levels. Deployment and recovery times and deployment location are listed in Table 3. Note that drifts are being numbered sequentially beginning each ECOHAB year. CTD profiles and bottle casts were taken at the start of each drift and water was collected for incubation experiments. CTD profiles and nutrients were taken at 3-24 hour intervals.

The deckboard grow-out incubations (Wells/Cochlan/Trick) during drifts were typically run for 4-5 days. Water was collected at the time the drifter was deployed. Treatments for the deckboard experiments included both metal (Fe, Cu) and chelators/ligands (desferal, domoic acid) manipulations. Incubation bottle and in-situ samples were taken for Chl a, nutrients, cell counts, species composition, rates of carbon uptake (P vs. E), DA concentrations. Additionally, samples for Fe uptake were taken for the deckboard experiments.

Deckboard dilution experiments (Lessard) were run for 24 hours with water collected once or twice each day; eleven experiments were performed at the Drift A time series. Samples for size-fractionated chlorophyll, picoplankton, nanoplankton and microplankton, macronutrients, dissolved and particulate DA were taken in each experiment. Experimental manipulations included the addition of DA, Fe, and macronutrients.

The first drift (Drifter A, 3818 and 3900) was begun on September 17 on the eastern edge of the eddy in a region with both high *PN* densities and significant DA (Fig. 5a). The drifter was followed for 9 days and the drift was only aborted because the cruise was ending. The drifter was replaced with an expendable drifter (#3900) on September 26 after the last CTD cast at Drifter A. This drift was our most successful to date, allowing us to follow a large dense patch of toxic *PN* through growth and senescence. Cell numbers and DA levels were potentially the highest ever measured in this region. As the bloom progressed, another species, believed to be of the genus Chattonella, dominated the assemblage. Between the first and last sampling the drifter circumnavigated most of the eddy. A time series of all parameters was taken with sufficient resolution (generally3 hr) to resolve changes in properties due to internal tidal fluctuations. Tidal fluctuations were extremely irregular in period and amplitude and affected all water properties, even at the sea surface. Two longer periods of 3 hourly sampling were accomplished—one for 36 hours, the second for 24 hr (the latter included iron measurement and characterization of phytoplankton assemblage with depth). As the drift continued, sampling intervals were reduced to 12 and even 24 hr periods. However, even then, 3-4 three hour samples were taken when we returned to the drifter in order to separate long term trends from tidal changes. Sampling successfully resolved both long term trends and tidal scale relationships between physical forcing and biological responses.

The second drift (DB, 9123, 3918 and 3901) was begun September 17 at the location of a drifter (#9123) that had been deployed near LAB 6 on September 10 as part of our initial cruise deployment of three expendable drifters (Fig. 5b). The drifter had been deployed on what was expected to be the southwest portion of the eddy. Based on the previous year we expected that drifter to move southwest and then southward as part of the coastal upwelling shelf break jet. In contrast to

September 2003, the eddy was much more isolated from the coastal front in 2004 and this drifter never left the eddy. As with the first drift, the water followed by DB after sampling began was in a patch of high *PN* and high particulate DA. However, nutrient levels in surface layers were initially higher, and were higher at depth, consistent with the fact that this drift location was over the eddy where isopycnals dome. The drifter was sampled on July 17, beginning drift DB. On September 18 this drifter was replaced with drifter #3918 and CTDs were performed at this drifter at approximately 24 hr intervals until the end of the cruise. On September 26 this drifter was replaced with the expendable drifter #3901. Overall, the patch of water flowed by these drifters remained in the eddy for at least 20 days, performing an entire circuit of the eddy.

The third drift (DC, 3884) was actually begun earlier than the other two drifts. However we had not decided to make it a “drift” until high DA levels were found in the CTD taken at the deployment site (Fig. 5c). Hence it is labeled as the third drift, rather than the first. The drifter was deployed at station CF05, in the presence of high densities of *PN* as well as high particulate DA. This drifter was followed intermittently throughout the cruise. Satellite imagery indicate that this drifter was located in a filament that extended southward from the eddy along the mid Washington coast. This is the type of filament (high in DA) hypothesized to move onshore during fall storms to impact the coastal clams.

3. Drifter Deployments (Amy MacFadyen, Barbara Hickey, James Postel, Brent Leithauser)

Several Davis-type Brightwater drifters 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. Drifter deployment and recovery times and deployment locations are given in Table 3.

Data were stored at the University of Washington and also transmitted to the ship by Sue Geier, Ryan McCabe, Nancy Kachel and Neil Banas. Drifter location and water temperatures are available at 30 minute intervals during deployment. Six drifters will continue to collect data until about the end of October.

Two drifters were deployed at the beginning of the cruise: one (#9124) just inside the strait; a second (#22248) near the expected center of the eddy; a third (#9123) near the southwest edge of the eddy (Fig. 6). All three drifters were deployed prior to any real time information about the eddy location. Only the drifter deployed inside the strait (#9124) escaped the eddy during the cruise period: this drifter apparently entered the Vancouver Island Coastal Current. Although it moved southward around Barkley Sound, it continued northwestward along the Vancouver Island coast during the cruise. The drifter deployed near the center of the eddy (#22248) remained in the eddy for the entire cruise, making a complete circuit of the eddy over that time.

The drifter deployed near the southwest edge of the eddy (#9123) as well as its replacements (# 3918 and # 3901) also remained in the eddy for the 21 days of the cruise. This drifter remained within the eddy for some time after the cruise as well. Near the end of the cruise when upwelling became more persistent some of the drifters did escape the eddy, heading south along the Washington coast (Fig. 6).

4. Satellite Imagery (Dana Woodruff, Rick Stumpf)

Satellite imagery during the cruise was provided by two groups who sent data to the WHOI FTP site—Dana Woodruff from Battelle Northwest Laboratory provided SST imagery and surface chlorophyll imagery was provided by Rick Stumpf at NOAA. Susan Geier and Nancy Kachel (Hickey group) assessed data quality for the shipboard group prior to putting on the ship's FTP site. The available imagery and an assessment of its quality are listed in Table 4. In general, because of the predominantly downwelling wind conditions, few good images were available during the sampling of the large scale grid. We were able to have three SST images combined for that period, with reasonable results. Some good images were obtained midway through the drift DA (September 19-20). Those chlorophyll and temperature images illustrated the filament moving down the coast in which the DC drifter was imbedded.

5. Laboratory Analyses

a) Lessard Group (Evelyn Lessard, Brady Olson, Mike Foy, 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* and other phytoplankton. We also took FlowCAM and fixed samples to follow the in situ spatial and temporal changes in the protist grazing community in relation to *PN* and hydrography.

On this cruise, we performed the following:

1. Twenty four dilution growth and grazing experiments. These experiments are part of the Ph. D. research of Brady Olson. In these experiments, we followed changes in <5 µm, >5 µm and total chlorophyll, particulate DA, dissolved DA, *PN* species abundance using whole cell hybridization assays, and macronutrients (including ammonia). Samples were also preserved and processed onboard for microscopic enumeration of major phytoplankton species later in the laboratory. Chlorophylls were analyzed

onboard as well as whole cell hybridizations for P. australis, P. pseudo-delicatissima, and P. multiseries , macronutrients (measured by Cochlan's group), dissolved and particulate DA (Trainer's group), and cyanobacteria (Trick's group). Eleven experiments were carried out in the Pseudo-nitzschia and Chattonella bloom while following Drifter A in the Juan de Fuca eddy, which will give an unprecedented view of bloom dynamics. Three experiments were run using TM clean water from the Fe Fish sampler to examine grazer/nutrient interactions using combinations of macronutrients and Fe additions. Experimental manipulations also included adding dissolved DA to determine if DA is a grazing deterrent or *PN* growth enhancer, and effects of macronutrients on DA production in a grazing gradient.

2. High frequency abundance estimates of *PN* and other plankton with the FlowCAM. Discrete samples from the Fe pump at every station along three transect lines were analyzed with the FlowCAM, as well as selected stations in the study grid throughout the surveys. All the 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. Replicate fixed samples were taken for microscopic enumerations and calibration of the FlowCAM. During surveys, the FlowCAM proved particularly useful for a quick assessment of *PN* abundance and community composition at the surface and at depth.

3. Grazing on *Pseudo-nitzschia australis*, *P. pseudodelicatissima* and *P. multiseries* was investigated measured with rRNA probes. Brady Olson ran whole cell analyses using the auD1 (*australis*–specific) and muD2 (*multiseries* and *pseudodelicatissima* specific) probes on initial and final samples from the dilution experiments to determine species-specific growth and grazing rates. *P. australis* proved to be rare, and the major species appeared to be *P. delicatissima*, as evidenced by their small size and non-response to the muD2 probe. The species will be positively identified by SEM by the Trainer group; cell abundances for growth and grazing rates will be determined by epifluorescence microscopy.

4. Vertical profiles of micro- and nanoplankton and macrozooplankton. We took preserved plankton samples at ten stations on the large scale survey, and at the beginning and end of drift stations for microscopic determination of autotrophic and heterotrophic nanoplankton, and heterotrophic/mixotrophic dinoflagellates and ciliates.

b) Sandwich Hybridization Assay (Vera Trainer)

The goal of this aspect of ECOHAB PNW was to validate the specificity and to continue field testing of *PN* sandwich hybridization assays (SHA) that will eventually be used to identify and enumerate HAB species in near real-time from environmental samples. In the SHA, extracted nucleic acids from cell lysates are assayed with two oligonucleotide probes, a capture probe and signal probe. The capture probe immobilizes target sequence from the crude cell extract onto a dextran-coated solid support. A "sandwich" hybrid complex is formed when the immobilized target sequence is transferred to a second solution containing a dig-labeled signal probe. SHA products are detected using an anti-dig antibody conjugated to horseradish peroxidase. The horseradish peroxidase reacts with a substrate to generate a blue colorimetric product, the intensity of which is representative of the target cells present in the original sample. When acidified this product turns yellow.

During this cruise, at selected survey stations where numerous *PN* were seen and at all drifter stations (in general, at 0, 5, 10 m depth), 400 ml of seawater were filtered onto a 0.65 µm, 25 mm Durapore membrane filters (Millipore). These filters were placed into plastic test tubes and frozen at –80 oC until analyzed. SHA was carried out using pre-dispensed reagents in 96-well microtiter plates. Cell lysate was prepared by adding filtered cells to Sample Solution Premix and incubating the cells within a lysis tube (thin wall tube) at 80ºC for 5 minutes. Cell lysates were then loaded into the Universal Processor (Affirm Corp.) for processing. The optical density (OD) of the colorimetric product was then read using a 96-well plate spectrophotometer.

Two capture probes will be tested on samples collected during this cruise with two primary *PN* species as targets. The auD1 probe targets *P. australis* and muD2 probe targets *P. pseudodelicatissima* and *P. multiseries*. Because *P. multiseries* has rarely been observed in Washington coastal samples, we hope that the muD2 probe will primarily target *P. pseudodelicatissima*.

Cell numbers of either *P. australis* or *P. pseudodelicatissima* will be determined by comparing sample absorbance values with known *PN* cell numbers generated from cultured cells. Standard curves have been generated from serial dilutions of cultured cells from cruise samples collected in the same region in 2003.

Corresponding whole cell assays were performed using complementary auD1 and muD2 probes (see Section e below).

c) RTC/SFSU Research Group (Bill Cochlan, Julian Herndon, Nick Ladizinsky)

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 domoic acid, and ambient concentrations of macro-nutrients and phytoplankton biomass. At each station, 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, after the survey grid, at 15 m as well. 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, 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, during deep canyon profiles, and at a series of vertical stations in Juan de Fuca Strait on the return transit. Samples from the Juan de Fuca transit were also analyzed for ammonium and urea, 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. Size-fractionated biomass: total planktonic community, as collected on Whatman GF/F filters (nominal pore-size of 0.7 µm), and cells > 5 µm in size (Poretics silver membranes) were determined for all incubator experiments (described below) and drifter stations.

A series of eleven shipboard incubation experiments (termed 'grow-outs') were designed to assess the role of trace metal (Cu and Fe) availability on the growth of *PN* and domoic acid production. Bacterial abundance estimates, to be determined at the University of Western Ontario using flow cytometry [Becton Dickinson, FACSCalibur] on preserved samples, will be used to calculate specific bacterial productivity. Photosynthetic-irradiance (P-E) curves were generated from short-term (1h) 14C uptake experiments using a photosynthetron during the grow-out experiments; these results will be used to describe the efficiency and capacity of phytoplankton photosynthesis with respect to light intensity. P-E curves were generated for most shipboard incubation experiments at the middle and end of the 3 or 4-day grow-out incubations. Potential new production rates were determined using the 15N-tracer technique using saturating and tracer concentrations of nitrate, ammonium and urea (10 and 0.1 µm respectively) to estimate maximal nitrate, ammonium and urea uptake potential as an indicator of phytoplankton community physiological "health". Size-fractionated phytoplankton biomass estimates (as previously described) were determined for all metal and chelator treatments on all days of the incubation experiments.

Expected Results:

1. Dissolved Nutrients: Over 60% of collected samples were analyzed onboard and final, processed concentration data made available. This enabled working maps of nutrients to be developed that helped guide further sampling strategies. The remainder will be available by November 1, 2004 using automated and manual colorimetric methods. Inadequate clean water supply precluded shipboard analysis of the remaining samples.

2. Phytoplankton Biomass: All initial survey grid samples, drifter profiles and onboard deck experiments were analyzed onboard, and are currently available in draft form.

3. Photosynthetic Efficiency: Radio-isotope samples (14C) were prepared on board for liquid scintillation counting ashore at RTC; P-E curves should be generated by December 1.

4. New and Regenerated Production: Samples must be returned to RTC for mass spectrometric analysis, and may be available prior to December 1, depending on the scheduled availability of the RTC mass spectrometer.

d) Trick Research Group (Charlie Trick, Liza McClintock, Benjamin Beall)

Our contribution to the ECOHAB project is two-fold: 1) to provide flow cytometric analysis (FCM) and HPLC pigment analysis 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 domoic acid per cell. Samples for FCM and HPLC were collected at the 5 m depth at all stations on the grid survey as well as the second LB line survey. This will allow for quantitative analysis of bacteria, cyanobacteria, and nanoplankton communities, complemented by pigment analysis to characterize the phytoplankton assemblage which will be performed using our HPLC isolation-and-characterization methods. This method uses the presence or absence of the taxon-specific pigments (often referred to as the “minor or accessory” pigments) in relation to the ubiquitous photosynthetic pigments (chlorophyll) to describe the phytoplankton community structure. Our analysis by HPLC will establish the composition of the communities before and after the presence of the diatom communities, thus serving as an important oceanographic descriptor. These samples will be analyzed within ~ 1-2 months since they preserve poorly. Maps of reconstructed photosynthetic communities will be available soon thereafter.

In our second major contribution to the cruise mandate, the personnel from the Cochlan, Wells and Trick labs carried out deckboard incubation growth experiments. For Liza McClintock’s Masters thesis, six of these experiments were designed and conducted to observe the response of the aging *PN* bloom and associated community (following Drifter A) to increased iron and copper stresses. 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, photosynthetic efficiency and iron [59Fe] uptake rates). 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). For every cruise we may have different hypotheses to test, but 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.

An additional component to our research on the ECOHAB 3 cruise was to gain understanding of the sedimentation characteristics of the phytoplankton community within the Juan de Fuca eddy region. Samples were collected at 5 m depth during the survey and during the drifter DA experiment. For Ben Beall's Masters research, the sinking rate and the potential for aggregate formation were both examined in order to understand the magnitude and causes of phytoplankton sedimentation.

e) Trainer Group (Vera Trainer, Nicolaus Adams, Keri Baugh, Jeannie Bush, Sheryl Day, Brian Bill)

At each survey and drift station, samples were routinely taken 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 drifter, eddy, and coast stations, depth profiles of cells and toxins were done at some of the following depths: 0, 5, 10, 20, 30, 50 m.

Particulate domoic acid 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 uses the displacement of [3H] kainate by DA in a sample from a cloned glutamate receptor. Each plate of samples is compared to known DA standards analyzed on the same plate. Endogenous glutamate was digested prior to sample analysis using glutamate dehydrogenase.

Whole cell hybridization assay

Up to 60 ml sample was filtered and fixed with saline-ethanol for 2 h. Then a specific P. australis probe (auD1, Texas Red labeled) and muD2 probe (fluorescein labeled) was incubated with samples from several depths and 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.

Dissolved domoic acid

These samples were filtered through a 0.45 mm syringe filter and refrigerated until analysis. Selected samples from survey “hot spots” were analyzed at 0, 5, 10 m and complete sets of dissolved DA were analyzed at drifter stations. A commercially available enzyme-linked immunosorbent assay with picomolar sensitivity was used for these analyses (Biosense Corporation).

Pseudo-nitzschia 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. Additionally, up to 100 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 (Nicolaus Adams, Master’s thesis).

f) Wells Group (Mark Wells, Lisa Pickell, Kathy Hardy, Peggy Hughes)

The primary goals of this ECOHAB PNW component on this cruise were to collect seawater samples for determining the distribution of dissolved Fe concentrations in and around the Juan de Fuca eddy, and to field test a new flow injection analysis instrument for online determinations of dissolved Fe and Cu concentrations in surface and deep waters. Over eighty water samples were collected using a trace metal clean tow-fish deployed from the ships’ main boom. These collections included both surface (underway) samples and three deep (= 100 m) profiles.

Flow injection analysis proved to be highly sensitive (detection limits for Fe of < 50 pm). Cross interferences of the dual chemiluminescent methods for Fe and Cu were tested and shown to be insignificant. Iron concentrations were highest in the nearshore shallow shelf regions and decreased in the offshore direction. Values in Juan de Fuca strait and along the Vancouver Island Coastal Current were very high (> 5 nm). Values obtained by flow injection analysis after short term (12 h) acidification will be compared with independent determinations on acidified samples by high resolution Inductively Coupled Plasma Mass Spectrometry.

6. Moored Sensor Arrays: (Barbara Hickey, Rick Thomson, Susan Geier, Tom Juhasz, Jim Johnson)

One of the many components of this project was to design and maintain three surface moorings to collect time series data of water properties and currents and in situ meteorological events in the Juan de Fuca eddy region. A summary of the deployment and recovery times and positions for each mooring is included in Table 5.

Deployment Cruise

The deployment cruise, 2004-07, on the Canadian Coast Guard Offshore Research and Survey Vessel John P. Tully was scheduled for April 26-May 9, 2004. The ECOHAB moorings were scheduled to be deployed on the second leg of the cruise. Bill Fredericks and Jim Johnson from the University of Washington and Nick Adams from the Northwest Fisheries Science Center drove the equipment to the Institute of Ocean Sciences, prepared it for deployment and loaded it on the CCGS John P. Tully. The Tully left the dock at Patricia Bay, Vancouver Island, B.C. on May 1, 2004 with Jim Johnson serving as Dr. Hickey’s representative on the cruise. Tom Juhasz from the Institute of Ocean Sciences was the Chief Scientist under the direction of Dr. Rick Thompson. The first two moorings to be deployed were EH3-2004 in the Eddy and EH2-2004 off the Washington Coast. They were successfully deployed on May 3, and 4. The last mooring to be deployed was EH1-2004 in the Straits of Juan de Fuca. The currents were so strong the surface buoy was partially pulled under. The buoy was brought back on deck and a 36 inch Scottsman float was secured inside the bridle to give it increased flotation. The mooring was successfully deployed May 8, 2004. The Tully returned to Patricia Bay May 9, 2004 and Mr. Johnson returned to Seattle.

Moorings were equipped with an ARGOS Satellite transmitter so that their positions could be checked from shore. The moorings were also equipped with Coast Guard approved lights. In order to insure the EH1-2004 mooring in the Straits did not lose power to its light Anthony Odell checked its visibility several times over the course of the summer. The lights on the other two moorings are solar powered.

Mooring Recovery Cruise

Sue Geier and Anthony Odell served as representatives from Dr. Hickey's group on the mooring recovery cruise, 2004-29. Tom Juhasz from the Institute of Ocean Sciences was the Chief Scientist under the direction of Dr. Rick Thompson. Ms. Geier and Mr. Odell joined the second leg of the cruise on Sept. 16, 2004. The CCGS John P. Tully left the dock at the Institute of Ocean Sciences, Patricia Bay early the next morning. All 3 moorings were successfully recovered on Sept. 18 and 19. The CCGS John P. Tully returned to the dock at the Institute of Ocean Sciences on September 23, 2004 and Ms. Geier and Mr. Odell returned to Seattle.

Acknowledgements

We would like to thank the captain and crew of the R/V Atlantis for their support and extra effort that made the September 2004 cruise successful. We thank the crew and officers of CCGS J.P Tully and the IOS/OSAP/UW mooring team of Tom Juhasz, Dave Spears and Susan Geier in advance for their help in mooring recovery in September. 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. Mooring recovery on the Tully was made possible by Canadian support to Richard Thomson at the Institute of Ocean Sciences.

List of Tables and Figures

Fig. 1 Cruise track with sampling stations

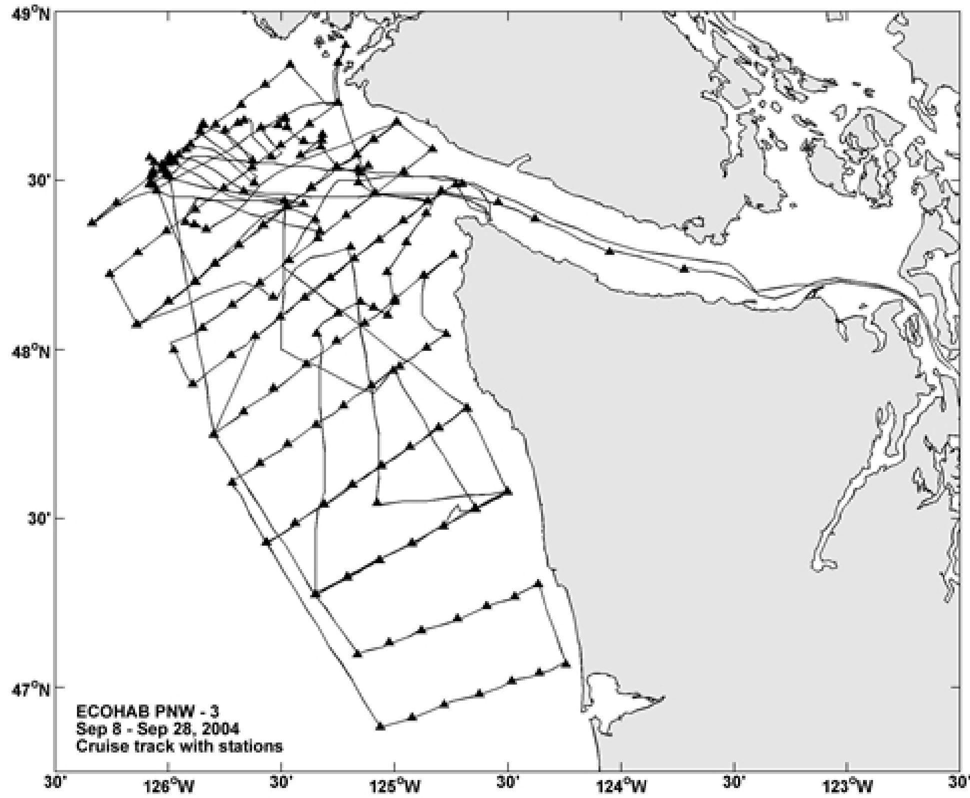


Fig. 2 Time series of shipboard vector winds during cruise

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. Three periods discussed in report text are also shown.

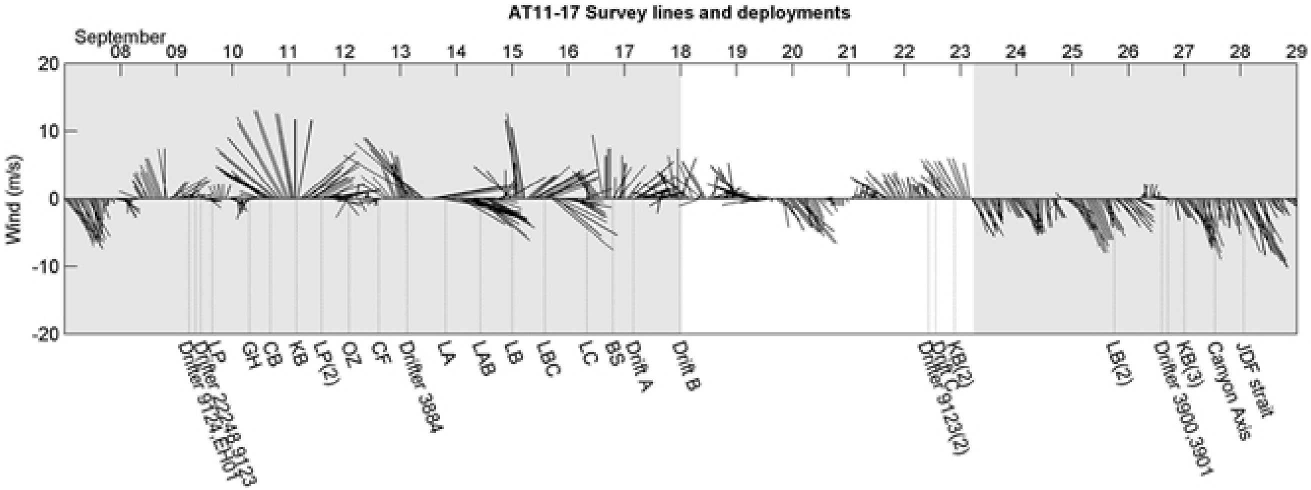


Fig. 3 Theoretical survey grid and locations of moored arrays

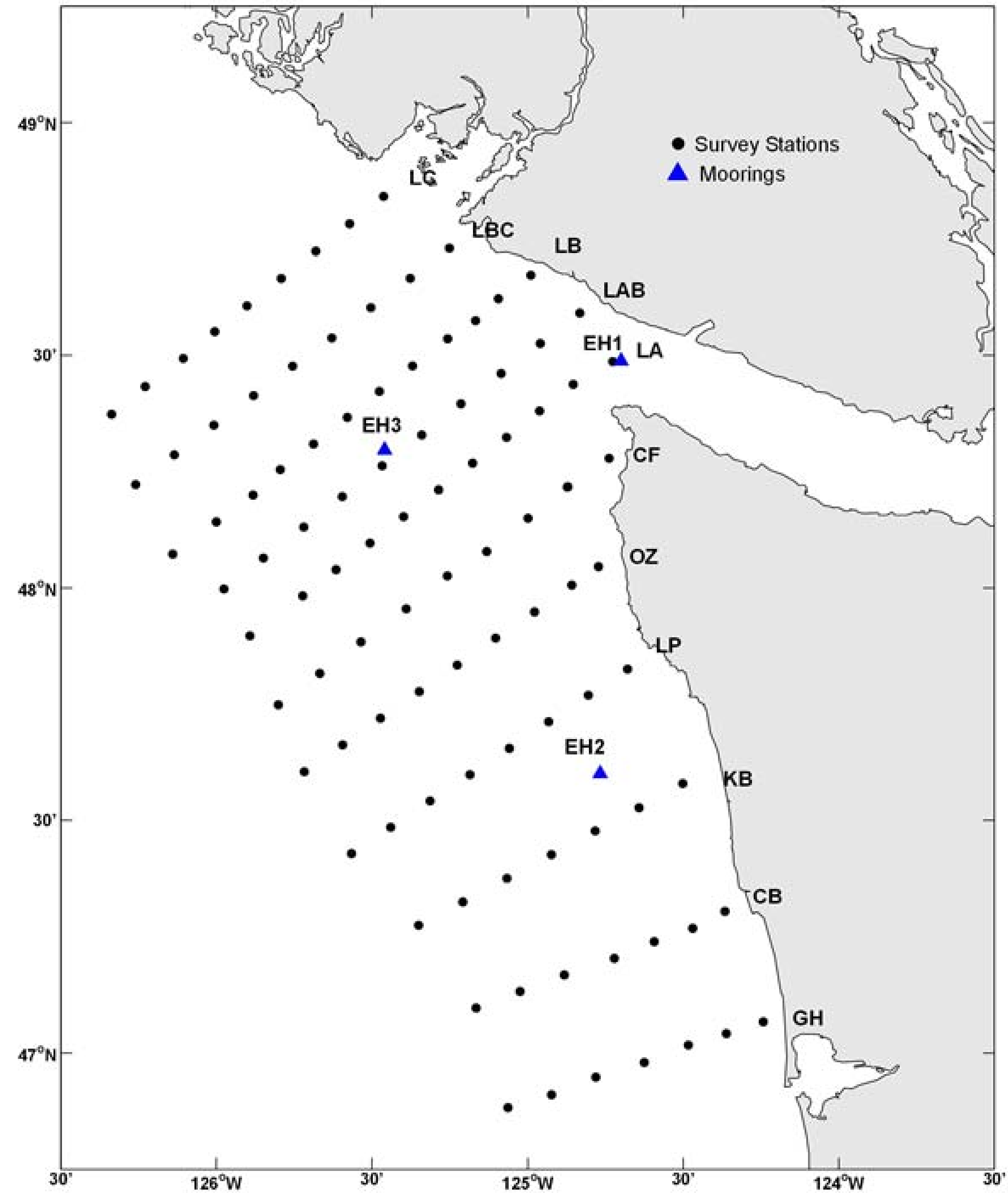


Fig. 4a CTD station numbers for Period 1

CTD numbers of Survey 1 are above the station marker. Numbers of additional CTDs prior to Survey 1 are below station markers.

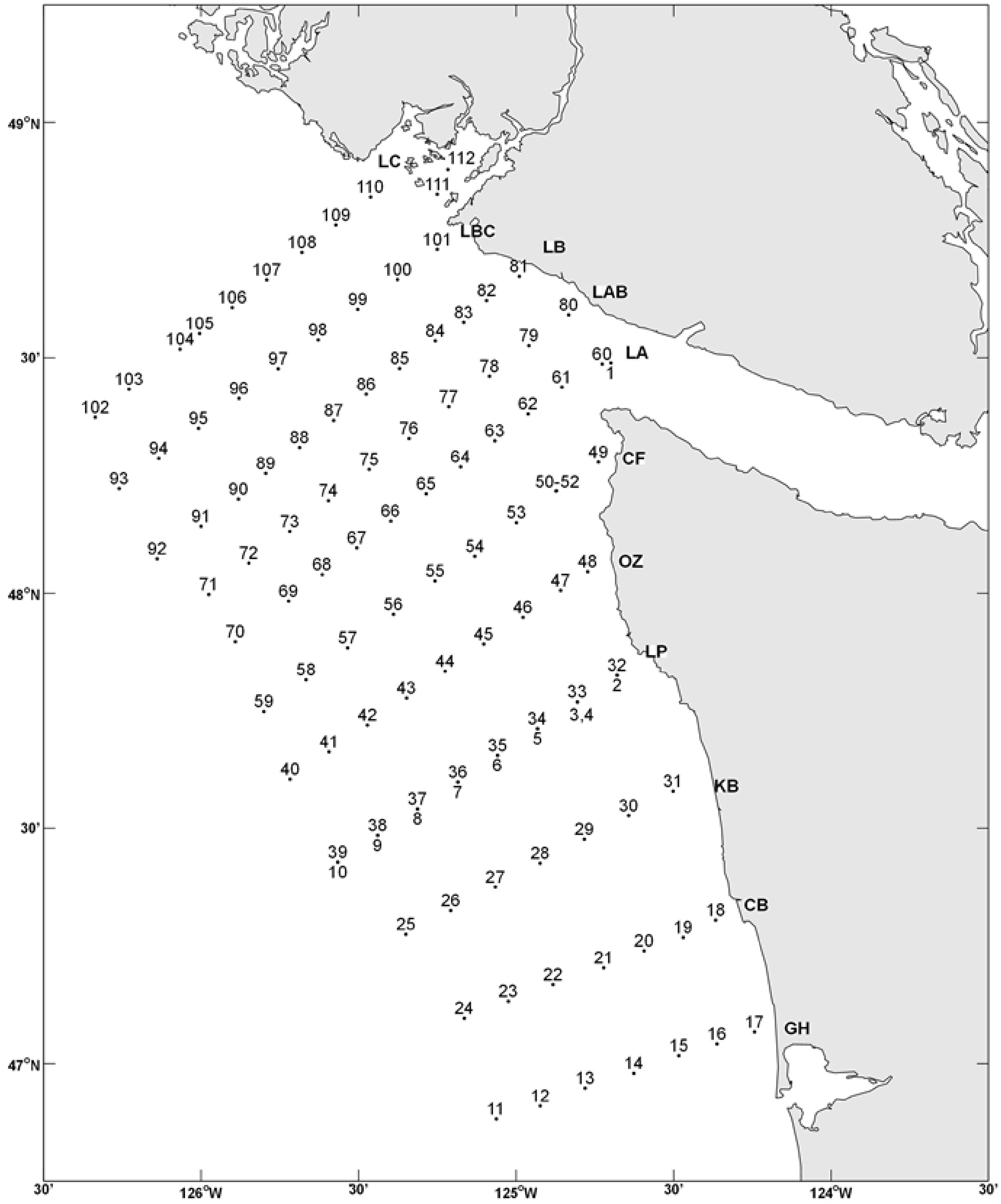


Fig. 4b CTD station numbers for Periods 2 and 3

CTD numbers during Period 2 are below the station markers, CTD numbers during Period 3 are above.

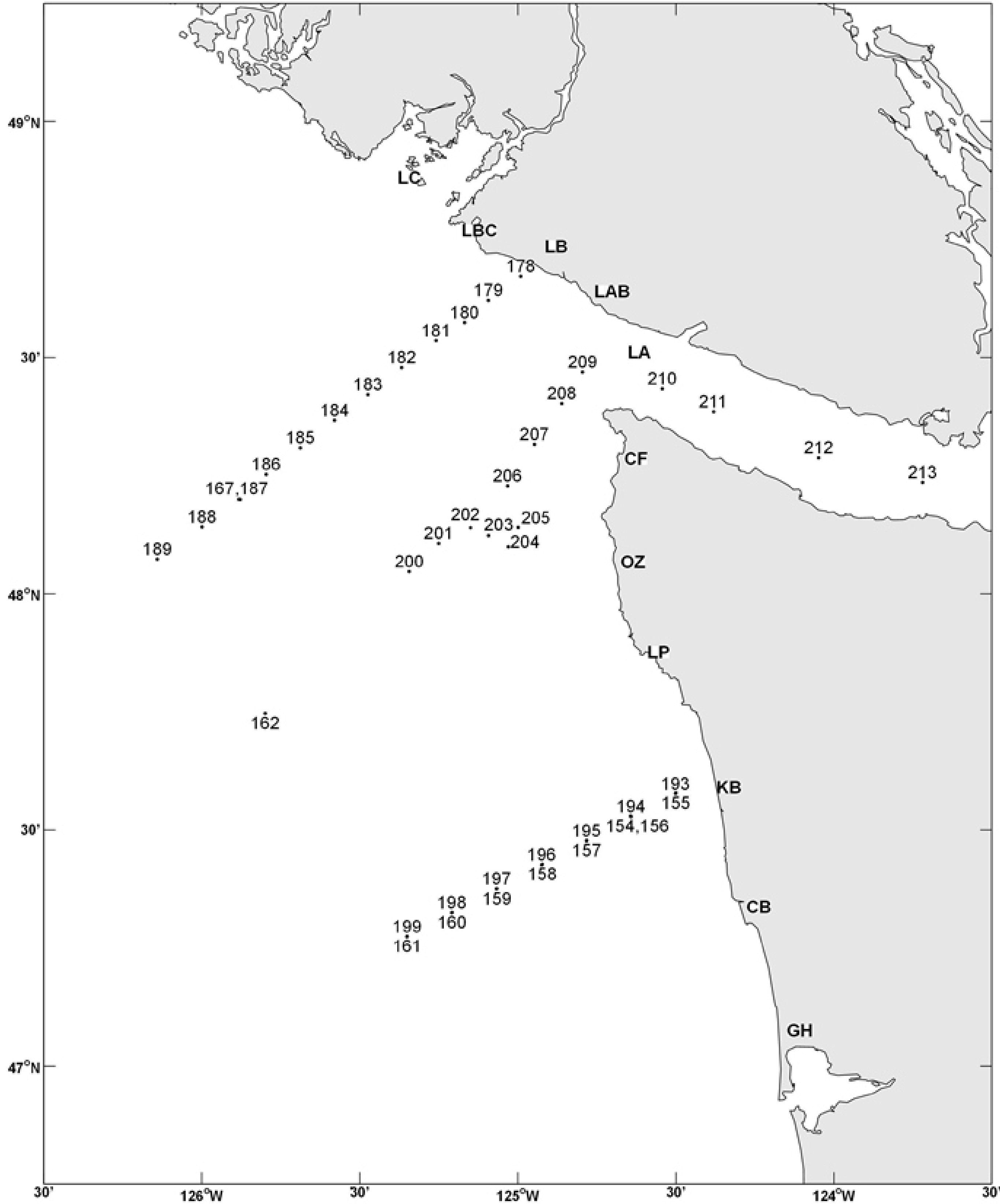
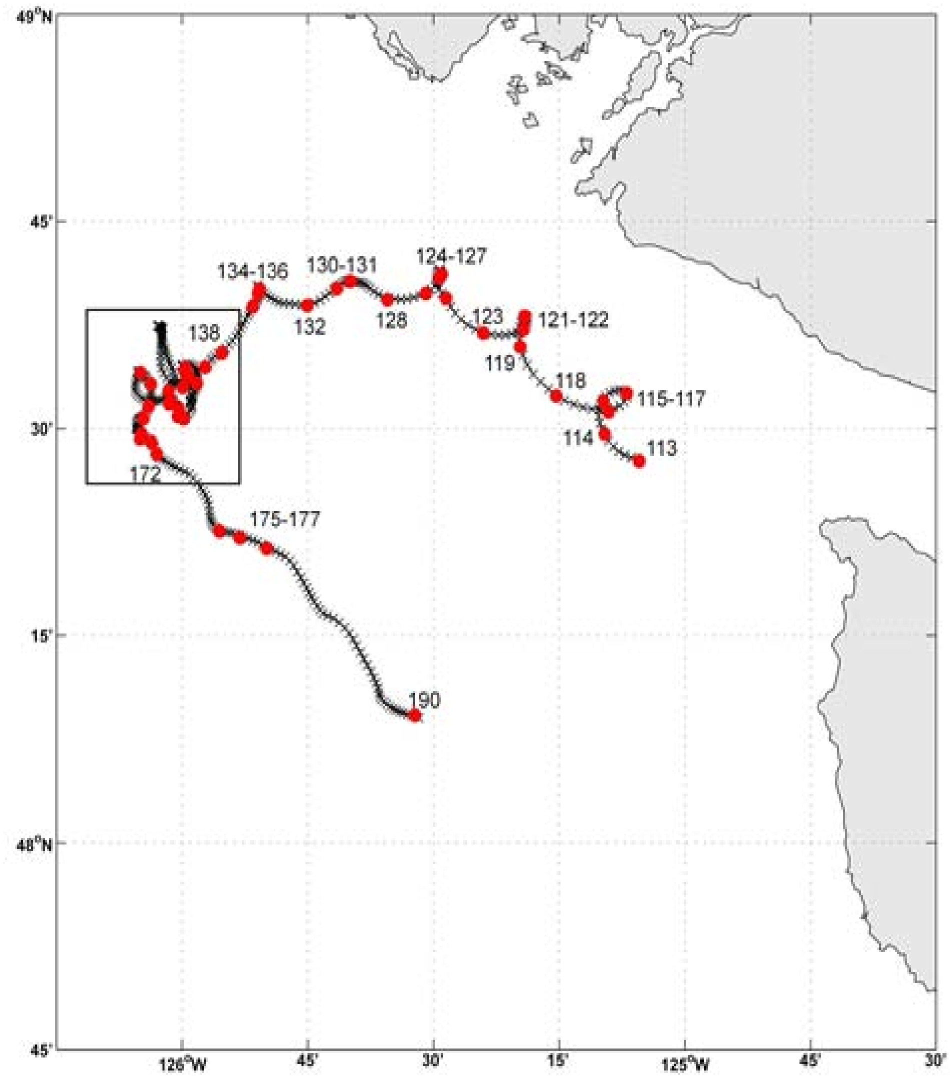


Fig. 5a Drifter track during Drift A (3818) with CTD cast numbers



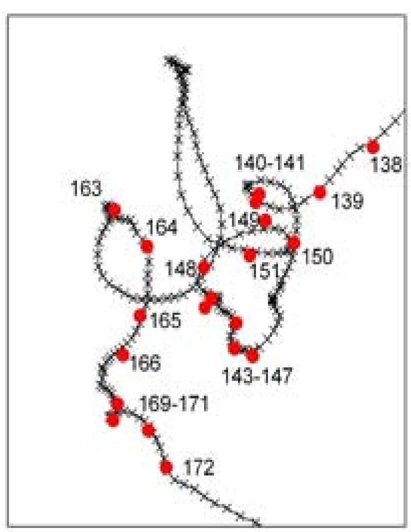


Fig. 5b Drifter track during Drift B (3918) with CTD cast numbers

Track shown in blue is from initial deployment. Drifter 3918 replaced 9123 on September 26th.

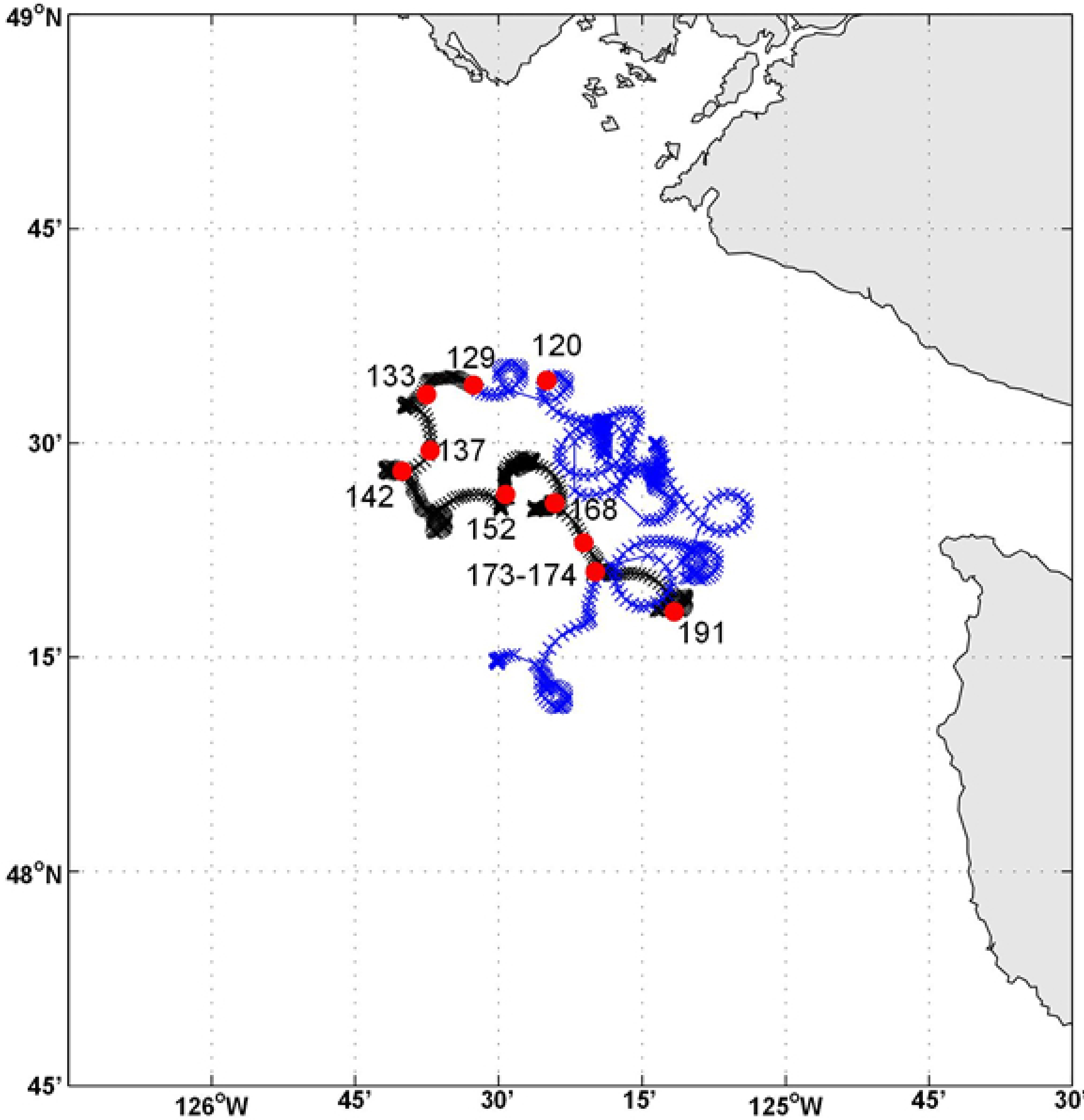


Fig. 5c Drifter track during Drift C (3884) with CTD casts numbers

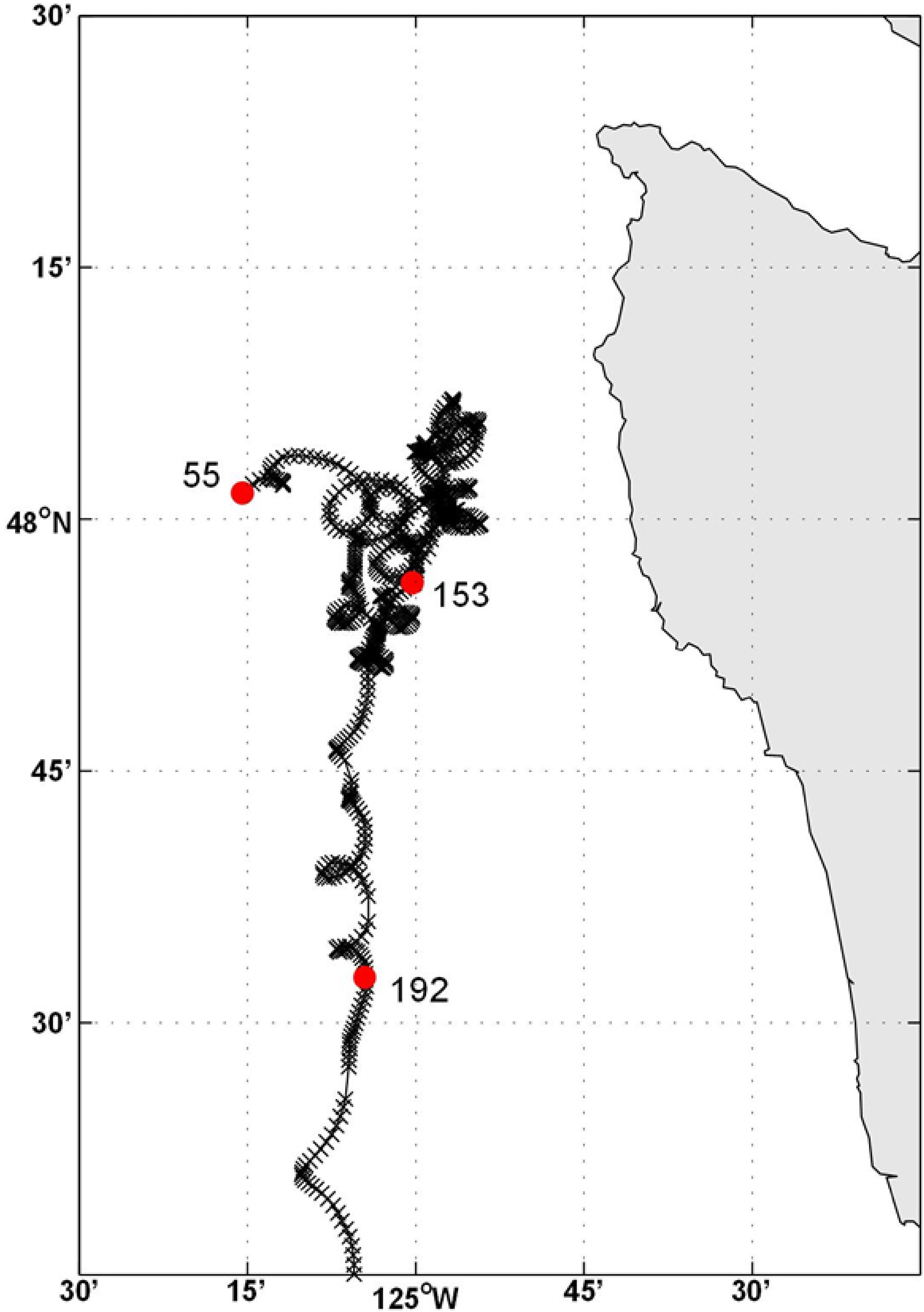
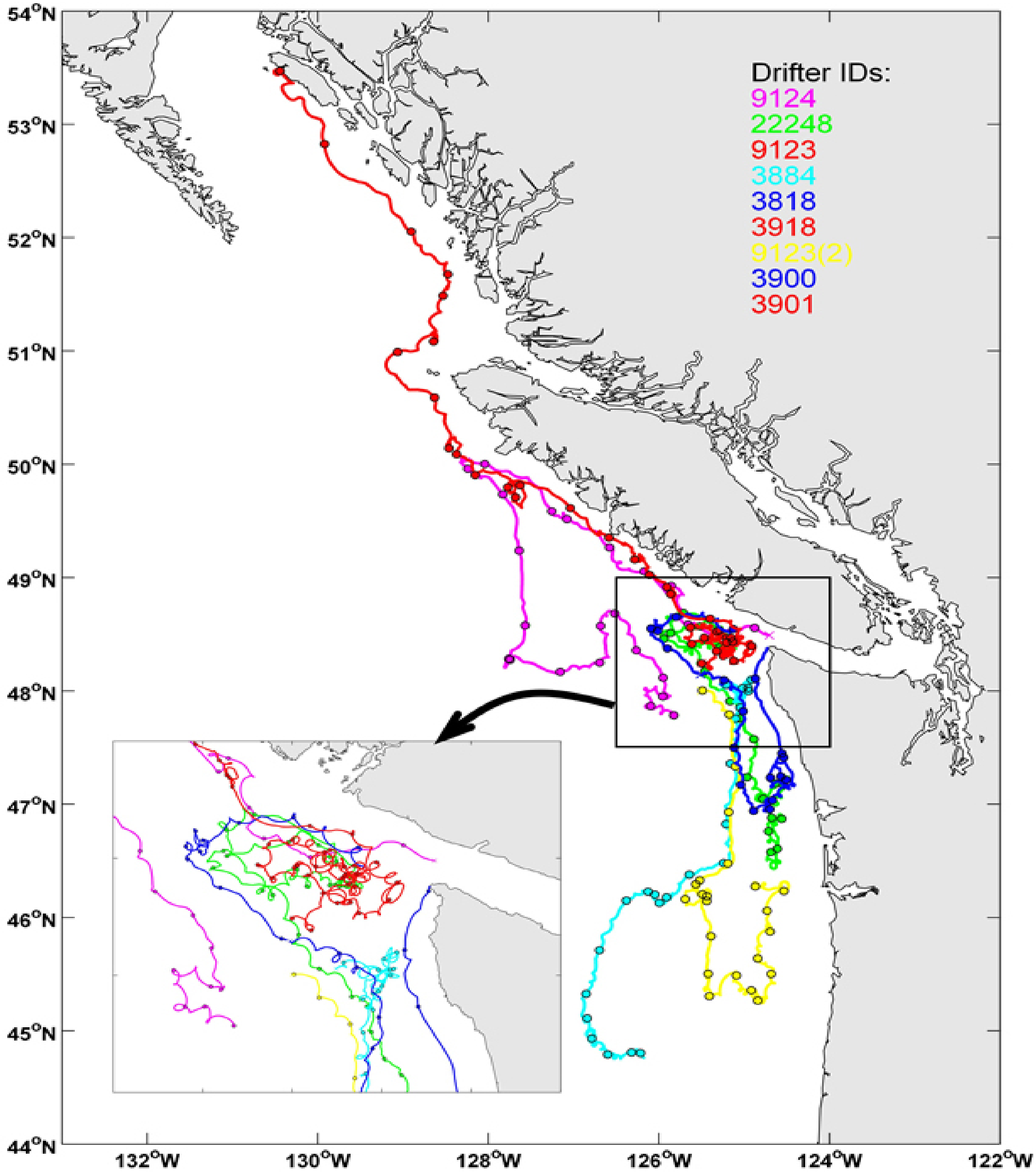
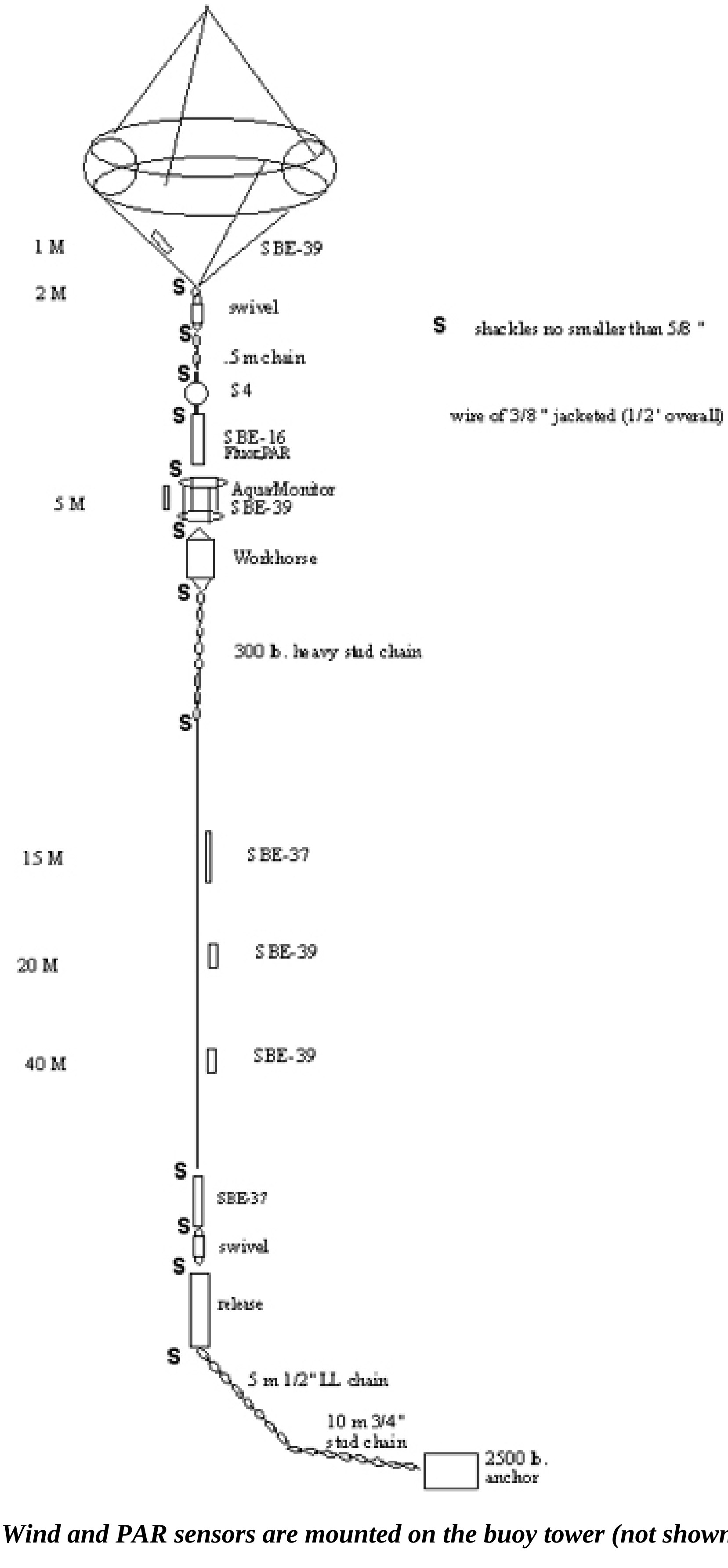


Fig. 6 Trajectories of all drifters deployed during the cruise



Drifters were deployed off of Northern Washington in the vicinity of the Juan de Fuca eddy. Colored dots represent 48 hours on the large-scale figure and 24 hours on the blow-up..

Fig. 7 Mooring schematic



Wind and PAR sensors are mounted on the buoy tower (not shown).

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)
1	09-Sep-2004	05:16	05:24	48	29.34	124	41.97	EH1	Deploy drifter #9124		257
2	09-Sep-2004	05:21	05:49	48	29.34	124	41.97	EH1	CTD 001	nuts, VTchl, salt,VTda	257
3	09-Sep-2004	08:10	08:15	48	30.10	125	14.99		Deploy drifter #22248		148
4	09-Sep-2004	08:20	08:25	48	30.18	125	15.03		Vtnet 001		
5	09-Sep-2004	10:25	10:28	48	14.94	125	29.96		Vtnet 002		
6	09-Sep-2004	10:30	10:33	48	14.91	125	29.91		Deploy drifter #9123		142
7	09-Sep-2004	11:32	11:37	48	08.75	125	18.34		VTnet003/bucketVB3-03	pDA, dDA, nettow,wholeH2O	160
8	09-Sep-2004	12:32	12:36	48	03.35	125	17.36		VTnet004/bucketVB#-04	pDA, dDA, nettow,wholeH2O	139
9	09-Sep-2004	13:28	13:34	47	57.83	124	56.72		VTnet005/bucketVB#-05	pDA, dDA, nettow,wholeH2O	100
10	09-Sep-2004	14:28	14:33	47	52.31	124	46.18		VTnet006/bucketVB#-06	pDA, dDA, nettow,wholeH2O	58
11	09-Sep-2004	15:20	15:37	47	49.50	124	40.70	LP 01	CTD 002	nuts, VT,chl, enzymes,flowcam	37
12	09-Sep-2004	15:29		47	49.50	124	40.70	LP 01	net tow #8		37
13	09-Sep-2004	16:37	16:55	47	46.10	124	48.31	LP 02	CTD 003	nuts, chl, VT	83
14	09-Sep-2004	16:37		47	46.10	124	48.31	LP 02	net tow #9		83
15	09-Sep-2004	17:25	17:42	47	46.10	124	48.31	LP 02	CTD 004	corrected PAR coefficients	83
16	09-Sep-2004	18:44	19:08	47	42.72	124	55.91	LP 03	CTD 005/net tow #10	chlor survey, VT	122
17	09-Sep-2004	20:52	21:14	47	39.30	125	03.54	LP 04	CTD 006	nuts, chl, VT, enzymes	181
18	09-Sep-2004	20:53	21:14	47	39.30	125	03.54	LP 04	net tow #11		181
19	09-Sep-2004	22:early	22:58	47	35.90	125	11.15	LP 05	CTD 007	chlor, VT	591
20	09-Sep-2004	23:51	00:24	47	32.51	125	18.75	LP 06	CTD 008	nuts, chl, VT, enzymes	1039
21	10-Sep-04	01:21	01:53	47	29.10	125	26.39	LP 07	CTD 009	VT, salt	1203
22	10-Sep-04	01:21		47	29.10	125	26.39	LP 07	net tow #12		1203
23	10-Sep-04	02:44	03:22	47	25.71	125	33.97	LP 08	CTD 010	nuts, salt, chl, VT, Liza,	1491
24	10-Sep-04	02:44		47	25.71	125	33.97	LP 08	net tow #13		1491
25	10-Sep-04	07:08	07:50	46	52.96	125	03.74	GH 07	CTD 011	salt, chl, VT	830
26	10-Sep-04	07:08		46	52.96	125	03.74	GH 07	net tow #14		830
27	10-Sep-04	08:36	09:17	46	54.62	124	55.39	GH 06	CTD 012	nuts, salt, chl, VT,	430
28	10-Sep-04	08:36		46	54.62	124	55.39	GH 06	net tow #15		430
29	10-Sep-04	10:02	10:24	46	56.89	124	46.87	GH 05	CTD 013	salt, VT	300
30	10-Sep-04	10:02		46	56.89	124	46.87	GH 05	net tow #16		300
31	10-Sep-04	11:14	11:32	46	58.78	124	37.55	GH 04	CTD 014	nuts, chl, VT	100
32	10-Sep-04	11:14		46	58.78	124	37.55	GH 04	net tow #17		100
33	10-Sep-04	12:22	12:37	47	01.04	124	29.00	GH 03	CTD 015	chl, VT	66
34	10-Sep-04	12:22		47	01.04	124	29.00	GH 03	net tow #18		66
35	10-Sep-04	13:20	13:34	47	02.52	124	21.72	GH 02	CTD 016	nuts, chl, VT	43
36	10-Sep-04	13:20		47	02.52	124	21.72	GH 02	net tow #19		43

37	10-Sep-04	14:31	14:41	47	04.02	124	14.59	GH 01	CTD 017	nuts, chl, VT, salt	20
38	10-Sep-04	14:31		47	04.02	124	14.59	GH 01	net tow #20		20
39	10-Sep-04	16:23	16:32	47	18.29	124	22.00	CB 01	CTD 018	nuts, chl, VT	32
40	10-Sep-04	16:23		47	18.29	124	22.00	CB 01	net tow #21		32
41	10-Sep-04	16:45	00:00(9/11)	47	18.29	124	22.00	CB 01	iron fish deployment	retrieved during CTD023/CB6	32
42	10-Sep-04	18:00	18:11	47	16.10	124	28.20	CB 02	CTD 019	nuts, chl, VT, salt (sample0296)	48
43	10-Sep-04	18:00		47	16.10	124	28.20	CB 02	net tow #22		48
44	10-Sep-04	19:01	19:20	47	14.39	124	35.58	CB 03	CTD 020	chl, VT	79
45	10-Sep-04	19:01		47	14.39	124	35.58	CB 03	net tow #23		79
46	10-Sep-04	20:20	20:36	47	12.24	124	43.33	CB 04	CTD 021	nuts, chl, VT, salt, flowcam	117
47	10-Sep-04	20:20		47	12.24	124	43.33	CB 04	net tow #24		117
48	10-Sep-04	21:52	22:09	47	10.08	124	53.00	CB 05	CTD 022	chl, VT, flowcam	157
49	10-Sep-04	21:52		47	10.08	124	53.00	CB 05	net tow #25		157
50	10-Sep-04	23:48	00:21(9\11)	47	07.95	125	01.41	CB 06	CTD 023	nuts, chl, VT, salt, flowcam	900-1000
51	10-Sep-04	23:48		47	07.95	125	01.41	CB 06	net tow #26		900-1000
52	11-Sep-04	01:23	01:57	47	05.82	125	09.87	CB 07	CTD 024	chl, VT, flowcam	appx 500
53	11-Sep-04	01:23		47	05.82	125	09.87	CB 07	net tow #27		appx 500
54	11-Sep-04	03:31	04:10	47	16.51	125	20.99	KB 07	CTD 025	chl, VT, salt, Trick	1707
55	11-Sep-04	03:31		47	16.51	125	20.99	KB 07	net tow #28		1707
56	11-Sep-04	05:11	05:46	47	19.53	125	12.47	KB 06	CTD 026	nuts, chl, VT, salt, Trick	1715
57	11-Sep-04	05:11		47	19.53	125	12.47	KB 06	net tow #29		1715
58	11-Sep-04	06:56	07:30	47	22.52	125	03.94	KB 05	CTD 027	chl, VT, Trick, (chl.max=30m)	1465
59	11-Sep-04	06:56		47	22.52	125	03.94	KB 05	net tow #30		1465
60	11-Sep-04	08:20	09:00	47	25.50	124	55.00	KB 04	CTD 028/net tow#31	nuts, chl, VT, salt	1096
61	11-Sep-04	09:55	10:15	47	28.63	124	47.00	KB 03	CTD 029	chl, VT, Trick	115
62	11-Sep-04	09:55		47	28.63	124	47.00	KB 03	net tow #32		115
63	11-Sep-04	11:07	11:26	47	31.62	124	38.53	KB 02	CTD 030	nuts, chl, VT, Trick	65
64	11-Sep-04	11:07		47	31.62	124	38.53	KB 02	net tow #33		65
65	11-Sep-04	12:14	12:26	47	34.74	124	30.11	KB 01	CTD 031	nuts, chl, VT	25
66	11-Sep-04	12:14		47	34.74	124	30.11	KB 01	net tow #34		25
67	11-Sep-04	14:10	14:23	47	49.50	124	40.60	LP 01	CTD 032	nuts, chl, VT, dilution, stab.iso. Flowcam	34
68	11-Sep-04	14:10		47	49.50	124	40.60	LP 01	net tow #35		34
69	11-Sep-04	15:40	16:00	47	46.14	124	48.33	LP 02	CTD 033	nuts, chl, VT, dilution, salt, Flowcam	80
70	11-Sep-04	15:40		47	46.14	124	48.33	LP 02	net tow #36		80
71	11-Sep-04	17:17	17:32	47	42.73	124	55.98	LP 03	CTD 034	chl, VT	120
72	11-Sep-04	17:17		47	42.73	124	55.98	LP 03	net tow #37		120
73	11-Sep-04	18:34	18:55	47	39.29	125	03.50	LP 04	CTD 035	nuts, chl, VT, salt, flowcam	180
74	11-Sep-04	18:34		47	39.29	125	03.50	LP 04	net tow #38		180

75	11-Sep-04	19:50	20:05?	47	35.90	125		LP 05	CTD 036	chl, VT, flowcam	597
76	11-Sep-04	19:50		47	35.90	125		LP 05	net tow #39		597
77	11-Sep-04	21:22		47	32.49	125	18.76	LP 06	CTD 037	nuts, chl, VT, 0/00, flowcam	1042
78	11-Sep-04	21:22		47	32.49	125	18.76	LP 06	net tow #40		1042
79	11-Sep-04	22:49	23:19	47	29.09	125	26.36	LP 07	CTD 038	chl, VT, flowcam@5m, no 0m bottle	1197
80	11-Sep-04	22:49		47	29.09	125	26.36	LP 07	net tow #41		1197
81	9/12/2004	00:07	00:39	47	25.70	125	33.94	LP 08	CTD 039	nuts, chl, VT, 0/00, flowcam	1489
82	9/12/2004	00:07		47	25.70	125	33.94	LP 08	net tow #42		1489
83	9/12/2004	02:00	02:39	47	36.31	125	42.99	OZ 09	CTD 040	chl, VT, flowcytometer	1456
84	9/12/2004	02:00		47	36.31	125	42.99	OZ 09	net tow #43		1456
85	9/12/2004	03:30	04:08	47	39.74	125	35.63	OZ 08	CTD 041	nuts, chl, VT, flowcyto, salt	1260
86	9/12/2004	03:30		47	39.74	125	35.63	OZ 08	net tow #44		1260
87	9/12/2004	05:09	05:46	47	43.18	125	28.33	OZ 07	CTD 042	chl, VT	1012
88	9/12/2004	05:09		47	43.18	125	28.33	OZ 07	net tow #45		1012
89	9/12/2004	06:34	07:14	47	46.61	125	20.85	OZ 06	CTD 043	nuts, chl, VT, salt	838
90	9/12/2004	06:34		47	46.61	125	20.85	OZ 06	net tow #46		838
91	9/12/2004	08:02	08:39	47	50.04	125	13.52	OZ 05	CTD 044	ch, VT	438
92	9/12/2004	08:02		47	50.04	125	13.52	OZ 05	net tow #47		438
93	9/12/2004	09:26	09:48	47	53.50	125	06.14	OZ 04	CTD 045	nuts, chl, VT, salt	148
94	9/12/2004	09:26		47	53.50	125	06.14	OZ 04	net tow #48		148
95	9/12/2004	10:38	10:55	47	56.88	124	58.69	OZ 03	CTD 046	chl, VT	108
96	9/12/2004	10:38		47	56.88	124	58.69	OZ 03	net tow #49		108
97	9/12/2004	11:39	11:53	48	00.35	124	51.51	OZ 02	CTD 047	nuts, chl, VT, salt	60
98	9/12/2004	11:39		48	00.35	124	51.51	OZ 02	net tow #50		60
99	9/12/2004	12:29	12:42	48	02.74	124	46.37	OZ 01	CTD 048	nuts, chl, VT, salt, (extra bottles for NA)	30
100	9/12/2004	12:29		48	02.74	124	46.37	OZ 01	net tow #51		30
101	9/12/2004	14:44	14:52	48	16.72	124	44.33	CF 01	CTD 049	nuts, chl, VT, salts, surf.isotopes	31
102	9/12/2004	14:44		48	16.72	124	44.33	CF 01	net tow #52		31
103	9/12/2004	15:09	22:15	48	16.72	124	44.33	CF 01	iron fish deployment	pumping water for incubation	31
104	9/12/2004	16:20	16:32	48	13.00	124	52.40	CF 02	CTD 050	nuts, chl, VT	59
105	9/12/2004	16:20		48	13.00	124	52.40	CF 02	net tow #53		59
106	9/12/2004	22:15	22:37	48	13.04	124	52.29	CF 02	CTD 051	nuts, chl, VT, dilution (NO BOW THRUSTERS)	59
107	9/12/2004	22:15		48	13.04	124	52.29	CF 02	net tow #54		59
108	9/12/2004	22:55	00:28	48	13.04	124	52.29	CF 02	CTD 052	"Naked Cast" with bow thrusters	59
109	9/12/2004	23:59	00:24 (9/13)	48	08.44	125	00.00	CF 03	CTD 053	chl, VT, salts, flowcam	355
110	9/12/2004	23:59		48	08.44	125	00.00	CF 03	net tow #55		355

111	9/13/2004	01:23	01:37	48	04.68	125	07.84	CF 04	CTD 054	nuts, chl, VT, flowcam	128
112	9/13/2004	01:23		48	04.68	125	07.84	CF 04	net tow #56		128
113	9/13/2004	02:32	02:51	48	01.55	125	15.45	CF 05	CTD 055	chl, VT, salt	159
114	9/13/2004	02:32		48	01.55	125	15.45	CF 05	net tow #57		159
115	9/13/2004	02:57		48	01.61	125	15.37	CF 05	deploy drifter #3884	drifter site DC	159
116	9/13/2004	03:51	?	47	57.28	125	23.39	CF 06	CTD 056	nuts, chl, VT	710
117	9/13/2004	03:51		47	57.28	125	23.39	CF 06	net tow #58		710
118	9/13/2004	05:27	06:02	47	53.03	125	32.06	CF 07	CTD 057	chl, VT,	780
119	9/13/2004	05:27		47	53.03	125	32.06	CF 07	net tow #59		780
120	9/13/2004	06:52	07:26	47	48.94	125	40.04	CF 08	CTD 058	nuts, chl, Vt	1091
121	9/13/2004	06:52		47	48.94	125	40.04	CF 08	net tow #60	Lessard bucket	1091
122	9/13/2004	08:17	08:52	47	44.92	125	48.03	CF 09	CTD 059	chl, VT, salt	1310
123	9/13/2004	08:17		47	44.92	125	48.03	CF 09	net tow #61 (LA line)		1310
124	9/13/2004	10:40		48	02.55	125	36.53	LA 09	net tow #62 (LA line)	begin hourly net tows on line LA to Neah Bay	364
125	9/13/2004	11:45		48	06.25	125	26.25		net tow #63 (LA line)	approx lat/lon	
126	9/13/2004	12:37		48	12.71	125	17.06		net tow #64 (LA line)		
127	9/13/2004	13:34		48	19.25	125	04.63		net tow #65 (LA line)		
128	9/13/2004	14:35		48	25.68	124	52.62		net tow #66 (LA line)		
129	9/13/2004	15:32		48	26.37	124	40.82		net tow #67 (LA line)		
130	9/13/2004								Neah Bay Personnel Exchange		
131	9/13/2004	19:20	?	48	29.20	124	43.62	LA 01	CTD 060	chl, VT, salt (no nuts)	260
132	9/13/2004	19:45	04:10?(9/14)	48	29.20	124	43.62	LA 01	iron fish deployment		260
133	9/13/2004	20:54	21:23	48	26.25	124	51.27	LA 02	CTD 061	nuts, chl, VT	314
134	9/13/2004	20:54		48	26.25	124	51.27	LA 02	net tow #68		314
135	9/13/2004	22:21	22:38	48	22.85	124	57.72	LA 03	CTD 062	chl, VT,	115
136	9/13/2004	22:21		48	22.85	124	57.72	LA 03	net tow #69		115
137	9/13/2004	23:28	23:50	48	19.43	125	04.02	LA 04	CTD 063	nuts, chl, VT,	183
138	9/13/2004	23:28		48	19.43	125	04.02	LA 04	net tow #70		183
139	9/14/2004	00:46	01:05	48	16.09	125	10.57	LA 05	CTD 064	chl, VT,	123
140	9/14/2004	00:46		48	16.09	125	10.57	LA 05	net tow #71		123
141	9/14/2004	01:48	02:06	48	12.62	125	17.15	LA 06	CTD 065	nuts, chl, VT, salt	110
142	9/14/2004	01:48	02:06	48	12.62	125	17.15	LA 06	net tow #72		110
143	9/14/2004	03:37	03:22	48	09.19	125	23.88	LA 07	CTD 066	chl, VT,	110
144	9/14/2004	03:37	03:22	48	09.19	125	23.88	LA 07	net tow #73		110
145	9/14/2004	04:22	04:43	48	05.76	125	30.35	LA 08	CTD 067	nuts, chl, VT, iron fish retrieval	142
146	9/14/2004	04:22	04:43	48	05.76	125	30.35	LA 08	net tow #74		142
147	9/14/2004	05:50	06:14	48	02.36	125	36.92	LA 09	CTD 068	chl, VT,	364
148	9/14/2004	05:50	06:14	48	02.36	125	36.92	LA 09	net tow #75		364
149	9/14/2004	07:10	07:47	47	58.96	125	43.34	LA 10	CTD 069	nuts, chl, VT,	935
150	9/14/2004	07:10	07:47	47	58.96	125	43.34	LA 10	net tow #76		935
151	9/14/2004	08:52	09:21	47	53.80	125	53.52	LA 11	CTD 070	chl, VT,	1565
152	9/14/2004	08:52		47	53.80	125	53.52	LA 11	net tow #77		1565

153	9/14/2004	10:11	10:48	47	59.85	125	58.53	LAB 10	CTD 071	nuts, chl, VT, salt	1450
154	9/14/2004	10:11		47	59.85	125	58.53	LAB 10	net tow #78		1450
155	9/14/2004	11:40	12:08	48	03.84	125	50.93	LAB 09	CTD 072	chl, VT	788
156	9/14/2004	11:40		48	03.84	125	50.93	LAB 09	net tow #79		788
157	9/14/2004	13:01	13:25	48	07.85	125	43.12	LAB 08	CTD 073	nuts, chl, VT	324
158	9/14/2004	13:01		48	07.85	125	43.12	LAB 08	net tow #80		324
159	9/14/2004	14:18	14:31	48	11.78	125	35.73	LAB 07	CTD 074	chl, VT	162
160	9/14/2004	14:18		48	11.78	125	35.73	LAB 07	net tow #81		162
161	9/14/2004	15:24	15:47	48	15.77	125	28.00	LAB 06	CTD 075	nuts, chl, VT	137
162	9/14/2004	15:24		48	15.77	125	28.00	LAB 06	net tow #82		137
163	9/14/2004	15:51		48	15.69	125	28.13	LAB 06	iron fish deployment		17
164	9/14/2004	16:58	17:11	48	19.75	125	20.37	LAB 05	CTD 076	chl, VT	115
165	9/14/2004	16:58		48	19.75	125	20.37	LAB 05	net tow #82		115
166	9/14/2004	18:23	18:46	48	23.71	125	12.85	LAB 04	CTD 077	nuts, chl, VT, salt, Trick	188
167	9/14/2004	18:23		48	23.71	125	12.85	LAB 04	net tow #83		188
168	9/14/2004	19:42	19:59	48	27.66	125	05.06	LAB 03	CTD 078	chl, VT	168
169	9/14/2004	19:42		48	27.66	125	05.06	LAB 03	net tow #84		168
170	9/14/2004	20:10	20:35	48	28.12	125	04.14	LAB 03	pump water for iron fish		168
171	9/14/2004	21:23	21:37	48	31.54	124	57.60	LAB 02	CTD 079	nuts, chl,. VT, salt	68
172	9/14/2004	21:23		48	31.54	124	57.60	LAB 02	net tow #85		68
173	9/14/2004	22:37	22:49	48	35.84	124	49.97	LAB 01	CTD 080	nuts, chl, VT, Nick	63
174	9/14/2004	22:37		48	35.84	124	49.97	LAB 01	net tow #86		63
175	9/14/2004	23:59	00:07 (9/15)	48	40.36	124	59.40	LB 01	CTD 081	nuts, chl, VT, Nick	38
176	9/14/2004	23:59		48	40.36	124	59.40	LB 01	net tow #87		38
177	9/15/2004	00:53	01:06	48	37.32	125	05.59	LB 03	CTD 082	nuts, chl, VT	95
178	9/15/2004	00:53		48	37.32	125	05.59	LB 03	net tow #88		95
179	9/15/2004	01:51	02:07	48	34.49	125	10.02	LB 05	CTD 083	chl, VT, Lessard, salt	106
180	9/15/2004	01:51		48	34.49	125	10.02	LB 05	net tow #89		106
181	9/15/2004	02:44	03:02	48	32.16	125	15.53	LB 06	CTD 084	nuts, chl, VT	115
182	9/15/2004	02:44		48	32.16	125	15.53	LB 06	net tow #90		115

183	9/15/2004	04:03	04:22	48	28.66	125	22.17	LB 07	CTD 085	chl, VT, salt	158
184	9/15/2004	04:03		48	28.66	125	22.17	LB 07	net tow #91		158
185	9/15/2004	05:10	05:30	48	25.35	125	28.55	LB 08	CTD 086	nuts, chl, VT	140
186	9/15/2004	05:10		48	25.35	125	28.55	LB 08	net tow #92		140
187	9/15/2004	06:18	06:33	48	22.02	125	37.74	LB 09	CTD 087	chl, VT	154
188	9/15/2004	06:18		48	22.02	125	37.74	LB 09	net tow #93		154
189	9/15/2004	07:22	07:41	48	18.56	125	41.27	LB 10	CTD 088	nuts, chl, VT	156
190	9/15/2004	07:22		48	18.56	125	41.27	LB 10	net tow #94		156
191	9/15/2004	08:26	08:45	48	15.26	125	47.72	LB 11	CTD 089	chl, VT, salt	209
192	9/15/2004	08:26		48	15.26	125	47.72	LB 11	net tow #95		209
193	9/15/2004	09:24	09:58	48	11.99	125	52.91	LB 13	CTD 090	nuts, chl, VT	599
194	9/15/2004	09:24		48	11.99	125	52.91	LB 13	net tow #96		599
195	9/15/2004	10:47	11:16	48	08.53	126	00.00	LB 14	CTD 091	chl, VT	1206
196	9/15/2004	10:47		48	08.53	126	00.00	LB 14	net tow #97		1206
197	9/15/2004	12:08	12:44	48	04.36	126	08.44	LB 15	CTD 092	nuts, chl, VT, salt	1555
198	9/15/2004	12:08		48	04.36	126	08.44	LB 15	net tow #98		1555
199	9/15/2004	13:57	14:31	48	13.30	126	15.57	LBC 09	CTD 093	chl, VT	1100
200	9/15/2004	13:57		48	13.30	126	15.57	LBC 09	net tow #99		1100
201	9/15/2004	15:25	15:59	48	17.18	126	08.12	LBC 08	CTD 094	nuts, chl, VT, salt	1112
202	9/15/2004	15:25		48	17.18	126	08.12	LBC 08	net tow #100		1112
203	9/15/2004	16:48	17:20	48	20.98	126	00.45	LBC 07	CTD 095	chl, Vt, salt	640
204	9/15/2004	16:48		48	20.98	126	00.45	LBC 07	net tow #101		640
205	9/15/2004	17:40	03:00	48	20.98	126	00.45	LBC 07	iron fish deployment		640
206	9/15/2004	18:54	19:30	48	24.81	125	52.84	LBC 06	CTD 096	nuts, chl, VT	160
207	9/15/2004	18:54		48	24.81	125	52.84	LBC 06	net tow #102		160
208	9/15/2004	20:11	20:30	48	26.61	125	45.30	LBC 05	CTD 097	chl, VT, Lessard, NickA	110
209	9/15/2004	20:11		48	26.61	125	45.30	LBC 05	net tow #103		110
210	9/15/2004	21:26	21:40	48	32.27	125	37.73	LBC 04	CTD 098	nuts, chl, VT, salt	82
211	9/15/2004	21:26		48	32.27	125	37.73	LBC 04	net tow #104		82
212	9/15/2004	22:42	22:53	48	36.19	125	30.19	LBC 03	CTD 099	chl, VT	113
213	9/15/2004	22:42		48	36.19	125	30.19	LBC 03	net tow #105		113
214	9/15/2004	23:49	00:01	48	39.96	125	22.60	LBC 02	CTD 100	nuts, chl, VT	70
215	9/15/2004	23:49		48	39.96	125	22.60	LBC 02	net tow #106		70
216	9/16/2004	03:00	03:15	48	43.80	125	15.03	LBC 01	CTD 101	nuts, chl, VT; 2 hr delay to fix ctd connections that	68

										prevented data stream from getting to the deck box--problem with OBS sensor?	
217	9/16/2004	03:00		48	43.80	125	15.03	LBC 01	net tow #107		68
218	9/16/2004	07:55	08:24	48	22.42	126	20.22	LC 10	CTD 102	chl, VT, salt	1266
219	9/16/2004	07:55		48	22.42	126	20.22	LC 10	net tow #108		1266
220	9/16/2004	09:07	09:42	48	26.00	126	13.72	LC 09	CTD 103	nuts, chl, VT	615
221	9/16/2004	09:07		48	26.00	126	13.72	LC 09	net tow #109		615
222	9/16/2004	10:39	10:55	48	31.09	126	04.01	LC 08 appx	CTD 104	chl, VT, salt	171
223	9/16/2004	10:39		48	31.09	126	04.01	LC 08 appx	net tow #110		171
224	9/16/2004	11:21	11:39	48	33.08	126	00.30	LC 07	CTD 105	nuts, chl, VT, salt	126
225	9/16/2004	11:21		48	33.08	126	00.30	LC 07	net tow #111		126
226	9/16/2004	12:18	12:30	48	36.41	125	54.10	LC 06	CTD 106	chl, VT	91
227	9/16/2004	12:18		48	36.41	125	54.10	LC 06	net tow #112		91
228	9/16/2004	13:10	13:24	48	39.94	125	47.48	LC 05	CTD 107	nuts, chl, VT, salt	63
229	9/16/2004	13:10		48	39.94	125	47.48	LC 05	net tow #113		63
230	9/16/2004	14:04	14:22	48	43.42	125	40.82	LC 04	CTD 108	chl, VT	160
231	9/16/2004	14:04		48	43.42	125	40.82	LC 04	net tow #114		160
232	9/16/2004	15:14	15:32	48	40.95	125	34.37	LC 03	CTD 109	nuts, chl, VT	140
233	9/16/2004	15:14		48	40.95	125	34.37	LC 03	net tow #115		140
234	9/16/2004	16:19	16:34	48	50.47	125	27.74	LC 01	CTD 110	nuts, chl, VT, Nick	95
235	9/16/2004	16:19		48	50.47	125	27.74	LC 01	net tow #116		95
236	9/16/2004	19:00	19:15	48	50.85	125	15.03	BS 01	CTD 111	nuts, chl, VT	95
237	9/16/2004	19:00		48	50.85	125	15.03	BS 01	net tow #117		95
238	9/16/2004	20:02	20:20	48	53.99	125	13.00	BS 02	CTD 112	nuts, chl, VT, Nick	107
239	9/16/2004	20:02		48	53.99	125	13.00	BS 02	net tow #118		107
240	9/16/2004	22:20	22:22	48	34.54	125	19.02	VB 3-7	bucket sample	search for the perfect drift site (LB 05)	
241	9/16/2004	23:08	23:10	48	27.60	125	05.09	VB 3-8	bucket sample	between LB 05 and LAB 03	
242	9/16/2004	23:44	23:50	48	26.92	124	57.23	VB 3-9	bucket sample	btwn LB 03?	
243	9/17/2004	00:20	00:25	48	26.25	124	51.32	VB 3-10	bucket sample	LA 02	
244	9/17/2004	03:42		48	27.59	125	05.27	DA	Deploy drifter #3818		
245	9/17/2004	03:59	04:18	48	27.65	125	05.44	DA 01	CTD 113	nuts, chl, VT, salt, drift-Adam(S5), start 100m S of drifter	168
246	9/17/2004	03:59		48	27.65	125	05.44	DA 01	net tow#119		168
247	9/17/2004	07:13	07:32	48	29.61	125	19.55	DA 02	CTD 114	nuts, chl, VT, 100m S of drifter	137
248	9/17/2004	07:13		48	29.61	125	19.55	DA 02	net tow #120		137

249	9/17/2004	10:03	10:22	48	31.98	125	09.72	DA 03	CTD 115	nuts, chl, Vt, salt, 100m S of drifter	112
250	9/17/2004	10:03		48	31.98	125	09.72	DA 03	net tow #121		112
251	9/17/2004	13:01	13:22	48	32.55	125	06.97	DA 04	CTD 116	nuts, chl, VT, S of drifter	115
252	9/17/2004	13:01		48	32.55	125	06.97	DA 04	net tow #122		115
253	9/17/2004	16:06	16:22	48	31.17	125	09.37	DA 05	CTD 117	nuts, chl,VT, S of drifter	125
254	9/17/2004	16:06		48	31.17	125	09.37	DA 05	net tow #123		125
255	9/17/2004	19:03	19:20	48	32.37	125	15.38	DA 06	CTD 118	nuts, chl, VT, salt	115
256	9/17/2004	19:03		48	32.37	125	15.38	DA 06	net tow #124		115
257	9/17/2004	22:03	22:18	48	35.94	125	19.64	DA 07	CTD 119	nuts, chl, VT, salt	130
258	9/17/2004	22:03		48	35.94	125	19.64	DA 07	net tow #125		130
259	9/17/2004	23:42	23:47	48	34.31	125	25.04	DBH	bucket sample	near drifter 9123; check for species present	
260	9/17/2004	23:54	00:08 (9/18)	48	34.38	125	24.97	DBH 01	CTD 120	nuts, chl,VT, salt	116
261	9/17/2004	23:54		48	34.38	125	24.97	DBH 01	net tow #126		116
262	9/18/2004	01:16	01:33	48	38.14	125	19.12	DA 08	CTD 121	nuts, chl, VT	105
263	9/18/2004	01:16		48	38.14	125	19.12	DA 08	net tow #127		105
264	9/18/2004	04:00	04:16	48	37.18	125	19.26	DA 09	CTD 122	nuts, chl, VT	108
265	9/18/2004	04:00		48	37.18	125	19.26	DA 09	net tow #128		108
266	9/18/2004	07:03	07:22	48	36.93	125	24.13	DA 10	CTD 123	nuts, chl	120
267	9/18/2004	07:03		48	36.93	125	24.13	DA 10	net tow #129		120
268	9/18/2004	10:00	10:17	48	39.45	125	28.50	DA 11	CTD 124	nuts, chl, VT, salt	80
269	9/18/2004	10:00		48	39.45	125	28.50	DA 11	net tow #130		80
270	9/18/2004	12:59	13:20	48	40.93	125	29.27	DA 12	CTD 125	nuts, chl, VT, salt	160
271	9/18/2004	12:59		48	40.93	125	29.27	DA 12	net tow #131		160
272	9/18/2004	15:59	16:18	48	41.17	125	29.02	DA 13	CTD 126	nuts, chl, VT	160
273	9/18/2004	15:59		48	41.17	125	29.02	DA 13	net tow #132		160
274	9/18/2004	19:03		48	39.79	125	30.92	DA 14	CTD 127	nuts, chl, VT	65
275	9/18/2004	19:03		48	39.79	125	30.92	DA 14	net tow #133		65
276	9/18/2004	22:03	22:17	48	39.34	125	35.56	DA 15	CTD 128	nuts, chl, VT	210
277	9/18/2004	22:03		48	39.34	125	35.56	DA 15	net Tow #134		210
278	9/18/2004		23:30	48	34.01	125	32.62	DBH 02	Drifter swap	Swap out drifter 9123 for 3918 with a light	110
279	9/19/2004	00:02	00:17	48	34.01	125	32.62	DBH 02	CTD 129	nuts, chl, VT, salt	110
280	9/19/2004	00:02		48	34.01	125	32.62	DBH 02	net tow #135		110
281	9/19/2004	04:01	04:18	48	40.66	125	39.96	DA 16	CTD 130	nuts, chl, VT	98
282	9/19/2004	04:01		48	40.66	125	39.96	DA 16	net tow #136		98
283	9/19/2004	07:04	07:16	48	40.16	125	41.51	DA 17	CTD 131	nuts, chl, VT	62
284	9/19/2004	07:04		48	40.16	125	41.51	DA 17	net tow #137		62
285	9/19/2004	10:02	10:15	48	38.90	125	45.02	DA 18	CTD 132	nuts, chl, VT, salt	61
286	9/19/2004	10:02		48	38.90	125	45.02	DA 18	net tow #138		61
287	9/19/2004	12:30	12:45	48	33.43	125	37.55	DBH 03	CTD 133	nuts, chl, VT	68

288	9/19/2004	12:30		48	33.43	125	37.55	DBH 03	net tow #139		68
289	9/19/2004	16:00	16:12	48	40.10	125	50.79	DA 19	CTD 134	nuts, chl, VT, salt	75
290	9/19/2004	16:00		48	40.10	125	50.79	DA 19	net tow #140		75
291	9/19/2004	19:30	19:45	48	39.77	125	50.95	DA 20	CTD 135	nuts, chl, VT	66
292	9/19/2004	19:30		48	39.77	125	50.95	DA 20	net tow #141		66
293	9/19/2004	22:00	22:15	48	38.85	125	51.55	DA 21	CTD 136	nuts, chl, VT, salt, ammonium	77
294	9/19/2004	22:00		48	38.85	125	51.55	DA 21	net tow #142		77
295	9/20/2004	01:33	01:47	48	29.47	125	37.17	DBH 04	CTD 137	nuts, chl, VT	98
296	9/20/2004	01:33		48	29.47	125	37.17	DBH 04	net tow #143		98
297	9/20/2004	04:03	04:16	48	35.48	125	55.25	DA 22	CTD 138	nuts, chl, VT	98
298	9/20/2004	04:03		48	35.48	125	55.25	DA 22	net tow #144		98
299	9/20/2004	07:02	07:17	48	34.46	125	57.25	DA 23	CTD 139	nuts, chl, VT, salt	99
300	9/20/2004	07:02	07:17	48	34.46	125	57.25	DA 23	net tow #145		99
301	9/20/2004	10:02	10:19	48	34.21	125	59.64	DA 24	CTD 140	nuts, chl, VT	115
302	9/20/2004	10:02		48	34.21	125	59.64	DA 24	net tow #146		115
303	9/20/2004	12:35	12:50	48	34.40	125	59.54	DA 25	CTD 141	nuts, chl, VT	116
304	9/20/2004	12:35		48	34.40	125	59.54	DA 25	net tow #147		116
305	9/20/2004	14:18	14:34	48	28.04	125	40.07	DBH 05	CTD 142	nuts, chl, VT	102
306	9/20/2004	14:18		48	28.04	125	40.07	DBH 05	net tow #148		102
307	9/20/2004	19:00	20:00					Neah Bay	personnel transfer	swapped Charlie for Jessica + future draft choice	
308	9/20/2004	21:30	04:30					Buoy JA	Deploy iron fish	water sampling every 15 minutes enroute to DA	
309	9/21/2004	04:34	04:52	48	30.70	125	59.75	DA 26	CTD 143	nuts, chl, VT, salt	137
310	9/21/2004	04:34		48	30.70	125	59.75	DA 26	net tow #149		137
311	9/21/2004	07:04	07:22	48	30.87	126	00.48	DA 27	CTD 144	nuts, chl, VT	138
312	9/21/2004	07:04		48	30.87	126	00.48	DA 27	net tow #150		138
313	9/21/2004	10:05	10:20	48	31.45	126	00.40	DA 28	CTD 145	nuts, chl, VT	133
314	9/21/2004	10:05		48	31.45	126	00.40	DA 28	net tow #151		133
315	9/21/2004	13:01	13:18	48	31.81	126	01.59	DA 29	CTD 146	nuts, chl, VT	145
316	9/21/2004	13:01		48	31.81	126	01.59	DA 29	net tow #152		145
317	9/21/2004	16:02	16:18	48	32.01	126	01.32	DA 30	CTD 147	nuts, chl, VT	142
318	9/21/2004	16:02		48	32.01	126	01.32	DA 30	net tow #152		142
319	9/21/2004	19:09	19:28	48	32.64	126	01.69	DA 31	CTD 148	nuts, chl, VT	142
320	9/21/2004	19:09		48	32.64	126	01.69	DA 31	net tow #153		142
321	9/21/2004	22:02	22:16	48	33.78	125	59.35	DA 32	CTD 149	nuts, chl, VT	112
322	9/21/2004	22:02		48	33.78	125	59.35	DA 32	net tow #154		112
323	9/22/2004	01:30	01:45	48	33.27	125	58.27	DA 33	CTD 150	nuts, chl, VT	111
324	9/22/2004	01:30		48	33.27	125	58.27	DA 33	net tow #155		111
325	9/22/2004	04:00		48	33.00	125	59.90	DA 34	recover Iron Fish		125
326	9/22/2004	04:12	04:26	48	33.00	125	59.90	DA 34	CTD 151	nuts, chl, VT, salt	125
327	9/22/2004	04:12		48	33.00	125	59.90	DA 34	net tow #156		125

328	9/22/2004	07:27	07:48	48	26.34	125	29.27	DBH 06	CTD 152	nuts, chl, VT	135
329	9/22/2004	07:27		48	26.34	125	29.27	DBH 06	net tow #157		135
330	9/22/2004	09:20	09:22	48	09.57	125	29.69		Isus sensor cleaning	reading before: 10.44/after:7.22	
331	9/22/2004	10:16	10:17	48	00.00	125	29.99	DD	Deploy drifter #9123		
332	9/22/2004	13:21	13:40	47	56.19	125	00.31	DC 01	CTD 153	nuts, chl, VT	115
333	9/22/2004	13:21		47	56.19	125	00.31	DC 01	net tow #158		115
334	9/22/2004	13:21	13:45	47	56.19	125	00.31	DC 01	Isus sensor cleaning	check flow cell	115
335	9/22/2004	16:00	20:03	47	31.79	124	38.56	KB 02	Fe Profiling	various depths	
336	9/22/2004	20:09	20:18	47	31.78	124	38.55	KB 02	CTD 154	"naked" ctd	69
337	9/22/2004	21:15		47	34.70	124	30.07	KB 01	Fe fish deployed		
338	9/22/2004	21:28	21:36	47	34.70	124	30.08	KB 01	CTD 155	nuts, chl, VT	30
339	9/22/2004	21:28		47	34.70	124	30.08	KB 01	net tow #159		30
340	9/22/2004	22:42	22:52	47	31.66	124	38.50	KB 02	CTD 156	nuts, chl, VT	70
341	9/22/2004	22:42		47	31.66	124	38.50	KB 02	net tow #160		70
342	9/23/2004	00:22	00:35	47	28.70	124	46.44	KB 03	CTD 157	chl, VT	122
343	9/23/2004	00:22		47	28.70	124	46.44	KB 03	net tow #161		122
344	9/23/2004	01:38	02:29	47	25.68	124	55.36	KB 04	CTD 158	nuts, chl, VT, salt; 1000m cast	1086
345	9/23/2004	01:38		47	25.68	124	55.36	KB 04	net tow #162		1086
346	9/23/2004	03:30	04:22	47	22.54	125	03.98	KB 05	CTD 159	chl, VT, salt; 1000m cast	1463
347	9/23/2004	03:30		47	22.54	125	03.98	KB 05	net tow #163		1463
348	9/23/2004	05:22	06:16	47	19.52	125	12.52	KB 06	CTD 160	nuts, chl, VT, salt; 1000m cast	1697
349	9/23/2004	05:22		47	19.52	125	12.52	KB 06	net tow #164		1697
350	9/23/2004	07:25	08:20	47	16.51	125	21.01	KB 07	CTD 161	chl, VT, salt; 1000m cast	1700
351	9/23/2004	07:25		47	16.51	125	21.01	KB 07	net tow #165		1700
352	9/23/2004	11:37	12:31	47	44.83	125	47.95	CF 09	CTD 162	nuts, chl, VT,salt; 1000m cast	1308
353	9/23/2004	11:37		47	44.83	125	47.95	CF 09	net tow #166		1308
354	9/23/2004	07:20	11:37						Isus sensor testing	underway KB 07 - CF 09; fluorometer values suspect also	
355	9/23/2004	18:15	18:34	48	34.06	126	05.02	DA 35	CTD 163	nuts, chl, VT,	155
356	9/23/2004	18:15		48	34.06	126	05.02	DA 35	net tow #167		155
357	9/23/2004	20:00		48	34.06	126	05.02	DA 35	Small boat op. rescue drifter from kelp		
358	9/23/2004	20:30		48	34.06	126	05.02	DA 35	iron fish deployment		
359	9/23/2004	23:01		48	33.20	126	03.76	DA 36	CTD 164	nuts, chl, VT	150
360	9/23/2004	23:01		48	33.20	126	03.76	DA 36	net tow #168		150
361	9/24/2004	02:03	02:19	48	31.63	126	04.04	DA 37	CTD 165	nuts, chl, VT	164
362	9/24/2004	02:03		48	31.63	126	04.04	DA 37	net tow #169		164
363	9/24/2004	05:11		48	30.72	126	04.68	DA 38	CTD 166	nuts, chl, VT, salt	172
364	9/24/2004	05:11		48	30.72	126	04.68	DA 38	net tow #170		172

365	9/24/2004	07:25	07:45	48	11.97	125	52.73	LB 13	CTD 167	nuts, chl, VT, 200m water for Julian	582
366	9/24/2004	07:25		48	11.97	125	52.73	LB 13	net tow #171	CTD dedicated to Jeannie Bush	582
367	9/24/2004	10:05	10:22	48	25.81	125	24.15	DBH 07	CTD 168	nuts, chl, VT	160
368	9/24/2004	10:05		48	25.81	125	24.15	DBH 07	net tow #172		160
369	9/24/2004	08:00	11:48						took Isus down and reoriented horizontally	calib #20	
370	9/24/2004	13:02	13:17	48	29.60	126	04.88	DA 39	CTD 169	nuts, chl, DA, Lessard	180
371	9/24/2004	13:02		48	29.60	126	04.88	DA 39	net tow #173		180
372	9/24/2004	16:05	16:24	48	29.23	126	05.04	DA 40	CTD 170	nuts, chl, DA, salt	193
373	9/24/2004	16:05		48	29.23	126	05.04	DA 40	net tow #174		193
374	9/24/2004	20:10	20:27	48	29.01	126	03.72	DA 41	CTD 171	nuts,chl, VT	180
375	9/24/2004	20:10		48	29.01	126	03.72	DA 41	net tow #175		180
376	9/24/2004	22:13	22:30	48	28.17	126	03.05	DA 42	CTD 172	nuts, chl, VT	181
377	9/24/2004	22:13		48	28.17	126	03.05	DA 42	net tow #176		181
378	9/25/2004	02:10	05:45	48	23.02	125	21.15	DBH 08	deploy iron fish	pump vertical profile	125
379	9/25/2004	02:25	02:38	48	23.02	125	21.15	DBH 08	CTD 173	nuts, chl, VT, salt	125
380	9/25/2004	02:25		48	23.02	125	21.15	DBH 08	net tow #177		125
381	9/25/2004	07:04	07:18	48	20.95	125	19.93	DBH 09	CTD 174	nuts, chl, VT	122
382	9/25/2004	07:04		48	20.95	125	19.93	DBH 09	net tow #178		122
383	9/25/2004	10:21	10:48	48	22.56	125	55.53	DA 43	CTD 175	nuts, chl, VT, salt	420
384	9/25/2004	10:21		48	22.56	125	55.53	DA 43	net tow #179		420
385	9/25/2004	13:03	13:21	48	21.10	125	53.12	DA 44	CTD 176	nuts, chl, VT	277
386	9/25/2004	13:03		48	21.10	125	53.12	DA 44	net tow #180		277
387	9/25/2004	16:01	16:21	48	21.35	125	49.95	DA 45	CTD 177	nuts, chl, VT, Julian, Lessard	155
388	9/25/2004	16:01		48	21.35	125	49.95	DA 45	net tow #181		155
389	9/25/2004	20:29	20:40	48	40.33	124	59.45	LB 01	CTD 178	nuts, chl, VT, Nick	38
390	9/25/2004	20:29		48	40.33	124	59.45	LB 01	net tow #182		38
391	9/25/2004	21:26	21:40	48	37.30	125	05.60	LB 03	CTD 179	nuts, chl, VT	95
392	9/25/2004	21:26		48	37.30	125	05.60	LB 03	net tow #183		95
393	9/25/2004	22:23	22:33	48	34.47	125	10.13	LB 05	CTD 180	chl, VT, salt	106
394	9/25/2004	22:23		48	34.47	125	10.13	LB 05	net tow #184		106
395	9/25/2004	23:14	23:28	48	32.20	125	15.49	LB 06	CTD 181	nuts, chl, VT, salt	115
396	9/25/2004	23:14		48	32.20	125	15.49	LB 06	net tow #185		115
397	9/26/2004	00:17	00:27	48	28.73	125	22.02	LB 07	CTD 182	chl, VT	158
398	9/26/2004	00:17		48	28.73	125	22.02	LB 07	net tow #186		158
399	9/26/2004	01:21	01:37	48	25.29	125	28.51	LB 08	CTD 183	nuts, chl, VT	134
400	9/26/2004	01:21		48	25.29	125	28.51	LB 08	net tow #187		134
401	9/26/2004	02:26	02:43	48	22.01	125	34.79	LB 09	CTD 184	chl, VT, salt	150

402	9/26/2004	02:26		48	22.01	125	34.79	LB 09	net tow #188		150
403	9/26/2004	03:43	04:00	48	18.55	125	41.33	LB 10	CTD 185	nuts, chl, VT, salt	155
404	9/26/2004	03:43		48	18.55	125	41.33	LB 10	net tow #189		155
405	9/26/2004	04:59	05:18	48	15.18	125	47.76	LB 11	CTD 186	chl, VT	210
406	9/26/2004	04:59		48	15.18	125	47.76	LB 11	net tow #190		210
407	9/26/2004	06:08	06:46	48	12.00	125	53.03	LB 13	CTD 187	nuts, chl, VT, salt	605
408	9/26/2004	06:08		48	12.00	125	53.03	LB 13	net tow #191		605
409	9/26/2004	07:50	08:36	48	08.50	125	59.95	LB 14	CTD 188	chl, VT, salt	1210
410	9/26/2004	07:50		48	08.50	125	59.95	LB 14	net tow #192		1210
411	9/26/2004	09:45	11:02	48	04.40	126	08.48	LB 15	CTD 189	nuts, chl, VT, salt	1570
412	9/26/2004	09:45		48	04.40	126	08.48	LB 15	net tow #193		1570
413	9/26/2004	13:39	13:59	48	09.26	125	32.24	DA 46	CTD 190	nuts, chl, VT	147
414	9/26/2004	13:39		48	09.26	125	32.24	DA 46	net tow #194		147
415	9/26/2004	14:18	14:19	48	08.98	125	31.38	DA end	Recover drifter#3818/Deploy drifter #3900	SST14.90, SSAL32.061, Wind035@0.5m/s	
416	9/26/2004	16:15	16:32	48	18.18	125	11.60	DB 10	CTD 191	nuts, chl, VT	171
417	9/26/2004	16:15		48	18.18	125	11.60	DB 10	net tow #195		171
418	9/26/2004	16:44	16:45	48	18.25	125	12.00	DB 10	recover drifter#3918/Deploy drifter #3901	SST14.59, SSAL32.14	
419	9/26/2004	21:14	21:27	47	32.74	125	04.55	DC 02	CTD 192	nuts, chl, VT	564
420	9/26/2004	21:14		47	32.74	125	04.55	DC 02	net tow #196		564
421	9/26/2004	23:52	23:59	47	34.62	124	30.10	KB 01	CTD 193	nuts, chl, VT	29
422	9/26/2004	23:52		47	34.62	124	30.10	KB 01	net tow #197		29
423	9/27/2004	01:04	01:14	47	31.69	124	38.53	KB 02	CTD 194	nuts, chl, VT	66
424	9/27/2004	01:04		47	31.69	124	38.53	KB 02	net tow #198		66
425	9/27/2004	02:08	02:23	47	28.63	124	46.97	KB 03	CTD 195	nuts, chl, VT	119
426	9/27/2004	02:08		47	28.63	124	46.97	KB 03	net tow #199		119
427	9/27/2004	03:35	04:07	47	25.59	124	55.52	KB 04	CTD 196	nuts, chl, VT, salt	1084
428	9/27/2004	03:35		47	25.59	124	55.52	KB 04	net tow #200		1084
429	9/27/2004	05:08	05:40	47	22.52	125	04.05	KB 05	CTD 197	chl, VT, salt	1458
430	9/27/2004	05:08		47	22.52	125	04.05	KB 05	net tow #201		1458
431	9/27/2004	06:46	07:17	47	19.49	125	12.56	KB 06	CTD 198	nuts, chl, VT	1704
432	9/27/2004	06:46		47	19.49	125	12.56	KB 06	net tow #202		1704
433	9/27/2004	08:01	08:31	47	16.49	125	21.05	KB 07	CTD 199	nuts, chl, VT, salt	1707
434	9/27/2004	08:01		47	16.49	125	21.05	KB 07	net tow #203		1707
435	9/27/2004	13:03	13:39	48	02.80	125	20.61	CA 01	CTD 200	nuts	506
436	9/27/2004	13:03		48	02.80	125	20.61	CA 01	net tow #204		506
437	9/27/2004	14:29	14:52	48	06.41	125	15.05	CA 02	CTD 201	nuts	337
438	9/27/2004	14:29		48	06.41	125	15.05	CA 02	net tow #205		337
439	9/27/2004	15:48	16:20	48	08.41	125	08.97	CA 02b	CTD 202	nuts	271
440	9/27/2004	15:48		48	08.41	125	08.97	CA 02b	net tow #206		271
441	9/27/2004	16:47	17:08	48	07.39	125	05.56	CA 03	CTD 203	nuts	303
442	9/27/2004	16:47		48	07.39	125	05.56	CA 03	net tow #207		303
443	9/27/2004	17:43	18:05	48	05.99	125	01.84	CA 03b	CTD 204	nuts	318

444	9/27/2004	17:43		48	05.99	125	01.84	CA 03b	net tow #208		318
445	9/27/2004	18:39	19:05	48	08.41	124	59.95	CA 03c	CTD 205	nuts	373
446	9/27/2004	18:39		48	08.41	124	59.95	CA 03c	net tow #209		373
447	9/27/2004	19:55	20:19	48	13.73	125	01.94	CA 04	CTD 206	nuts	324
448	9/27/2004	19:55		48	13.73	125	01.94	CA 04	net tow #210		324
449	9/27/2004	21:11	21:34	48	18.97	124	56.89	CA 05	CTD 207	nuts	355
450	9/27/2004	21:11		48	18.97	124	56.89	CA 05	net tow #211		355
451	9/27/2004	22:25	22:48	48	24.18	124	51.70	CA 06	CTD 208	nuts	345
452	9/27/2004	22:25		48	24.18	124	51.70	CA 06	net tow #212		345
453	9/27/2004	23:37	23:58	48	28.17	124	47.68	CA 07	CTD 209	nuts	297
454	9/27/2004	23:37		48	28.17	124	47.68	CA 07	net tow #213		297
455	9/28/2004	01:25	01:45	48	26.07	124	32.62	JDFA	CTD 210	nuts, VT, salt	243
456	9/28/2004	01:25		48	26.07	124	32.62	JDFA	net tow #214		243
457	9/28/2004	02:55	03:15	48	23.12	124	22.81	JDFB	CTD 211	nuts, VT, salt	235
458	9/28/2004	02:55		48	23.12	124	22.81	JDFB	net tow #215		235
459	9/28/2004	05:30	05:49	48	17.27	124	02.93	JDFC	CTD 212	nuts, VT, salt	190
460	9/28/2004	05:30		48	17.27	124	02.93	JDFC	net tow #216		190
461	9/28/2004	07:50	08:08	48	14.16	123	43.12	JDFD	CTD 213	nuts, VT, salt	163
462	9/28/2004	07:50		48	14.16	123	43.12	JDFD	net tow #217		163

Table 2 CTD stations organized by sample line and date, showing types of bottle samples taken as well as associated surface iron samples

Date (GMT)	Line ID	Direction	CTD Cast Nos.	Stn IDs	Nutrient Sites	Fe Sampling Sites	Lessard Dilutions Expts	Sedimentation
9/9/2004	Strait mooring		1	EH01	EH01			
9/9-9/10/2004	La Push	E-W	2-10	LP01-02,02-08	LP01,02,04,06,08		LP02	LP01-06
9/10/2004	Gray's Harbor	W-E	11-17	GH07-01				GH01
9/10-9/11/2004	Copalis Beach	E-W	18-24	CB01-07			CB05	CB01-07
9/11/2004	Kalaloch Beach	W-E	25-31	KB07-01				
9/11-9/12/2004	La Push	E-W	32-39	LP01-08			LP02	LP01-07
9/12/2004	Ozette	W-E	40-48	OZ09-01				
9/12-9/13/2004	Cape Flattery	E-W	49-59	CF01-02,02,02-09			CF02	CF02-05,07
9/13-9/14/2004	La Perouse A	E-W	60-70	LA01-11			LA02	LA01-11
9/14/2004	La Perouse AB	W-E	71-80	LAB10-01			LAB05	LAB01-07
9/14-9/15/2004	La Perouse B	E-W	81-92	LB01,03,05-11,13-15			LB05	LB01,03,05,07-10,14
9/15-9/16/2004	La Perouse BC	W-E	93-101	LBC09-01			LBC05	LBC01-09
9/16/2004	La Perouse C	W-E	102-110	LC10-3,01			LC03	LC01,03
9/16/2004	Barkley Sound	W-E	111-112	BS01-02				BS01-02
9/17/2004	Drift A		113-119	DA01-07			DA06	DA06
9/17/2004	Drift B		120	DB01				
9/18/2004	Drift A		121-128	DA08-DA15			DA13	DA13
9/18/2004	Drift B		129	DB02			DB02	
9/19/2004	Drift A		130-132	DA16-18				
9/19/2004	Drift B		133	DB03				
9/19/2004	Drift A		134-136	DA19-21			DA20	DA19-21
9/20/2004	Drift B		137	DB04				
9/20/2004	Drift A		138-141	DA22-25				DA22
9/20/2004	Drift B		142	DB05			DB05	
9/21-22/2004	Drift A		143-151	DA26-34			DA29	DA30

9/22/2004	Drift B		152	DB06				
9/22/2004	Drift C		153	DC01			DC01	
9/22-9/23/2004	Kalaloch Beach	E-W	154-161	KB02,01-07			KB03	
9/23/2004	Cape Flattery		162	CF09				
9/23/2004	Drift A		163-166	DA35-38			DA35	DA35
9/24/2004	La Perouse B		167	LB13				
9/24/2004	Drift B		168	DB07				
9/24/2004	Drift A		169-172	DA39-42			DA39	
9/25/2004	Drift B		173-174	DB8-9				
9/25/2004	Drift A		175-177	DA43-45			DA45	
9/25-26/2004	La Perouse B	E-W	178-189	LB01,03,05-11,13-15				
9/26/2004	Drift A		190	DA46			DA46	
9/26/2004	Drift B		191	DB10				
9/26/2004	Drift C		192	DC02				
9/26-9/27/ 2004	Kalaloch Beach	E-W	193-199	KB01-KB07				
9/27/2004	JDF Canyon	W-E	200-209	CA01-CA10	CA01-07			
9/28/2004	JDF Strait	W-E	210-214					

Table 3 Drifter deployment locations and times

Drifter ID	Model	Deployed (GMT)	Lat deg	Lat min	Lon deg	Lon min	Recovered/Last transmit	Drift	Comments
9124	115	9/9/2004 5:16	48	29.34	124	41.97	10/23/04 12:33	-	Deployed at EH1
22248	115	9/9/2004 8:10	48	30.1	125	14.99	10/23/04 12:30	-	Center of eddy
9123	115	9/9/2004 10:30	48	14.91	125	29.91	9/18/04 23:00	-	SW edge of eddy - recovered
3884	115	9/13/2004 2:57	48	1.61	125	15.37	10/27/04 13:30	C	CF05
3818	104a	9/17/2004 3:42	48	27.59	125	5.27	9/26/04 14:18	A	C/T drifter - recovered
3918	104a	9/18/2004 23:30	48	34.01	125	32.62	9/26/04 16:44	B	Switched in for 9123 - recovered
9123	115	9/22/2004 10:16	48	0	125	29.99	11/5/04 23:30	-	Coastal front
3900	115	9/26/2004 14:19	48	8.98	125	31.38	10/22/04 22:30	A	Beached - Cape Flattery
3901	115	9/26/2004 16:45	48	18.25	125	12	11/17/04 11:00	B	Beached - Northern BC

Table 4 Dates and file name of available satellite imagery

Sea Surface Temperature
2003_0602_1431_sst-blowup.jpg
2003_0602_1431_sst.jpg
2003_0602_306_sst.jpg
2003_0604_0426_sst.jpg
2003_0605_1357_sst-blowup.jpg
2003_0606_0402_sst-blowup-R.jpg
2003_0606_0402_sst-blowup.jpg
2003_0606_0402_sst-R.jpg
2003_0606_0402_sst.jpg
2003_0608_1504_sst-blowup.jpg
2003_0609_0328_sst-blowup.jpg
2003_0609_0328_sst.jpg
2003_0613_0425_sst-blowup.jpg
2003_0613_0425_sst.jpg
2003_0615_1526_sst-blowup.jpg
2003_0615_1526_sst.jpg
2003_0616_1515_sst.jpg
2003_0618_1452_sst-blowup.jpg
20030605_041407PDT_5daycomp.jpg
20030605_041407PDT_WA.jpg
Ocean colour
2003_0602_1324_chl.jpg
2003_0604_1446_chl.jpg
2003_0606_1429_chl.jpg
2003_0608_1412_chl.jpg
2003_0615_1403_chl.jpg
2003_0618_1428_chl.jpg
2003155200800.jpg
2003167214501.jpg
NW20031662103_rrs670.jpg
NW20031672006_rrs670.jpg

Table 5 Mooring locations, bottom depths, deployment times and satellite PTT ID

Mooring	Location	Lat deg	Lat min	Lon deg	Lon min	Deployed (GMT)	Depth (m)	PTT ID
E1	Juan de Fuca Strait	48	29.303	124	41.987	5/11/03 18:32	255	3944
E2	Washington coast	47	36.020	124	46.051	5/10/03 20:41	89	3973
E2-subsurface	Washington coast	47	35.826	124	45.955	6/3/03 22:17	91.5	9128
E3	Juan de Fuca eddy	48	17.807	125	27.530	5/10/03 0:58	127	3939