CRUISE REPORT
NOAA Ship *Ronald H. Brown*
26 September 2001

Cruise No:	RB-01-03 Leg 3
FOCI No:	3RB01

Dates:	25 May 2001 depart Kodiak, AK 08 June 2001 arrive Dutch Harbor, AK

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1.0 Background

1.1 Program Description: This cruise was part of the Fisheries Oceanography Coordinated Investigations (FOCI) - an effort by NOAA and academic scientists to understand the physical and biological processes that determine recruitment variability of commercially valuable fin-fish and shellfish stocks in Alaskan waters. FOCI consists of several projects including the present ones funded by the North Pacific Marine Research (NPMR) Program and the International Arctic Research Center (IARC).

1.2 Cruise Objectives: The purpose of the NPMR project was to understand the influence of mesoscale eddies on continental slope-shelf exchange in the Southeastern Bering Sea. The objectives were to

(1) Detect movements of nutrient-rich slope water onto the shelf and relate them to temporal and spatial variations in chlorophyll,
(2) Identify physical mechanisms that create slope-water fluxes onto the continental shelf,
(3) Detect ocean-color variability in relation to physical processes,
(4) Use shipboard measurements of near-surface optical and biological parameters to validate and extend bio-optical algorithms for use in autonomous sampling and remote sensing, and
(5) Investigate the effects of on-shelf flow on phytoplankton biology.

The IARC project (Tanaka) had the complementary objective of measuring the isotopic fractionation of nitrate and carbon to show biological features due to the interaction of basin water with the shelf.

1.3 Operating Area: Gulf of Alaska and southeastern Bering Sea (Fig. 1).

1.4 Participating Organizations

A. NOAA/Pacific Marine Environmental Laboratory (PMEL)
7600 Sand Point Way NE
Seattle, WA 98115-6439

B. University of Alaska-Fairbanks (UAF)
School of Fisheries & Ocean Sciences
P.O. Box 757220
Fairbanks, AK 99775-7220

C. Dalhousie University (Dal)
Department of Oceanography
Halifax, NS B3H 4J1
Canada

D. Frontier Research System for Global Change
International Arctic Research Center (IARC)
Univ. Alaska Fairbanks
930 Koyukuk Dr.
P.O. Box 757335
Fairbanks, Alaska 99775-7335

E. US Naval Academy (USN)

1.5 Personnel

	Name	Title	Affil.	E-mail address
1.	Edward (Ned) Cokelet, Ph D	Chief Scientist	PMEL	Cokelet@pmel.noaa.gov
2.	Carol DeWitt	Field Ops. Spec.	PMEL	Dewitt@pmel.noaa.gov
3.	William Floering	Field Ops. Spec.	PMEL	Floering@pmel.noaa.gov
4.	John Cullen, Ph D	Professor	Dal	John.Cullen@dal.ca
5.	Richard Davis	Research Assistant	Dal	Richard.Davis@dal.ca
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7.	Stephane Kirchhoff	Research Assistant	Dal	S.kirchoff@dal.ca
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11.	Taekeun Rho	Graduate Student	UAF	Fttr@uaf.edu
12.	Stephanie Moreland	Research Assistant	UAF	Fnsmm@aurora.uaf.edu
13.	Amy Childers	Research Assistant	UAF	Ruehs@ims.uaf.edu
14.	Sarah Heidt	Midshipman	USN	M022778@usna.edu
15.	Andrew Winberry	Midshipman	USN	M027278@usna.edu
16.	Timothy Ray	Midshipman	USN	M025454@nadn.navy.mil
17.	Colleen O'Malley	Midshipman	USN	M024980@usna.edu

1.6 CTD Watch Schedule:

0000-1200: William Floering
0000-0600: Andrew Winberry
0600-1200: Timothy Ray

1200-0000: Carol DeWitt
1200-1800: Sarah Heidt
1800-0000: Colleen O'Malley

2.0 Cruise Narrative

The ship departed Kodiak on 25 May and proceeded to station 1 (Fig. 1 and Table 1) where a subsurface current meter mooring was deployed in the Gulf of Alaska to support GLOBEC (Global Ecosystem Dynamics) Steller sea lion research.

From there to Unimak Pass *Brown* ran a Sea Beam transect along the continental slope in 600-900 m of water to provide bathymetric data for the Tsunami Warning and Environmental Observatory of Alaska (TWEAK).

After a three-day transit *Brown* arrived at station 2, the historical site of SEBSCC (Southeast Bering Sea Carrying Capacity) Mooring 3 in the SE Bering Sea, and began a CTD transect towards the northeast along the SEBSCC line. Stations 8-12 sampled an X-shaped region centered on SEBSCC Mooring 2. Mooring site 3 (station 13) was re-sampled by the bio-optical oceanographers during daylight hours.

Commencing with station 14, *Brown* began an 8-day study of an eddy interacting with the continental slope (Fig. 2). Satellite altimetry data indicated that the best candidate was an anticyclonic "eddy" (or possibly a meander in the Bering Slope Current) located in about 2000 m of water at the mouth of the Pribilof Canyon. At station 14 we deployed a satellite-tracked drifter drogued at 40 m to measure the eddy's induced horizontal current velocity, and began a series of CTD stations occupying sites on an 80-nm by 80-nm grid with 8 nm spacing. The objectives were to span the feature and map it. Figure 2 shows every grid point that was occupied. Seventy-six CTD casts were taken in the eddy, and 4 drifters deployed there including 3 with ocean color measuring capability to compare with SeaWiFS satellite imagery.

Brown returned to Dutch Harbor on 8 June.

3.0 Physical and Chemical Oceanographic Measurements

Conductivity-Temperature-Depth (CTD) casts were made with a Sea-Bird 911plus instrument with dual temperature and conductivity sensors. On the continental shelf, the instrument package carried a WETLabs WETStar fluorometer. The profiler carried a Benthos altimeter with 100 m range, and casts were to the shallower of 1500 m or 10 m above the bottom. Generally, one salinity sample was taken on each cast - alternating one shallow and one deep between casts - and analyzed with the ship's AutoSal for conductivity calibration purposes. CTD data were processed to 1-dbar averages.

A 150-kHz RDI acoustic Doppler current profiler (ADCP) ran continuously measuring the velocity of the water relative to the ship. Auxiliary input from a Trimble P-code GPS receiver, Sperry ring-laser-gyro and Seatex Seapath 200 GPS-based attitude determination unit allow for the determination of absolute current velocity relative to the sea bottom.

The ship carried a thermosalinograph to measure the temperature and salinity of near-surface waters and a flow-through Turner fluorometer to measure near-surface fluorescence on a continuous basis.

A total of 870 water samples were collected from CTD casts for analysis of nutrient concentration. Samples were analyzed with an onboard Alpkem RFA Model 300 automated Nutrient Analyzer. There were 100 samples analyzed from the SEBSCC line, 700 from the eddy transects and 70 for $^{13}C/^{15}N$ productivity and nutrient amendment studies.

4.0 Bio-Optical Characterization of Bering Sea waters

by John Cullen, Richard Davis, Yannick Huot, Stephane Kirchoff, Moritz Lehmann and Christina Schallenberg, Dalhousie University

During operations in the Bering Sea, 29 May–7 June 2001, we collected measurements of biological and optical properties of surface waters in the Bering Sea. This preliminary, informal report outlines the results that we have obtained to date and explains some of the data that have been collected. Emphasis is on aspects directly related to NOAA contracts.

Solar radiation

We measured solar radiation almost continuously using a Satlantic multichannel UV-visible detection system (MVDS). Spectral irradiance (µW cm^{-2} nm^{-1}) was measured in seven wavebands between 325 and 700 nm, including the wavebands corresponding to the SeaWiFS sensor. Data were logged every 10 s. The instrument was not available for several days of the cruise, because a connector was cannibalized to repair our profiling instrument. Data are available at full resolution.

Solar radiation was also measured with a hyperspectral radiometer (123 wavebands between 400 and 800 nm, with roughly 3.3 nm resolution). Operation was intermittent, but data are available for much of the cruise.

Upwelling radiance

A Satlantic tethered spectroradiometer buoy (TSRB) was used to measure upwelling radiance (L_u; µW cm^{-2} nm^{-1} sr^{-1}) and downwelling solar irradiance (E_d; µW cm^{-2} nm^{-1}) in 123 wavebands between 400 and 800 nm, with roughly 3.3 nm resolution. The TSRB was typically deployed for 5-30 minutes at approximately 39 stations during the cruise.

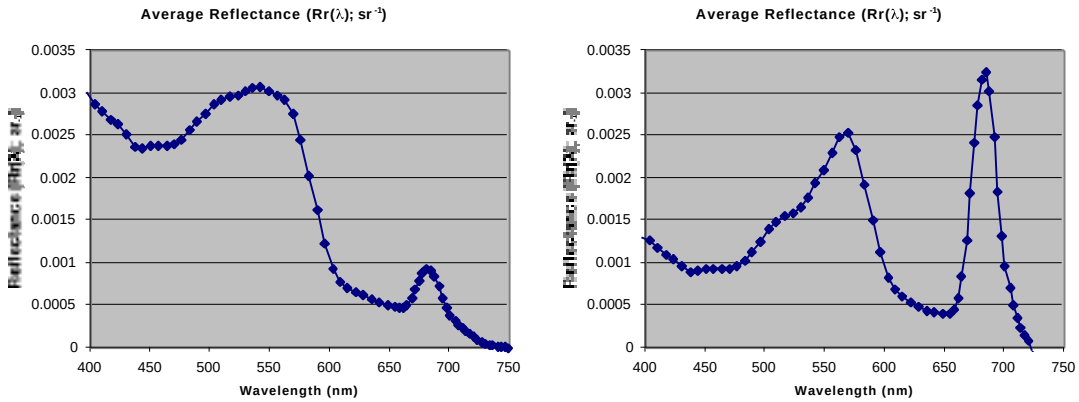

Fig. 3. Reflectance spectra for Station 50 (left) and Station 59 (right).

The ratio of L_u to E_d gives the reflectance spectrum (Rr; sr^{-1}), which clearly show the biologically determined optical variability associated with different phytoplankton assemblages at the stations (Fig. 3). Variability in shape and the peak near 683 nm (sun-induced fluorescence of chlorophyll *a*) will be analyzed as part of this project. We hope to discern influences of taxonomic composition as well as physiological status of phytoplankton.

Chlorophyll *a* and other pigments

We measured the concentration of chlorophyll *a* fluorometrically in triplicate for about 240 samples. About half as many samples were frozen for determination of pigments in the lab using HPLC. Generally, we sampled with a bucket during optical buoy measurements (depth = 0) and also from 4 depths sampled with the corresponding CTD. Chlorophyll was measured

fluorometrically for the CTD cast, and with HPLC for the bucket sample and one depth from the CTD. Chlorophyll concentrations were generally high (> 5 mg m^{-3}), indicative of bloom conditions.

Absorption

We froze samples to measure the spectral absorption coefficients of particulate matter in surface waters. We also filtered water through a 0.2 µm filter and then stored it for transport to Dalhousie where we can measure the absorption due to dissolved materials. An objective of our study was to relate measures of near-surface reflectance to surface chlorophyll. The relationships have not yet been examined for this cruise.

Penetration of spectral irradiance

During almost every deployment of the tethered radiometer, we deployed a free-falling multichannel profiling radiometer, with sensors to measure downwelling irradiance in 13 wavebands (305, 323, 338, 380, 412, 443, 490, 510, 532, 555, 670, 683, and 700 nm), including those of the SeaWiFS sensors. High-quality data were obtained, which will allow us to calculate diffuse attenuation coefficients for each waveband as functions of depth for each profile. Proper analysis requires careful treatment of dark blanks, which was begun during the cruise and will be completed at Dalhousie. We will report diffuse attenuation coefficients at 490 nm and relate these coefficients quantitatively to upwelling radiance ratios. Penetration of photosynthetically utilizable radiation will also be examined. Contact Dalhousie to discuss full spectral information.

Bio-Optical Profiling Package

At approximately 27 stations a bio-optical profiling package was deployed. On this package was a WETLabs ac-9, a Chelsea FAST*tracka* fluorometer (which failed and was eventually removed), and a HOBI Labs Hydroscat 6. A typical deployment would include a profile to 100 m. The package was then redeployed with a 0.2 µm filter in place, to measure absorption of dissolved materials.

Absorption and Attenuation

Absorption (a) and attenuation (c) of the upper water column were measured at 9 wavelengths (412, 440, 488, 510, 532, 555, 650, 676, 715 nm) using a WETLabs ac-9. Two profiles were performed at each station. The first was an unfiltered drop to measure a and c for all constituents in the water. A second filtered cast (0.2 µm) was performed so that a and c of dissolved material only was measured. Daily calibrations of the instrument were performed with ship water run through an organic removal filter, an ultrapure filter, and finally a 0.2 µm filter. In these high-biomass waters, the filters clogged and the absorption-attenuation meter did not always work. Data from the unfiltered ac-9 look good for the upper 50 meters or so, which is enough for most of our analyses.

Phytoplankton Physiology from Fluorescence

A Chelsea Instruments FAST*tracka* Fast Repetition Rate (FRR) fluorometer is designed to measure physiological properties of phytoplankton *in situ*. The instrument did not work and could not be fixed, despite help from the ET.

Discrete samples were analysed for fluorescence properties using methods that can be compared to FRR fluorometry. Pulse Amplitude Modulated (PAM) fluorometry was generally performed on samples from four depths per cast, and fluorescence was also measured in the absence and presence of the photosynthetic inhibitor DCMU. This latter analysis fails when phytoplankton are aggregated in colonies. Since many of the samples were dominated by *Pheocystis* and chain diatoms, DCMU measurements were often not attempted.

Backscattering

A HOBI Labs hydroscat 6 was used to measure backscattering at 6 wavelengths (442, 470, 510, 589, 620, and 671 nm). Data from this instrument has not been processed to date.

Phytoplankton species composition

Surface net-tows were conducted at most stations for which bio-optical observations were made. Fresh samples were examined, showing the dominant large phytoplankton — the prasinophyte *Pheocystis* and/or chain diatoms. Some of the net samples were preserved for examination in the lab.

5.0 Productivity Studies

by TaeKeun Rho, University of Alaska, Fairbanks

Primary production was measured using ^{13}C and ^{15}N stable isotope techniques. At each productivity station, water for the incubation was collected between 1000-1200 local time using Niskin bottles mounted on the CTD rosette at six light levels (100, 50, 30, 12, 5 and 1% of surface values) as determined by bio-optic group from Dalhousie University. Water samples from the Niskin bottles were transferred directly to the incubation bottles through a 333 um screen to remove large zooplankton. Incubation bottles were covered by neutral density screens to simulate the 6 in-situ light levels and placed in an incubator cooled by running surface sea water to regulate the temperature. Incubations were terminated after 4 hours. Samples were filtered with GF/F glass fiber filters and frozen to await further analysis with UAF's mass spectrometer.

Two additional experiments were conducted to observe the effects on phytoplankton nitrate uptake due to iron addition (10 nM $FeCl_3$ solution) and high ammonium concentration. The experiments were performed at two sites: station 8 (in the middle shelf domain of the southeastern Bering Sea shelf corresponding to SEBSCC Mooring 2) and station 40 (in the Bering Sea basin).

At station 8, six bottles (10 L polycarbonate) were filled with water taken at the 50% light level and incubated in an incubator cooled with running surface sea water. Each bottle had a different treatment (control, control +10 nM Fe, 20 uM nitrate, 20 uM nitrate+10 nM Fe, 5 uM ammonium, 5 uM ammonium + 10 nM Fe). Initial subsamples were taken after the treatments for the nitrate and ammonium uptake rate with ^{15}N-nitrate and ^{15}N-ammonium isotope, chlorophyll, and nutrient concentrations. Incubation was continued for 4 days.

At the station 40, eight water samples were collected with 10 L polycarbonate bottles and incubated with different treatments: control (2), 10 nM iron addition (3), 15 uM of nitrate and silicate + 10 nM iron addition (2). Subsamples for the nitrate and ammonium uptake rates, chlorophyll, and nutrient concentration were also continued during 4 days.

6.0 Geographical distribution of natural abundance of ^{15}N in nitrate

by Tomoyuki Tanaka, International Arctic Research Center, University Alaska, Fairbanks

Nitrogen cycling in seawater is mediated by biological processes and is accompanied by isotopic fractionation to a degree dependent upon environmental conditions. Our understanding of factors that control the nitrogen isotopic composition of nitrate, suspended particulate nitrogen (PN) and sinking PN in seawater is based both on results of natural isotope abundance and laboratory culture experiments under various conditions. However, field data are rather limited, especially under low nitrate concentration conditions commonly encountered in the euphotic zone.

The objective of this study was to estimate the geographical distribution of the isotopic nitrogen composition of nitrate and the contribution of nitrate to phytoplankton in the southeast Bering Sea.

Water samples were collected at the stations shown in Table 2 using the following sampling methods. Nitrogen isotopic composition of nitrate and PN: 2.5 L seawater samples were collected from the surface to 500 m and filtered through pre-combusted Whatman GF/F filters of 47 mm diameter. After filtration, the filter samples for ^{15}N in PN were frozen at -20 C. 2 L filtered seawater samples for ^{15}N in nitrate were stored in glass bottles with addition of 8 ml conc. HCl.

Table 2: Isotopic nitrogen sampling locations

Station No. (Mooring)	Depth (m)
2 (M3)	0, 20, 30, 50, 75, 100, 109
6	0, 20, 30, 40, 50, 82
8 (M2)	0, 20, 30, 40, 50, 61
15	0, 20, 30, 50, 75, 100, 250, 500
20	0, 20, 30, 50, 75, 100, 250, 500
24	0, 20, 50, 100, 300, 567
55	0, 20, 75, 100, 130

The following analytical methods were employed. ^{15}N in nitrate: A method described by Cline and Kaplan (1975) has been modified. This procedure for liberating nitrogen gas from nitrate for isotopic analysis involves reduction of nitrate to ammonia and subsequent oxidation of ammonia to nitrogen gas. Details of the analytical procedure will be presented elsewhere. ^{15}N in PN: For determination of nitrogen and carbon amount and nitrogen isotopic composition in suspended particulate matter, the sample filter will be freeze-dried, exposed to HCl fumes and then freeze-dried again. The isotope measurement of the prepared filter sample will be made by using a Elemental Analyzer + Mass Spectrometer in IMS/UAF.

7.0 Acknowledgements

We thank Captain Donald Dreves and the crew of the NOAA Ship *Ronald H. Brown* for their work and support during this cruise. Working conditions on the *Ronald H. Brown* were excellent. Several crew members went out of their way to be cooperative and collegial. Such friendly and professional treatment helps the science to go better. The midshipmen were a big help, and it was a pleasure to work with them. The living conditions on the Brown were also superb, and the food was varied and very well prepared. The stewards are to be commended.

8.0 Figures

9.0 Tables

Figure 1. RB-01-03 Leg 3 station locations.
Depth contours at 100, 200, 500, 1000, 2000 and 4000 m.

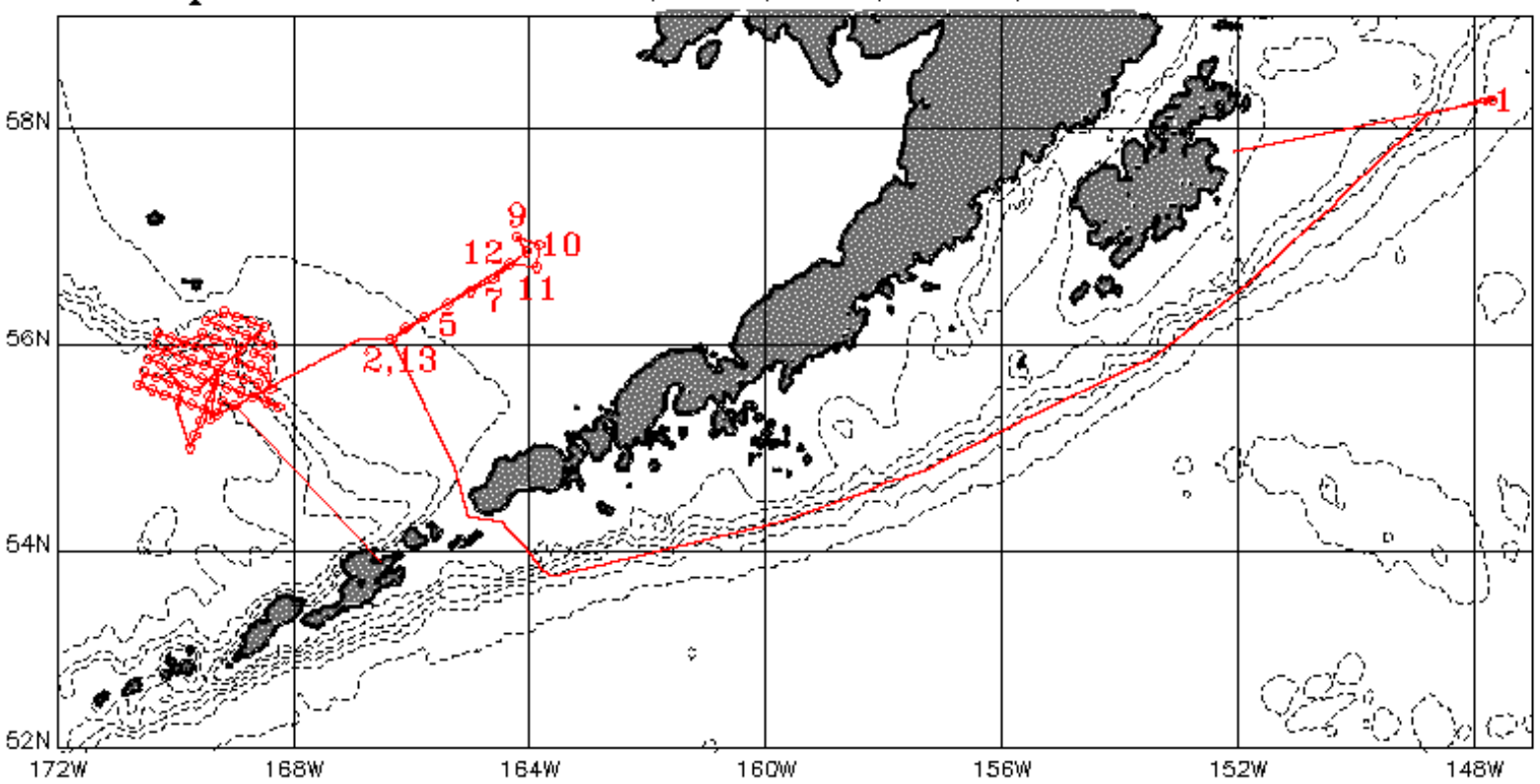

Figure 2. RB-01-03 Leg 3 eddy station locations.
Depth contours at 100, 200, 500, 1000 and 2000 m.

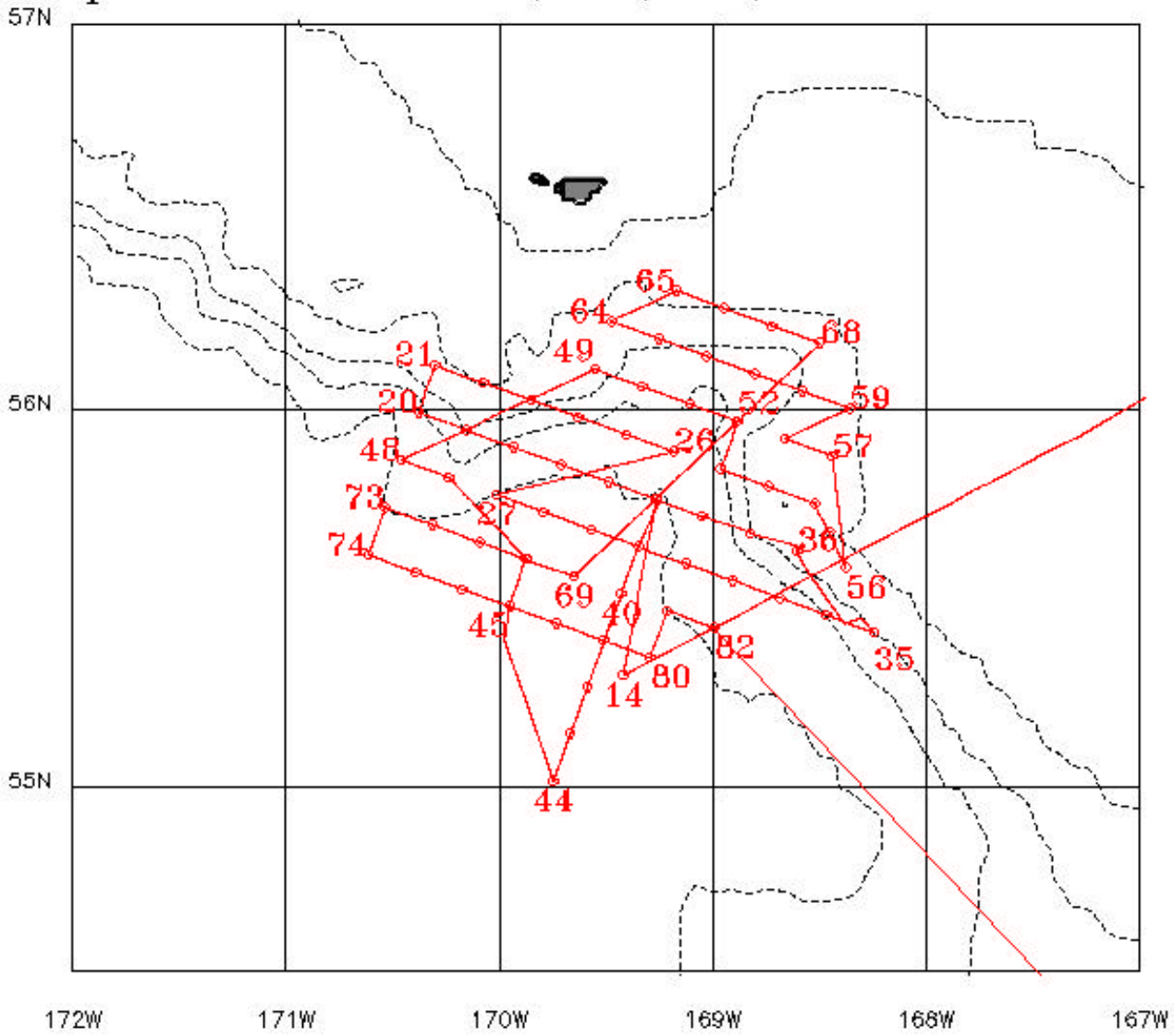

Table 1. Cruise RB-01-03 Leg 3 Master Log Sheet
NOAAS Ronald H. Brown
25 May-8 June 200 (YD 145-159)

Station Number	CTD Cast Number	Year Day YD (GMT)	Time GMT	Bottom Depth m	Latitude deg.	Latitude min.	N	Longitude deg.	Longitude min.	W	CTD (PMEL)	Chlr. (Rho)	Production (Rho)	Nutrients (TEW)	PAR (PMEL)	Fluor. (PMEL)	Chrl. (Dal.)	PA+CDOM(Dal.)	HPLC (Dal.)	DCMU (Dal.)	Profiler Fl,T,S,Kd (xls)	Reference (Dal.)	Hypaerspectral TSRB (pdf)	BOP (Dal.)	N15 (Tanaka)	Comments:
1	1	146	17:15	2388	58°	15.7'	N	147°	42.5'	W	X															FATE mooring deployed
2	2	149	11:13	124	56°	3.6'	N	166°	20.1'	W	X	X		X		X									X	
3	3	149	12:42	96	56°	10.0'	N	166°	6.0'	W	X	X		X		X										
4	4	149	14:22	84	56°	16.3'	N	165°	46.4'	W	X	X		X		X										
5	5	149	16:07	88	56°	23.4'	N	165°	23.6'	W	X	X		X		X										
6	6	149	18:08	81	56°	30.5'	N	164°	59.9'	W	X	X		X		X	X	X	X	X			X		X	
7	7	149	20:36	78	56°	37.7'	N	164°	36.3'	W	X	X		X	X	X										
8	8	149	23:20	73	56°	52.4'	N	164°	3.1'	W	X	X		X	X	X	X	X	X	X			X		X	
8	9	150	00:13	74	56°	52.4'	N	164°	3.2'	W	X	X	X	X	X	X										
8	10	150	00:58	74	56°	52.4'	N	164°	3.2'	W	X				X	X										
9	11	150	02:18	71	57°	1.0'	N	164°	13.0'	W	X	X		X	X	X	X	X	X	X			X			
10	12	150	04:15	71	56°	56.6'	N	163°	50.1'	W	X	X		X	X	X	X	X	X	X			X			
11	13	150	05:58	75	56°	43.9'	N	163°	53.1'	W	X	X		X	X	X										
12	14	150	07:34	75	56°	46.1'	N	164°	20.0'	W	X	X		X	X	X										
13	15	150	16:06	122	56°	3.6'	N	166°	20.1'	W	X	X		X	X	X										
13	16	150	18:07	122	56°	3.6'	N	166°	20.1'	W	X	X	X	X		X	X	X	X	X			X	X		
14		151	03:19	2522	55°	18.1'	N	169°	25.1'	W																drifter 13135 deployed
15	17	151	07:18	2462	55°	46.0'	N	169°	15.9'	W	X	X		X			X	X	X	X			X	X	X	
15		151	08:01	2462	55°	46.0'	N	169°	16.0'	W																ocm drifter 29349 deployed
16	18	151	09:40	2506	55°	48.7'	N	169°	29.3'	W	X	X		X												
17	19	151	12:42	1847	55°	51.5'	N	169°	42.7'	W	X															
18	20	151	17:14	1779	55°	54.2'	N	169°	56.0'	W	X	X		X												
18	21	151	19:39	1736	55°	54.2'	N	169°	55.9'	W	X	X	X	X			X	X	X	X	X		X	X		
18		151	19:50	1735	55°	51.2'	N	169°	51.2'	W																ocm drifter 29347 deployed
19	22	151	21:06	618	55°	56.9'	N	170°	9.4'	W	X	X		X			X	X	X	X	X	X	X	X		
20	23	152	00:37	1344	55°	59.6'	N	170°	22.8'	W	X	X		X			X	X	X	X	X	X	X	X	X	
21	24	152	04:54	131	56°	7.0'	N	170°	17.7'	W	X	X		X			X	X	X	X	X	X	X	X		
22	25	152	06:21	129	56°	4.4'	N	170°	4.5'	W	X	X		X												
23	26	152	07:01	143	56°	1.7'	N	169°	51.1'	W	X	X		X	X	X										
24	27	152	09:40	583	55°	59.0'	N	169°	37.6'	W	X	X		X	X	X										X	
25	28	152	11:45	1725	55°	56.2'	N	169°	24.2'	W	X	X		X												
26	29	152	14:00	1542	55°	53.5'	N	169°	10.9'	W	X	X		X												
27	30	152	17:45	2708	55°	46.7'	N	170°	0.7'	W	X	X		X			X	X	X	X	X	X	X	X		
27	31	152	19:49	2706	55°	46.7'	N	170°	0.7'	W	X	X	X	X												

28	32	152	20:54	2443	55°	44.0'	N	169°	47.4'	W	X	X		X			X	X	X	X			X	X		
29	33	153	01:47	2651	55°	41.2'	N	169°	34.1'	W	X	X		X			X	X	X	X	X		X	X		
30	34	153	05:24	2538	55°	38.4'	N	169°	20.8'	W	X	X		X			X	X	X	X	X		X	X		
31	35	153	07:53	1883	55°	35.8'	N	169°	7.6'	W	X	X		X												
32	36	153	09:27	1348	55°	33.2'	N	168°	54.4'	W	X	X		X												
33	37	153	13:17	1526	55°	30.3'	N	168°	41.1'	W	X	X		X												
34	38	153	15:16	753	55°	27.6'	N	168°	27.9'	W	X	X		X												
35	39	153	18:33	412	55°	24.9'	N	168°	14.7'	W	X	X		X	X	X	X	X	X	X	X	X	X	X		
35	40	153	19:10	412	55°	24.9'	N	168°	14.7'	W	X	X	X	X	X	X										
36	41	153	21:49	206	55°	37.9'	N	168°	36.2'	W	X	X		X	X	X	X	X	X	X	X	X	X	X		
37	42	154	00:36	297	55°	40.7'	N	168°	49.5'	W	X	X		X	X	X	X	X	X	X	X		X			
38	43	154	02:36	1439	55°	43.2'	N	169°	2.8'	W	X	X		X	X		X	X	X	X	X		X			
39		154	04:34	2465	55°	46.0'	N	169°	16.0'	W							X	X	X	X	X	X	X			
40	44	154	07:37	2106	55°	31.0'	N	169°	25.5'	W	X	X	X	X	X											
41	45	154	09:54	2557	55°	23.5'	N	169°	30.4'	W	X	X		X	X											
42	46	154	12:11	2490	55°	16.0'	N	169°	35.3'	W	X	X		X	X											
43	47	154	14:29	2467	55°	8.5'	N	169°	40.1'	W	X	X		X	X											
44	48	154	17:44	3087	55°	0.9'	N	169°	44.7'	W	X	X		X	X		X	X	X	X	X	X	X	X		
44	49	154	21:53	3090	55°	1.0'	N	169°	44.8'	W	X	X	X	X	X											
44	50	154	22:27	3090	55°	1.0'	N	169°	44.9'	W	X		X		X											
44		154	23:37	3090	55°	1.0'	N	169°	44.9'	W																Argo drifter 585 deployed
45	51	155	02:36	2839	55°	29.0'	N	169°	57.1'	W	X	X		X	X		X	X	X	X	X	X	X	X		
46	52	155	06:41	2868	55°	36.7'	N	169°	52.7'	W	X	X		X	X		X	X	X	X	X	X	X	X		
47	53	155	09:48	1357	55°	49.5'	N	170°	14.3'	W	X	X		X												
48	54	155	11:59	1455	55°	52.2'	N	170°	27.6'	W	X	X		X												
49	55	155	15:32	203	56°	6.5'	N	169°	33.2'	W	X	X		X			X	X	X	X	X	X	X	X		
49	56	155	17:37	210	56°	6.5'	N	169°	33.0'	W	X	X	X	X												
50	57	155	20:42	315	56°	3.7'	N	169°	19.7'	W	X	X		X			X	X	X	X	X	X	X	X		
51	58	155	23:07	1072	56°	1.0'	N	169°	6.3'	W	X	X		X			X	X	X	X	X		X	X		
52	59	156	02:35	885	55°	58.3'	N	168°	52.9'	W	X	X		X			X	X	X	X	X		X	X		
52	60	156	03:24	885	55°	58.3'	N	168°	52.9'	W	X															
53	61	156	05:26	720	55°	50.8'	N	168°	57.7'	W	X	X		X			X						X			ocm drifter 29348 deployed
54	62	156	07:00	153	55°	48.0'	N	168°	44.5'	W	X	X		X												
55	63	156	08:23	144	55°	45.3'	N	168°	31.3'	W	X	X		X	X	X									X	
56	64	156	10:04	151	55°	35.1'	N	168°	22.8'	W	X	X		X	X	X										

57	65	156	12:22	150	55°	52.9'	N	168°	26.3'	W	X	X		X	X	X								X	X	
58	66	156	13:40	165	55°	55.5'	N	168°	39.7'	W	X	X		X	X	X								X	X	
59	67	156	15:21	180	56°	0.4'	N	168°	21.5'	W	X				X	X	X	X	X	X	X		X	X		
59	68	156	16:22	180	56°	0.3'	N	168°	21.4'	W	X				X											
60	69	156	20:33	632	56°	3.0'	N	168°	35.0'	W	X	X		X	X		X	X	X	X	X		X	X		
61	70	156	23:34	706	56°	5.8'	N	168°	48.3'	W	X	X		X	X		X	X	X	X	X		X	X		
62	71	157	02:05	595	56°	8.6'	N	169°	1.7'	W	X	X		X	X		X	X	X	X	X		X	X		
63	72	157	03:54	645	56°	11.3'	N	169°	15.1'	W	X	X		X			X	X	X	X			X			
64	73	157	05:11	485	56°	14.0'	N	169°	28.6'	W	X	X		X												
65	74	157	07:05	147	56°	18.8'	N	169°	10.2'	W	X	X		X												
66	75	157	08:10	135	56°	16.0'	N	168°	56.6'	W	X	X		X												
67	76	157	09:25	197	56°	13.3'	N	168°	43.2'	W	X	X		X												
68	77	157	10:50	232	56°	10.5'	N	168°	29.8'	W	X	X		X												
69	78	157	15:50	2601	55°	33.7'	N	169°	39.0'	W	X	X		X			X	X	X	X	X		X	X		
69	79	157	17:50	2701	55°	33.9'	N	169°	39.2'	W	X	X	X	X												
70	80	157	20:47	2853	55°	36.4'	N	169°	52.2'	W	X	X		X			X	X	X	X	X		X	X		
71	81	158	00:15	2845	55°	39.1'	N	170°	5.7'	W	X	X		X			X	X	X	X	X	X	X	X		
72	82	158	03:28	2278	55°	41.9'	N	170°	18.7'	W	X	X		X			X	X	X	X	X		X	X		
73	83	158	05:54	2074	55°	44.7'	N	170°	32.0'	W	X	X		X									X			
74	84	158	07:55	3015	55°	37.2'	N	170°	37.0'	W	X	X		X												
75	85	158	10:14	3180	55°	34.4'	N	170°	23.6'	W	X	X		X												
76	86	158	12:34	3008	55°	31.7'	N	170°	10.4'	W	X	X		X												
77	87	158	14:49	2839	55°	29.0'	N	169°	57.2'	W	X	X		X												
78	88	158	17:02	2698	55°	26.3'	N	169°	43.9'	W	X	X		X									X			
79	89	158	19:19	2554	55°	23.5'	N	169°	30.7'	W	X	X		X												
80	90	158	21:45	2393	55°	20.8'	N	169°	17.5'	W	X	X		X												
81	91	159	00:20	2263	55°	28.3'	N	169°	12.8'	W	X	X		X												
82	92	159	02:43	1989	55°	25.6'	N	168°	59.6'	W	X	X		X												