

APPENDIX 2

CRUISE PLAN R/V *Oceanus*

Oregon State University
College of Oceanic & Atmospheric Sciences

FILING DATE:	2013
CRUISE NUMBER:	OC1310A (cruise dates July 19-29, 2013)
TITLE:	Science and Technology Center for Coastal Margin Observation and Prediction (CMOP)
CONTRACT/GRANT NUMBER:	NSF
PRINCIPAL INVESTIGATOR(S):	Antonio M. Baptista et al.

PURPOSE: (Short, non-technical statement on how cruise relates to overall project)
<p>The goals of <i>R/V Oceanus</i> operations are:</p> <ol style="list-style-type: none"> 1. To sample the three Estuarine Turbidity Maximum (ETM) of the Columbia River Estuary, and appropriate non-ETM background environments. These samples will focus on determining which bacterial assemblages are associated with which particle size using water samples collected with a pump attached to a CTD system, and using samples collected with an Owen-style bottom withdrawal tube. Samples will also be collected to compare metagenomes and metatranscriptomes of the three ETM and identify signature genetic capabilities and gene expression patterns of ETM microbial communities. Results will be compared with those from cruises in April and October 2012. 2. To collect contextual chemical and biological data associated with nucleic acid samples collected for goal 1. These data will include sensor-based data measured with a CTD sensor package, and direct measurements of nutrients, organic matter, pigments, cell abundance, bacterial growth rate, and respiration rate. 3. To collect contextual physical and chemical data with AUV, profiling nutrient analyzer, and boom mounted ADCP in estuary and plume. 4. To measure methane concentration and CDOM in surface waters using sensors attached to the ships flow-through seawater system.

ITINERARY: (Include station positions and route waypoints. Please send/fax/or bring a PAGE SIZE CRUISE TRACK for submission to UNOLS).

WILL RADIOACTIVE METHODS BE USED? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
If so, list OSU radiation use authorization number: Applied For

WILL YOU BE BRINGING HAZARDOUS MATERIALS ABOARD?	<input checked="" type="checkbox"/>	YES	<input type="checkbox"/>	NO
If so, you are responsible for providing the Master with an Inventory of such materials & associated MSDS sheets.				

SAMPLING PLAN:

Please see attached for more details

1. In the estuary we will use a **small estuary CTD unit** consisting of the ship’s stainless steel Sea-Bird CTD frame and sensor array set into a small and sturdy cage that the scientists will provide. This cage has hydrodynamic flaps to keep the CTD package from spinning in the strong currents of the estuary. Heavy weights are attached at the bottom of the cage and the end of a length of tubing is attached to the leading end of the cage (see pictures below). This CTD will be deployed with the standard starboard CTD boom. Tubing for a deck Pacer pump will be attached to the frame and clipped to the wire every 3 meters during the cast. This tubing will be detached from the CTD unit when water samples are not required. This ship’s CTD unit will be equipped with sensors for CTD, Oxygen, and Turbidity (transmissometer), and will also include CMOP-supplied wetlabs FLNTU sensor and a CDOM sensor.
2. **(AUV) Autonomous Underwater Vehicle** operations in North Channel of Columbia River estuary and plume – 2 x REMUS 100. Daylight operations with deployment and recovery of AUVs using the ship’s RHIB. Four acoustic transponders will be deployed on the first day in the estuary using the ship’s RHIB in order to help the AUV navigate. In event of emergency surfacing of the vehicle, the RHIB will be used to recover the vehicle at the earliest opportunity using GPS positions sent by the vehicle to the ship over Iridium. Recovery of the four transponders by ship’s RHIB at end of the experiment must be done at slack tide because the small surface float on recovery line needs to be on surface. When the AUV is in the water, an acoustic Ranger must be hung overboard to track the AUV’s progress. This is also used on RHIB during recovery operations.
3. **(OT and CTD) Estuarine Turbidity Maximum (ETM)** water sampling plan. During two 6-hour periods per day, CTD casts will be done every 15-30 min and bottom water (~1m from bottom) will be collected before, during and after ETM resuspension events using a Pacer pump linked to the small estuary CTD unit. Water may be collected at other depths and times. During peak ETM turbidity an Owen-style bottom withdrawal tube will be deployed off the stern simultaneously. The Owen Tube will be delivered to the ship and tested by David Langner.
4. **(APNA) Autonomous Profiling Nutrient Analyzer** will be deployed to determine water column profiles of inorganic nutrients during the operations described in (3). The instrument and reagents will be located on deck in a small incubator. Sample water pumped from the Pacer pump will be diverted to the instrument for real time analysis during the downward casts of the CTD.
5. **Particle & microeukaryote characterizations.** Samples from the CTD casts described in (3) will be collected for real time analysis of plankton size distribution and taxonomic identification. Two instruments will be located in the dry lab, the FlowCAM (Fluid Imaging, Inc.) and a prototype microfluidic particle counter.
6. **(ADCP) Boom mounted ADCP** will be used on the port side with an additional transducer added. Installation of this device will be managed by David Langner. This

Byron Crump 2/20/13 11:49 AM
 Comment [1]: Craig – can you update?

will be deployed whenever possible during the cruise, but will not be deployed during transit.

7. **In-line Methane analyzer** will be installed in the wet lab attached to the flow through system. Installation will be done by Fred Prahl. Someone in Joe Needoba's group will be instructed on how and when to operate this device. A wetstar CDOM sensor will also be installed in the wet lab attached to the flow through system (as was done by Dave O'Gorman on the last CMOP cruise – OC1304C). David Langner will deliver and install the CDOM sensor.
8. **(SATURN)** We will rely on several Endurance Stations and mobile platforms of the SATURN network for necessary context on the dynamics of the estuary. Those including in particular SATURN-01 (North channel), SATURN-02 (near plume), SATURN-03 (South Channel), SATURN-04 (Cathlamet Bay), SATURN-05 (Freshwater at Beaver Army Dock), and SATURN-07 (Baker Bay).
9. **ETM Watches:** In order to predict the timing of ETM resuspension events, we will rely on the "ETM watch" website that formats SATURN-01 and SATURN-03 data for monitoring the ETM in the North and South Channels (respectively).
http://www.stccmop.org/datamart/observation_network/etm
10. **Virtual Columbia River:** We will request forecasts of bottom salinity and velocity in the North and South channels to help predict the ETM events.
11. **Sediment model:** We request time and location predictions of ETM events in the South and North Channel.

EQUIPMENT REQUIRED: (Should be included on Shared-Use Equipment request form)

Website with equipment list

<http://ceoas.oregonstate.edu/oceanus/>

Standard Ship's Outfit

DAS shipboard data logging/display system

Shipboard networking services

Dry Lab tables and cabinets in various heights and sizes

Refrigerator

Chest Freezer (in wet lab)

RDInstruments shipboard Doppler current profilers; Frequency 75/300 kHz.

Rigid-hull inflatable boat (RHIB) for deploying and retrieving bottom nodes and AUVs, and for collecting water samples at shallow sites in the lateral bays of the estuary. Setup on deck, deploy with Morgan knuckle crane

Rigid-hull inflatable boat (a second one) for emergency retrieval of AUVs when primary RHIB is occupied with sampling at lateral bays. Setup on the bridge level

Transient Equipment

-70°C freezer, 5 cu. ft. (Place this freezer next to the -20 chest freezer in the wet lab)

Refrigerator (in Dry Lab)

Deionized distilled water system

Fume hood (in Wet Lab)

Countertops in Wet Lab – we request a long countertop to the left of the fume hood.

Hazardous chemical cabinet (in Dry lab or on deck)

Backup sensors for CTD in case of failure (Turbidity, CTD, Oxygen, Fluorescence)

Ship's Deck Equipment

Midships hydro boom (for deploying CTD)

Markey DESH-5 Hydro Winch with 33,000\ 3-conductor EM for deploying Small Estuary CTD unit w/ pumped hose.

Stern A-frame (for deploying Owen Tube)

Hydraulic tugger winch with cable over A-frame for deploying Owen Tube.

Computer cable long enough to reach back deck to download data from Seabird SBE39 attached to Owen Tube.

Vans

Radiation Laboratory Van with incubator and scintillation counter. Setup on the 01 deck near bulkhead.

Scientist supplied equipment

Small Estuary CTD frame and weights (Wilkin)

FLNTU sensor to attach to the CTD (Wilkin)

CDOM sensor to attach to the CTD (Wilkin)

Owen Tube and frame to secure to deck (Langner, Crump)

Seabird SBE39 to attach to Owen Tube (Wilkin)

Deck Incubator with hoses to be connected to surface water system. Setup on the 01 deck aft of radiation laboratory van near railing (Needoba, Crump)

Autonomous Profiling Nutrient Analyzer (Needoba)

Boom-mounted ADCP (Langner)

Various computers, peripherals and deck units in the Main Lab (all)

Various filtration rigs for use in the Dry Lab (Crump)

Methane analyzer to be attached to the flow-through system (Prahl)

Wetstar CDOM sensor to attach to the flow-through system (Langner)

FlowCAM to be set up in the dry lab (Peterson)

Prototype particle analyzer to be set up in the dry lab (Needoba)

Nitrogen (N₂) tank to be used in dry lab (Wunsch)

SCIENTIFIC PERSONNEL TO BE ONBOARD: (Provide full legal name & affiliation)	
Scientists in Charge:	Byron Crump (UMCES)
Other Scientist(s):	Craig McNeil (UW), Trina Lichendorf (UW), (UW), Nicholas Michel-Hart (UW), Joseph Needoba (OHSU)
Party Chief:	
Technicians:	
Grad Students:	Sheree Watson (OHSU), Kayce Pierce (OHSU), Urban Wunsch (AWI-Germany), Lindy Fine (UMCES), Kristina Remple (OHSU)
Undergraduate Students:	John Michael Wojahn (OSU), Patrick Feller (OHSU), Christina Nhan (UW)
Observers:	

OSU Marine Technician(s) Assigned to Cruise:	Erik Arnesen
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USER SUPPLIED EQUIPMENT:	
Vans/Containers:	
Number:	
Size:	
Estimated Weight:	
Location:	

OTHER BULKY HEAVY ITEMS:	
Location:	Starboard quarter: RIB for AUV ops
Estimated Weight:	Unknown

BILLING INFORMATION: For project related charges – non-specific to projects goes to A. Baptista if and only if explicitly pre-approved	
Name: Craig McNeil	Byron Crump
Address: Applied Physics Laboratory U. Washington 1013 NE 40 th Street Seattle, WA 98105	Address: Oregon State University 104 CEOAS Admin Bldg. Corvallis, OR 97331-5503
Phone: 206-543-2157	541-737-4369, cell 541-224-8076
Account Number (or number to reference):	

DO YOU WANT CELLULAR/INMARSAT PHONE ACCESS:	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
Chief Scientist will be responsible for all charges – dedicated science phone.		

CMOP cruise plan
Columbia River Estuary
R/V Oceanus
 20-29 July 2013

Area of Operations: Columbia River estuary

Scientific personnel.

Name	Inst	Activity	Berth	Watch	R&C, etc.
Byron Crump	OSU	Chief Sci.		TBD	X
Craig McNeil	UW	AUV lead		TBD	X
Trina Litchendorf	UW	AUV ops		TBD	
Nicholas Michel-Hart	UW	AUV ops		TBD	X
Lindy Fine	UMCES	OT/CTD ops		TBD	
John Michael Wojahn	OSU	OT/CTD ops		TBD	X
Kristina Remple	OHSU	OT/CTD ops		TBD	X
Joe Needoba	OHSU	APNA/CTD ops		TBD	
Sheree Watson	OHSU	APNA/CTD ops		TBD	X
Kayce Pierce	OHSU	APNA/CTD ops		TBD	X
Urban Wunsch	OHSU	APNA/CTD ops		TBD	X
Patrick Feller	OHSU	CTD ops		TBD	X
Christina Nhan	UW	AUV ops		TBD	X
Erik Arnesen	OSU	Marine Technician		TBD	
BERTHS FILLED					
BERTHS OPEN					

Shifts and Activities

Watches: TBA, may various with tidal cycle

We request copies of all calibration/information sheets for *R/V Oceanus* instruments.

Watches will be modified during the cruise to make sure groups are rested and data is being QC'ed and examined.

Sampling details

Days 1-3: Before entering the estuary the ship will hold station for an hour outside the mouth of the estuary (location TBD) and conduct one or two CTD casts to collect water in and below the river plume. Then the ship will enter the estuary and anchor in the North Channel at 46° 14.0'N, 123° 53.4'W, which is just west of the A-M Bridge Pier 11 where SATURN-01 is operating. The RHIB will be used to deploy 4 acoustic transponders along the south slope of the North Channel. AUV, Owen Tube, CTD, APNA, and ADCP time series of operations and water sampling will begin as soon as the equipment is ready to go (see details below). If the ETM is not strongly present at this location, the anchor station will be moved west.

Methane analyzer: The 'fast methane analyzer' plumbed into the ship's flow thru system via a shower head equilibrator will be run continuously at all four sites where the ship is held on

anchor for hourly times series sampling (North Channel near SAT01: 21-23 July and 27-28 July; Youngs Bay: 23-24 July; South Channel near SAT03: 24-25 July). Hourly, throughout the period of each operation, the operator will check on the flow rate of seawater through the shower head equilibrator (record time, in UTC, and reading on the flow totalizer).

At the Young's Bay and SAT03 anchor station, water samples will also be collected hourly over the entire time series at surface and bottom depths. Samples will be taken by syringe for nutrients and 'dissolved' metals (Mn, Fe). Water collected in the syringe (w/ black rubber end on plunger) for nutrients will be filtered through a 0.45um in-line filter into a 30mL Nalgene vial and stored frozen. Water collected in the syringe (all plastic, NO RUBBER on plunger) for 'dissolved' metals will be filtered through a 0.45um in-line filter into a 30 mL Nalgene vial (nitric acid pre-cleaned) and, after addition of trace metal clean 3N HNO₃ (two drops) shaken and stored at room T. Water collected in a 2L brown Nalgene bottle will be used to obtain a sample (~150-200mL) for determination of SPM concentration (47mm pre-weighed polycarbonate filter), a sample (~250mL each) for POC/PN and HPLC pigment analysis (both 25mm GFF filter). SPM samples will be folded in half, placed in a plastic petri dish and dried in an oven (~50°C). POC/PN and HPLC samples will be folded in half and stored frozen (-80°C) after wrapping in aluminum foil.

Pacer Pump:

The Small Estuary CTD unit equipped with the ship's CTD package, transmissometer, Wetlabs FLNTU, and a CDOM sensor will be deployed at slack tide before a predicted ETM resuspension event. The hose for the Pacer Pump will be hose-clamped to the Small Estuary CTD unit and clipped onto the winch cable during deployment. Vertical profiles of the water column will be conducted every 15-30 minutes, and between profiles the CTD will be left at a near-bottom depth (~1 m off the bottom) to monitor turbidity with the transmissometer and FLNTU. Pump will be turned on and primed, and flow will be channeled through a chamber containing the APNA to measure nutrient concentrations during profiles. Water will be collected from near-bottom depth before, during, and after each ETM resuspension event. Water may also be collected at other depths and times. Onboard analysis of samples will be performed by Craig McNeil's group for dissolved O₂ by the Winkler titration method to calibrate sensors on the AUVs.

Owen Tube:

Bottom water (1m from bottom) will be collected with an Owen Tube bottom withdrawal tubes deployed from the stern A-frame with an air tigger winch. The Owen Tube will be deployed at the same time as the CTD. Once on deck the Owen Tube is placed in a special rack in a vertical position, and four settling fractions will be collected after specific time periods (#1: 5.75min, #2: 19.25min, #3: 40.5min, #4: immediately thereafter). Deployment and sampling will take about 90 min. Owen Tube sampling periods may be adjusted.

AUVs:

Two vehicles will be used during the cruise (see pictures below). Due to limitations for recharge time it may not be possible to deploy both vehicles every day. Vehicles are deployed/recovered by RHIB at safe distance from the ship and the mission started/stopped remotely using the acoustic Ranger. On the first use of a vehicle, its compass is calibrated by commanding the AUV to circle (~20m diameter) at the sea surface for several minutes prior to starting its mission.

During standard missions the vehicles travels along the channel (east/west). But we may send the vehicle across the channel (north/south) also. The vehicle is pre-programmed to travel on a repeated section, defined by multiple waypoints. It also undulates from approximately 1.5m below the sea surface (below small boat propeller depth) to close to the sea floor. Planned deployment and recovery times for any mission depend on the timing of the ETM event under study, daylight operating hours, surface currents, which affect the RHIB deployment, and battery lifetime (< 10 hours). An Iridium antenna (ship mounted) is used to find the vehicle in the event of an emergency surfacing of the vehicle. This may occur if the AUV becomes confused/lost/damaged, or can't fight the currents. Under emergency, the AUV aborts its mission, floats to the surface and drift freely with the surface currents, hence rapid recovery of AUV is critical. Emergency tracking is by GPS/Iridium to a ship-mounted antenna (we usually install this on pole mounted to an upper deck railing).

Two RHIBs:

A second RHIB will be aboard the Oceanus in case there is an emergency with the AUVs during times that the primary RHIB will be occupied with Lateral Bay output sampling.

Lateral Bay output sampling. The Rigid-Hulled Inflatable Boat (RHIB) on board the Oceanus will be used to collect suspended particles and water that is emitted from the two lateral bays in the North Channel of the estuary (Baker, Grays) during strong ebb tides. Water will be sampled from near-bottom depths with a submersible pump (Super Twister DTW) and hand-held OBS sensor (TPS WP-88, LaMotte 2020we, Global Water WQ770) that are attached to a line and weight and lowered to near-bottom depth at the entrance to each Bay during the peak of the strong ebb tide. A portion of these water samples will be filtered immediately (on board the RHIB) through a 142mm diameter filter holder containing stacked 3um and 0.2um pore sized filters using a battery-powered peristaltic pump. The remaining water will be returned to the ship for processing. Sampling of the suspended particles and water emitted from the two lateral bays in the South Channel of the estuary (Youngs, Cathlamet) will be done from the Oceanus.

Location	Latitude	Longitude	Platform	Sunrise	Sampling dates & times
				05:45	July 21, 2013 @ 0300-0500
				05:46	July 22, 2013 @ 0400-0600
				05:47	July 23, 2013 @ 0500-0700
Youngs Bay entrance	46° 11.220'N	123° 53.040'W	Oceanus	05:48	July 24, 2013 @ 0600-0800
Baker Bay entrance	46° 16.095'N	124° 0.102'W	RHIB	05:49	July 25, 2013 @ 0700-0900
Cathlamet Bay entrance	46° 13.013'N	123° 44.593'W	Oceanus	05:50	July 26, 2013 @ 0800-1000
Grays Bay entrance	46° 17.236'N	123° 43.606'W	RHIB	05:52	July 27, 2013 @ 0900-1100
Baker or Grays Bay entrance			RHIB	05:53	July 28, 2013 @ 1000-1200

Cruise Plan

Station	Date	Latitude	Latitude	Longitude	Longitude
Plume near SATURN02	20 July	46° 10.400'N	46.1733	123° 07.600'W	-122.8733
North Channel near SATURN01	21-23 July	46° 14.071'N	46.2345	123° 52.307'W	-122.1282
Youngs Bay	23-24 July	46° 11.220'N	46.1870	123° 53.040'W	-122.1160
South Channel near SATURN03	24-25 July	46° 12.060'N	46.2010	123° 56.460'W	-122.0590
Upriver site	25 July	TBD			
Cathlamet Bay	26 July	46° 13.013'N	46.2169	123° 44.593'W	-122.2568
South Channel near SATURN03	26 July	46° 12.060'N	46.2010	123° 56.460'W	-122.0590
North Channel near SATURN01	27-28 July	46° 14.071'N	46.2345	123° 52.307'W	-122.1282

Prior to July 19

The CMOP field team (POCs: Michael Wilkin and Antonio Baptista) has or expects to deploy:

- **SATURN-01:** This Endurance Station is currently operating, and is planned to operate throughout the cruise. Located in the North Channel, on the Astoria-Megler Bridge (46° 14.071'N, 123° 52.307'W), this station provides a key reference for the variability of channel conditions during the cruise. It includes an upward-looking ADP and a winch-driven profiler measuring salinity, temperature, CDOM, FLNTU, DO, phycoerythrin and nitrate. Data is available in near real-time at http://www.stccmop.org/datamart/observation_network/fixestation?id=saturn01
- **SATURN-02:** This endurance seasonal station is located SW of the CR entrance, at a depth of ~40m, to characterize near plume dynamics. The station is equipped with (a) a met station (pressure, temperature, wind speed, direction and gust); (b) a downward looking ADP; (c) surface salinity, temperature, CDOM, FLNTU, DO, phycoerythrin, nitrate and multi-frequency chlorophyll; (d) additional salinity and temperature at 6, 11, 16 and 21m; and (e) salinity, temperature and DO near bottom (35m). Data will be available near real-time at http://www.stccmop.org/datamart/observation_network/fixestation?id=saturn02.
- **SATURN-03:** Located on a pier near Hammond, OR. Water from the South Channel is pumped from multiple depths through a series of sensors housed in a building on the pier. Sensor descriptions and data access are available at: http://www.stccmop.org/datamart/observation_network/fixestation?id=saturn03
- **SATURN-04:** Located on a pier near in Mott Basin in Cathlamet Bay. Water from Mott Basin is pumped from multiple depths through a series of sensors housed in a building on the pier. Sensor descriptions and data access are available at: http://www.stccmop.org/datamart/observation_network/fixestation?id=saturn03
- **SATURN-07:** This station is deployed in Baker Bay at 1m depth. Measurements are surface salinity, temperature, CDOM, DO, Turbidity (ftu) and Chlorophyll (rfu). Data is expected to be available near real-time. Data will be available near real-time at: http://www.stccmop.org/datamart/observation_network/fixestation?id=saturn07

The CMOP cyber team (POCs: Charles Seaton and Antonio Baptista) will maintain an ETM watch website, designed to assist the prediction of the timing of the next-day ETM at SATURN-01 and SATURN-03.

http://www.stccmop.org/datamart/observation_network/etm

The CMOP modeling team (POCs: Charles Seaton and Antonio Baptista) will assist the cyber team to deploy two variations of forecasts of circulation and (in very preliminary form) sediment transport.

18 July 2013 Thursday

20:00 APL group arrives, checks into hotel.

19 July 2013 Friday

- 08:00 Loading day in Newport. OHSU and OSU participants will arrive at 10:00-11:00. David Langner installs the Boom-mounted ADCP, Fred Prahl installs the Methane Analyzer.
- 13:00 Hold meeting with Captain, Chief, ResTech, Bos'n and others to discuss operations.
- 20:00 Scientists sleep on board ship

20 July 2013 Saturday

- 08:00 OSU Radiation Safety Officer Rainier Farmer delivers isotope to ship.
- 09:00 Deadline for all hands on board. Anyone not shipping out should be off the ship.
- 10:00 Conduct boat drills and safety lecture. All science party must try on survival suits once per year on the *Oceanus*
- 11:00 Finish Safety Drills, throw lines and leave Newport
- 21:00 Arrive at Columbia River Estuary plume
- 22:00 Conduct several CTD casts in Columbia River Plume (stations to be determined) to collect marine end-member water and particles.
- 24:00 Cross Columbia River bar during high slack after flood and anchor ship in North Channel (46° 14.07'N, 123° 53.31'W)

21 July 2013 Sunday (sunrise 5:45, sunset 20:58) (set up equipment, North Channel ETM stronger flood and weaker ebb, deploy transponders)

- 06:00 Set up and test Owen tubes, CTD and Pacer pump.
- 07:00 At slack tide deploy RHIB with small crane on aft starboard side in order to deploy acoustic transponders for AUV operations.
- 09:00 **Begin stronger flood tide ETM sampling** (Max Flood 11:01). **Procedure:** Lower CTD to near-bottom depth and monitor for salinity and turbidity. CTD profile every 30 min returning CTD to bottom. Pump will be turned on periodically to flow water through the APNA chamber. Bottom water will be collected with Pacer pump before, during and after ETM event. At peak ETM turbidity cast Owen Tube off A-frame.
- 13:00 End stronger flood tide ETM sampling
- 15:00 **Begin weaker ebb tide ETM sampling** (Max Ebb 16:22)
- 20:00 End weaker ebb tide ETM sampling

22 July 2013 Monday (sunrise 05:46, sunset 20:57) (North Channel ETM stronger ebb and stronger flood, AUV operations)

- 02:00 **Begin stronger ebb tide ETM sampling** (Max Ebb 04:39)
- 06:00 Deploy RHIB for AUV operations.
- ~07:00 Recover RHIB
- 07:00 End stronger ebb tide ETM sampling
- 09:00 **Begin stronger flood tide ETM sampling** (Max Flood 11:46)
- 14:00 End stronger Flood ETM sampling
- ~18:00 Deploy RHIB to recover AUV
- ~19:00 Recover RHIB

23 July 2013 Tuesday (sunrise 05:47, sunset 20:56) (North channel ETM stronger ebb and wstronger flood, AUV operations, move to S. Channel, begin Youngs Bay series)

- 03:00 **Begin stronger ebb tide ETM sampling** (Max Ebb 05:28)
- 08:00 End stronger ebb tide ETM sampling

07:00 Deploy RHIB for AUV operations.
 ~08:00 Recover RHIB
 10:00 **Begin stronger flood tide ETM sampling** (Max Flood 12:29)
 15:00 End stronger Flood ETM sampling
 ~18:00 Deploy RHIB to recover AUV
 ~19:00 Recover RHIB
 18:00 Move ship to anchor in South Channel near Youngs Bay (46.187N 123.884W).
 20:00 **Begin hourly time series sampling** (at ebb slack tide) with CTD and Pacer Pump for 12 hours during weak flood and strong ebb tide.

24 July 2013 Wednesday (sunrise 05:48, sunset 20:55) (finish Young's Bay series, Begin SATURN-03 ETM series, South Channel ETM stronger flood)

06:00 Approximate time of particle flush from Young's Bay.
 08:00 End hourly time series sampling
 08:00 Move ship and anchor at South Channel near SATURN-03; (46° 12.060'N, 123° 56.460')
 10:00 **Begin stronger flood tide ETM sampling** (Max Flood 13:10)
 15:00 End stronger Flood ETM sampling
 21:00 **Begin hourly time series sampling** (at ebb slack tide) with CTD and Pacer Pump for 12 hours during weak flood and strong ebb tide.

25 July 2013 Thursday (sunrise 05:49, sunset 20:54) (Continue SATURN-03 ETM series, sample Baker Bay, South Channel ETM stronger flood).

05:30 Deploy RHIB to sample particles from Baker Bay (46° 16.095'N, 124° 0.102'W). Samples will probably be collected at Max Ebb tide at 07:01.
 08:00 Recover RHIB
 09:00 End hourly time series sampling, continue with ETM sampling series to sample a second strong ETM.
 11:00 **Begin stronger flood tide ETM sampling** (Max Flood 13:50)
 16:00 End stronger Flood ETM sampling
 18:00 Move ship up river into freshwater reach where there is freshwater all the way to the bottom.
 19:00 Collect three freshwater samples to serve as endmember samples.
 22:00 Move ship to anchor at the mouth of Cathlamet Bay (46° 13.013'N, 123° 44.593'W)

26 July 2013 Friday (sunrise 05:50, sunset 20:52) (Sample Cathlamet Bay, AUV operations in North channel, South Channel ETM stronger flood and weaker ebb)

05:00 Begin CTD casts every 30 minutes during Strong Ebb
 06:00 Deploy RHIB for AUV operations.
 07:48 (Max Ebb) Approximate time of particle flush from Cathlamet Bay
 08:00 Recover RHIB
 10:00 Move ship to SATURN03
 12:00 **Begin stronger flood tide ETM sampling** (Max Flood 14:28)
 17:00 End stronger Flood ETM sampling
 18:00 **Begin weaker ebb tide ETM sampling** (Max Ebb 20:26)
 23:00 End weaker ebb ETM sampling
 24:00 Move ship to anchor in North Channel (46° 14.0'N, 123° 53.4'W)

27 July 2012 Saturday (sunrise 05:52, sunset 20:51) (Sample Baker Bay, AUV deployment, North Channel ETM) stronger flood and weaker ebb)

06:00 Deploy RHIB for AUV operations.
 07:00 Change teams on RHIB (AUV team off, Lateral Bay team on)
 07:00 Deploy RHIB to sample particles from Baker Bay (46° 16.095'N, 124° 0.102'W).
 Samples will probably be collected at Max Ebb tide at 08:35.
 08:35 (Max Ebb) Approximate time of particle flush from Baker Bay
 11:00 Recover RHIB
 13:00 **Begin stronger flood tide ETM sampling** (Max Flood 15:06)
 18:00 End stronger Flood ETM sampling
 19:00 **Begin weaker ebb tide ETM sampling** (Max Ebb 21:16)
 24:00 End weaker ebb ETM sampling

28 July 2013 Sunday (sunrise 05:53, sunset 20:50) (Sample Gray's Bay, AUV operations, North Channel ETM stronger flood, Recover transponders, leave estuary)

06:00 Deploy RHIB for AUV operations.
 07:00 Change teams on RHIB (AUV team off, Lateral Bay team on)
 07:00 Deploy RHIB to sample particles from Grays Bay (46° 17.236'N, 123° 43.606'W).
 Samples will probably be collected at Max Ebb tide at 09:25.
 09:25 (Max Ebb) Approximate time of particle flush from Grays Bay
 11:00 Recover RHIB
 14:00 **Begin stronger flood tide ETM sampling** (Max Flood 15:46)
 19:00 End stronger Flood ETM sampling
 19:00 Deploy RHIB to recover transponders
 21:00 Recover RHIB
 21:00 Transit to Newport

29 July 2013 Monday

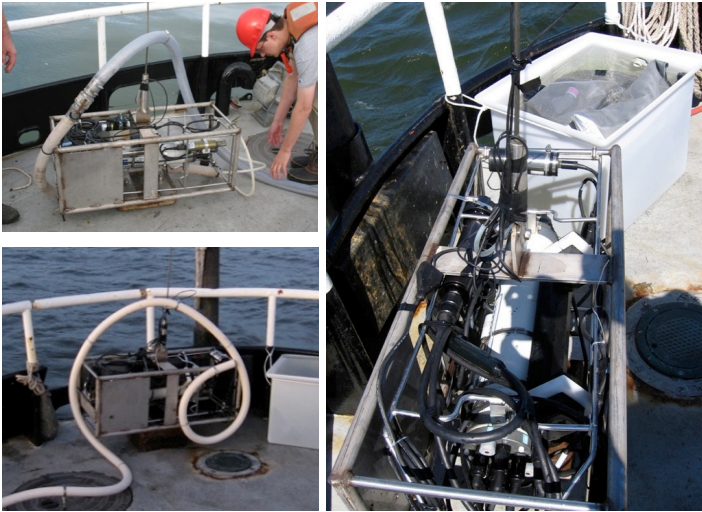
07:00 Arrive Newport and demobilize

Data details:

1. CTD casts will be denoted according to OSU method.
2. Owen Tube (OT) stations will be named in a unique way, perhaps as done in the past. Water fractions collected from OT will be assigned CMOP Water Sample Numbers sequentially.
3. Water samples collected with the Pump will be assigned CMOP Water Sample Numbers sequentially.

Equipment pictures:

Small estuary CTD unit consisting of stainless steel Sea-Bird CTD frame set in a cage that we will provide. Tubing and CTD data cable are clipped to the CTD wire every 3 meters during the cast. This tubing will be removed when water samples are not required. This CTD unit will be equipped with a CTD sensor package supplied by the scientists. We constructed the cage to protect the CTD and other sensors during deployment in the Columbia River estuary. We attach a heavy weight to help get the package below the surface currents during strong ebb tides. The cage also has some hydrodynamic flaps to keep the package oriented properly when deployed.

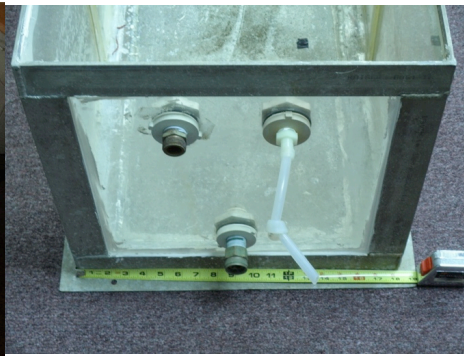


Pacer Pump

We attach the ends of a rigid tube to the CTD cage and to an impeller pump on deck. This tubing is paid out as the cage is lowered, and clipped onto the hydrowire. Our maximum deployment depth in the estuary is approximately 25m.



Deck Incubator



Owen Tubes

We are bringing a Standard Owen Tube, Quad Owen Tube, and a horizontal version of a General Oceanics bottle with a frame to hold it on deck



AUVs

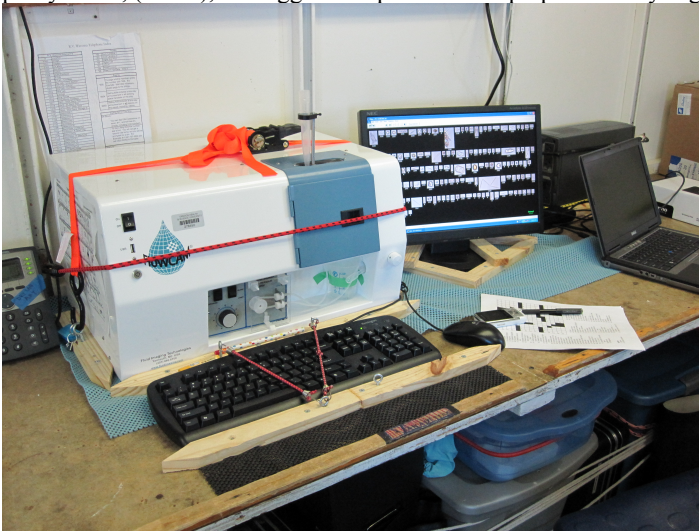
Shown are: (A) the REMUS 100 Autonomous Underwater Vehicle; (B) navigation transponders, previously deployed in fixed locations on the south side of the north channel; (C) the 'Ranger', which is hung overboard while the AUVs are in water to allow acoustic communications with the vehicles and used on RHIB during AUV recovery operations; and (D) example of a standard along-channel AUV track line (we may also perform cross-channel missions). Actual mission track lines TBD.



(APNA) Autonomous Profiling Nutrient Analyzer. The APNA is the black cylinder in the picture. The syringes will be replaced with small IV bags.

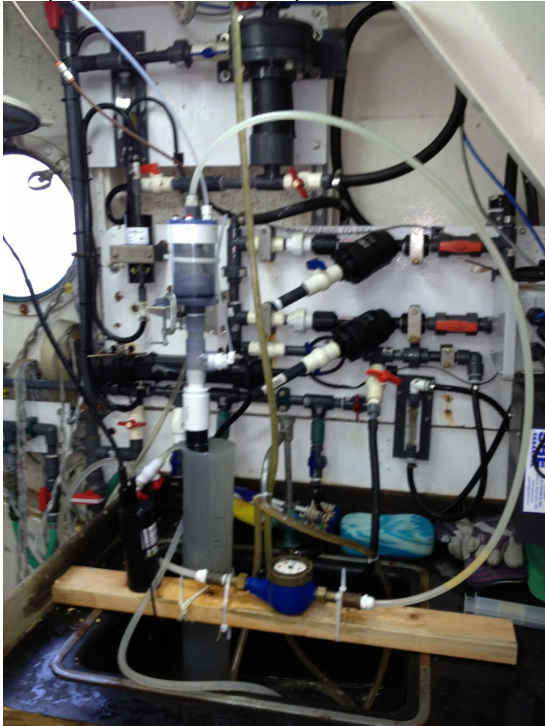


FlowCAM. Shown as it has been setup on board in the past. As for the particle counter, it is pretty small, (4"x4"), the biggest footprint is the laptop and the syringe pump.



In-line Methane analyzer.

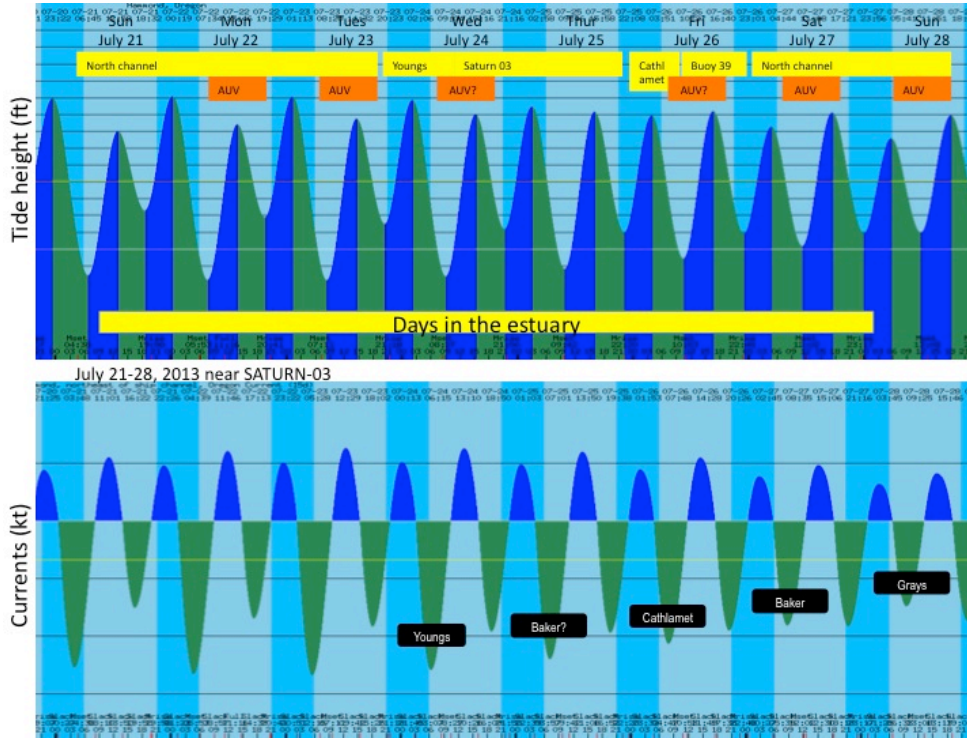
Setup (shows shower head equilibrator and wet star CDOM sensor) over the sink in the wet lab:



On bench in wet lab



Tide and current charts:



Berthing Chart (draft)

