APPENDIX 2

CRUISE PLAN R/V *Oceanus*

Oregon State University
College of Oceanic & Atmospheric Sciences

FILING DATE:	20 April 2012
CRUISE NUMBER:	OC1204B
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)

The goals of *R/V Oceanus* operations are:

1. To measure the dominant physical processes in the Estuarine Turbidity Maximum (ETM) of the Columbia River Estuary, including velocity, turbulence, mixing, sediment burden and water characteristics.
2. To determine which bacterial assemblage is associated with which particle size in and out of ETM using water samples collected with a pump attached to a CTD system, and using samples collected with Owen Tube bottom withdrawal tubes.
3. Collect contextual physical and chemical data with AUV, remote sensing of water column salinity, bottom mounted ADP and CTD, and boom mounted ADCP in estuary and plume.

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? [X] YES [ ] NO

If so, list OSU radiation use authorization number: **Applied For**

WILL YOU BE BRINGING HAZARDOUS MATERIALS ABOARD? [X] YES [ ] 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. Winch lowered platform containing a wide variety of sensors for water properties, turbidity, sediment concentration, velocity and turbulence to continuously profile, especially during the flood tide when the ETM occurs. The platform is operated from a winch with electromechanical cable to leads to a sheave attached to the main crane that is supported on a crutch. Initially, observations will be continuous for a flood and following ebb tide. Some of the time the profiler will oscillate throughout the water column, and other times it will remain a fixed heights above the bottom for time series observations. It is anticipated that the profiler will operated most of the time, with breaks when the conditions are not changing much.
2. In the estuary we will use a **small estuary CTD unit** consisting of stainless steel Sea-Bird CTD frame set in a cage that we 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 stern A-Frame and an Air Tugger winch. Tubing and a data cable for sensors will be 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 CTD unit will be equipped with the following sensors that we will provide: Seabird SBE25, Wetlabs FLNTU. (Final sensor package is still being decided)
3. **AUV** 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.
4. **Estuarine Turbidity Maximum** (ETM) water sampling plan. During two 6-hour periods per day, CTD casts will be done every 30 min and bottom water (~1m from bottom) will be collected before, during and after ETM resuspension events using either (a) a Pacer pump linked to the small estuary CTD unit or with (b) an Owen-style bottom withdrawal tube.
5. **Boom mounted ADCP** will used on the port side with an additional transducer added. This will be deployed intermittently in estuary and plume during Leg2 (will not be deployed during transit).
6. Two bottom sited instruments will be deployed prior to the cruise: 1) the **Sigma Profiler** is a cable that electromagnetically determines the vertical profile of salinity will be deployed near Saturn 01; 2) the **Bottom Node** is a trawl resistant housing that encloses an ADP, CTD and acoustic release, which will likely be deployed near the mouth of the N. Channel.
7. We will rely on several endurance stations and mobile platforms of the SATURN network for necessary context on the dynamics of the estuary and the North channel in particular. Those including in particular SATURN-01 (North channel), SATURN-02

(near plume), SATURN-7 (Baker Bay) and a glider (WA shelf).
8. We will rely on an ETM watch and on forecasts of circulation for day-to-day planning of campaign details.

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

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

Transient Equipment
Low Temperature freezer -85C, 5 cu. ft.

Ship's Deck Equipment
Crane (for deploying WP instrument package).
Hydro Winch: 0.322" 3-conductor EM for CTD, 1000m max depth.
Trawl Winch 9/16" wire over A-frame for deploying Small Estuary CTD unit w/ pumped hose
Air Tugger with line over A-frame for deploying Owen Tubes

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
CTD and sensor package for the Small Estuary CTD frame, including data cable.
Owen Tubes
Winch Profiler Sensor package
Deck Incubator with hoses to be connected to surface water system. Setup on the 01 deck aft of radiation laboratory van near railing.
Boom-mounted ADCP
Various computers, peripherals and deck units in the Main Lab

SCIENTIFIC PERSONNEL TO BE ONBOARD: (Provide full legal name & affiliation)

Scientists in Charge:	Tom Sanford (UW), Byron Crump (UMCES)
Other Scientist(s):	Craig McNeil (UW), Trina Lichendorf (UW), Andrey Shcherbina (UW)
Party Chief:	
Technicians:	Jim Carlson (UW), John Dunlap (UW), Avery & Keaton Snyder (UW)

Grad Students:	Lindy Fine (UMCES), Dong-Yoon Lee (UMCES), Jesse Lopez (OHSU)
Undergraduate Students:	
Observers:	

OSU Marine Technician(s) Assigned to Cruise:	Daryl Swensen

USER SUPPLIED EQUIPMENT:	
Vans/Containers:	
Number:	
Size:	
Estimated Weight:	
Location:	

OTHER BULKY HEAVY ITEMS:	
Location:	O1 Level: Electro-hydraulic winch; Starboard quarter: RHIB for AUV ops
Estimated Weight:	800 lbs.: unknown

BILLING INFORMATION: For project related charges – non-specific to projects goes to A. Baptista if **and only if** explicitly pre-approved	
Name: Thomas Sanford or Craig McNeil	Byron Crump
Address: APL U. Washington 1013 NE 40th Street	Address: Horn Point Laboratory P.O. Box 775
City, State, Zip Seattle, WA 98105	Cambridge, MD 21613
Phone: 206.543.1365	410.221.8382, cell 410-330-0051
Account Number (or number to reference):	

DO YOU WANT CELLULAR/INMARSAT PHONE ACCESS:	X	YES		NO
Chief Scientist will be responsible for all charges – dedicated science phone.				

CMOP cruise plan
Columbia River Estuary
R/V Oceanus
30 April – 9 May 2012

Area of Operations: Columbia River estuary

Scientific personnel.

Name	Inst	Activity	Berth	Watch
Tom Sanford	UW	Chief Sci.	SR 9	TBD
Byron Crump	UMCES	Co-Chief Sci.	SR 9	TBD
Craig McNeil	UW	AUV lead	SR 5	TBD
John Dunlap	UW	WP engineer	SR 13	TBD
Avery Snyder	UW	WP engineer	SR 14	TBD
Keaton Snyder	UW	WP engineer	SR 14	TBD
Jim Carlson	UW	WP engineer	SR 13	TBD
Trina Litchendorf	UW	AUV ops	SR 12	TBD
Andrey Shcherbina	UW	AUV ops	SR 5	TBD
Lindy Fine	UMCES	OT/CTD ops	SR 12	TBD
Dong-Yoon Lee	UMCES	OT/CTD ops	SR 11	TBD
Jesse Lopez	OHSU	Liaison OHSU	SR 11	TBD
Daryl Swensen	OSU	Marine Technician	SR 10	TBD
BERTHS FILLED	13			
BERTHS OPEN	1 (none on 01)			

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

Day 1: On arrival in the CRE, the ship will be anchored near 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 purpose is to test the observational system and to collect observations to compare with those from the Saturn 01 autonomous profiler. The RHIB will be used to deploy 4 acoustic transponders along the south slope of the N. Channel. This anchorage may last for most of the day. It is expected that we will relocate to a site a few miles to the west for the major operations, say in mid channel about 123° 54.6'W. See diagram below.

Day 2: AUV, WP, OT, CTD and ADCP time series of operations, profiles and water sampling will begin. The readiness and/or performance will determine the timing and duration of each operation in-water operation. Operational plans for later days will be developed based on weather conditions and the needs and performances of various systems.

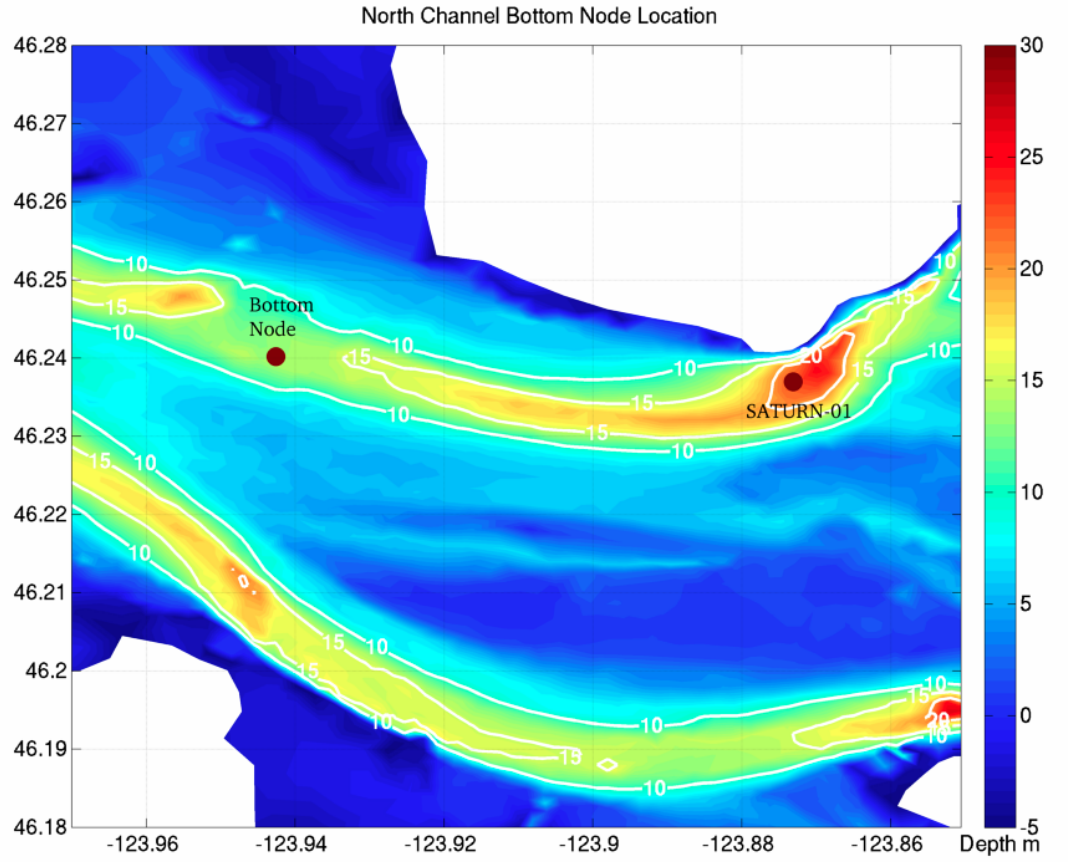


Figure 1

Schematic diagram of the N. and S. Channels of the CRE. The time series station is proposed to be in the middle of the N. Channel along meridian_123° 54.6'W. If the ETM not strongly present there, the anchor station will be moved west toward the Bottom node.

Winched Profiler:

The instrumentation outfitted with SBE 37 (T, S), SBE 43 (DO), SBE 7 (µconductivity), SBE 8 (µtemperature), SonTek ADV (U, V, W), APL turbulence (ε, KE dissipation rate), Wet Labs ECO Triplet (fluorescence and optical backscatter), LISST-100X (sediment content), BEI Motion Pak II (platform attitude), DataSonics PSA 910 (altitude), and Spartan compass (magnetic heading). The electric-hydraulic winch was refurbished and tested. A 20-conductor cable is the electrical and mechanical connection to the sensor platform. An aggregator box with 4 microprocessors and two serial data links has been designed and built. This unit takes the dozen or so analog or digital inputs and combines them into one of two serial data links that send data to the surface at 115.2 kbaud.

The Winched Profiler operations begin with system testing to confirm acceptable performance. Metrics will be comparisons of ADV in profiler mode with shipboard ADCP (especially the boom mounted unit), ship lowed sensors (CTD, FLNTU), and expected values of velocity and turbulence at various depths and stages of the tidal flow. It might be possible to compare the LISST-100X observations with the Owen Tube results. The initial evaluations are important to assure the best quality of measurements.

Two modes are envisioned: continuous profiling over a given depth interval or time series are at one or a few fixed depths or heights above the bottom. The normal operations will focus

on the period before, during and after the arrival of the ETM. The first cycle should include continuous profiling through a complete tidal cycle: flood through ebb to next (maybe through) flood. This operation will require 12.42 h or more. If probe damage is severe, the turbulence sensors (e.g., KE dissipation rate, SBE 7 & 8 micro T and C) will be reserved for ETM studies. When the WP is recovered, the normal CTD operations are possible from the starboard station.

Pacer Pump:

The Small Estuary CTD unit equipped with an SBE25 CTD, OBS, Fluorescence sensor, and a Wetlabs FLNTU (if possible) will be deployed with the A-Frame at slack tide before a targeted 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. The data cable for the CTD will also be clipped onto the winch cable. (note that the arrangement of tubing and data cable has to be worked out during the cruise). Vertical profiles of the water column will be conducted every 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 OBS sensor or FLNTU. Pump will be turned on and water collected from near-bottom depth before, during, and after an ETM resuspension event. Water may also be collected from surface waters periodically. Onboard analysis of samples will be performed 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 several different Owen Tube bottom withdrawal tubes deployed with the stern A-frame and an air tugger winch. We are testing several different Owen Tubes during this cruise to determine optimal sample collection methods. When Owen Tubes are being cast we will not be collecting water with the CTD-Pacer Pump arrangement. Once on deck the Owen Tubes are 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.

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).

Cruise Plan

Prior to April 28

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, near the Astoria Megler bridge (see Fig. 1), provides a key reference for the variability of channel conditions during the cruise – but might be too upstream to charaIt 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/fixedstation?id=saturn01
- **Bottom node**: This special-purpose station will be deployed in the lower North Channel (see Fig. 1). Instrumentation will include an upward-looking ADP and a bottom-installed CTD. There will be no telemetry, hence no real-time access to the data. Deployment is expected to be on or before April 26.
- **Sigma Profiler**: This bottom-mounted instrument determines the vertical profile of salinity using active electric current transmissions. A source of electric current provides electric fields at distances of 6 and 20 from transmitter to receivers.. This is scheduled for deployment on or before 28 April.
- **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/fixedstation?id=saturn02, Deployment is expected to be in the week of April 23.
- **A glider**: The glider will be deployed on the WA shelf, between Grays Harbor and Quinault. Sampling will follow a pattern similar to prior missions. The goal is to characterize the properties of the source water to the estuary, for northerly wind conditions. Data (salinity, temperature, CDOM, FLNTU, DO) will be available at http://www.stccmop.org/datamart/observation_network/glider in near real-time. Weather and other logistics permitting, the first deployment opportunity will be April 20.
- **SATURN-07**: Time permitting, this station will be deployed in Baker Bay, to begin addressing issues of exchange of sediments between this later bay and the North Channel. Measurements will include surface salinity, temperature, CDOM,

FLNTU, DO, phycoerythrin and multi-frequency chlorophyll. Data is expected to be available near real-time.

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

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

- http://www.stccmop.org/datamart/virtualcolumbiariver/forecasts/products?fcast=f26&run=today
- http://www.stccmop.org/datamart/virtualcolumbiariver/forecasts/products?fcast=f27&run=today

Collaboration between the CMOP field team and volunteer kayakers (POC: Antonio Baptista) might result in collection of biogeochemical in Baker Bay through an instrumented kayak ("Kiviuq"). The timing and pattern of sampling are at the discretion of the kayakers, within areas defined as of CMOP interest. The kayak is instrumented to measure near-surface values of salinity, temperature, CDOM, FLNTU, DO and phycoerythrin. Data is expected to be available near real-time, when the link is activated at http://www.stccmop.org/datamart/observation_network/kiviuq.

28 April 2012 Saturday

20:00 APL WP group arrives, checks into hotel. (One of the AUV team may need to drive down early Sunday morning; TBD).

29 April 2012 Sunday

08:00 Loading day in Newport. OHSU participants will arrive at 11:00.
13:00 Hold meeting with Captain Crews, Chief, ResTech, and Bos'n and discuss op plans
20:00 Scientists sleep on board ship

30 April 2012 Monday

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

01 May 2012 Tuesday

On arrival in N. Channel: Anchor at 46° 14.0'N, 123° 53.4'W
07:00 Test winched platform (WP) system, including real time display; Set up Owen tubes, CTD and Pacer pump.
10:00 Operate WP in continuous profiling and fixed height modes and test water sampling equipment during slack tide.

10:30 At slack tide deploy RHIB with small crane on aft starboard side in order to deploy acoustic transponders for AUV operations.
17:00 Begin flood tide ETM sampling. WP continuously in water operated in various modes. CTD profile every 30 min from A-frame. Bottom water collected with Pacer pump before, during and after ETM event.
23:00 End flood tide ETM sampling; WP obs continue through ebb tide the next morning

02 – 08 May 2012 First AUV deployments will occur May 02 (possibly starting as early as 06:00). Operations will continue in similar fashion but adjusted based on conditions and experience. The ship may reposition when the AUVs are not in the water. Owen Tubes will be cast from the A-frame during some days and tides. We have to determine if an Owen Tube can be cast during the same tidal series as the CTD.

08 May 2012
10:00 In anticipation of slack tide, deploy RHIB with small crane on aft starboard side in order to recover acoustic transponders for AUV operations at slack tide. If AUV operations occur this day, we would delay to 18:00 and coordinate with AUV recoveries.

09 May 2012
07:00 Transit to Newport

10 May 2012
07:00 Arrive Newport and demobilize

Data details:

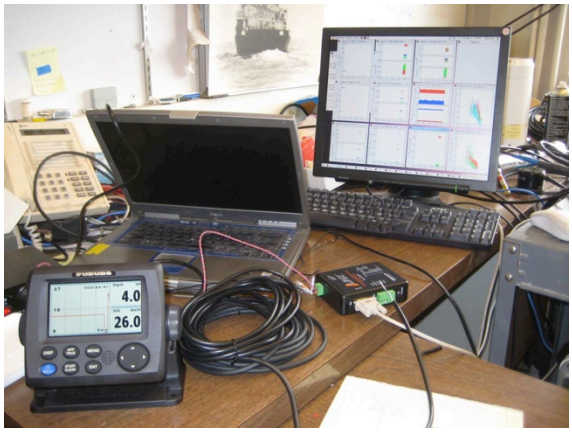
1. CTD casts will be denoted according to OSU method
2. Winch Profiler (WP) casts will be denoted with the same number while in the water. That is, WP1 lasts from the time the WP is prepared for deployment through when it is secured on the deck and turned off. The next deployment is WP2.
3. SP will be SP4 and have filenames that denote specific time periods of observations.
4. BN will be BN2 and have files archived with filenames that indicate the time interval.
5. Owen Tube (OT) stations will be named in a unique way, perhaps as done in the past.
6. Water samples collected with the Pump will be assigned CMOP Water Sample Numbers sequentially.
7. AVP or ADCP operated from the rail – TBD

Equipment pictures:

Winched Profiler: Winch, Tow Body and Sensors, Lab Processing and Display (at this time)

Winch and E-M cable

Tow Body



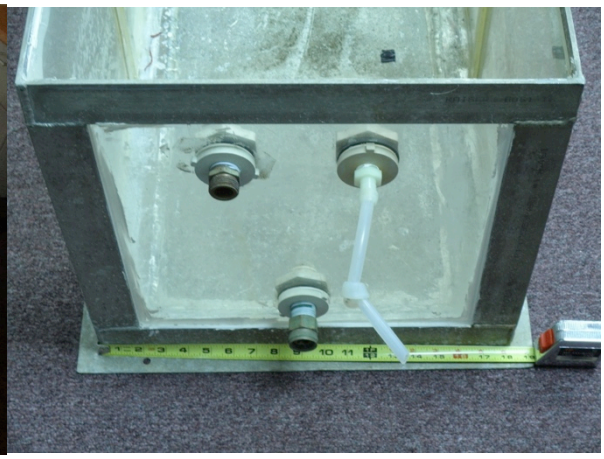
Sensors, processors and displays (some assembly required!)

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

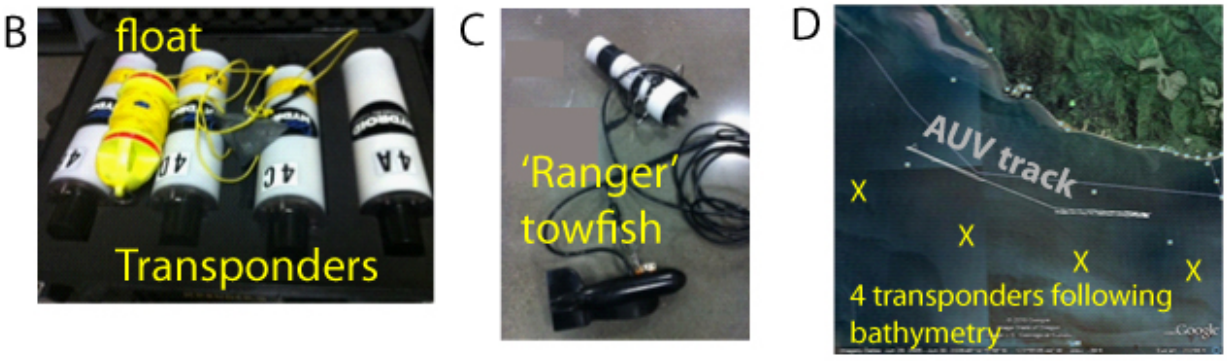
We attach the ends of a rigid tube to the CTD cage and to an impeller pump on deck. This tubing is paid out as the cage is lowered, and clipped onto the hydrowire. Our maximum deployment depth in the estuary is approximately 25m.

Deck Incubator

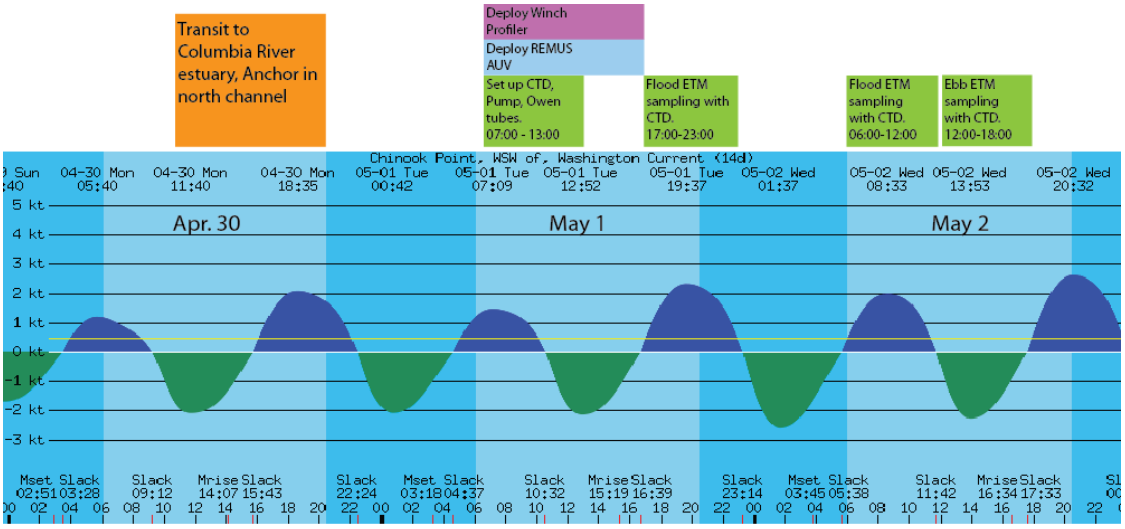


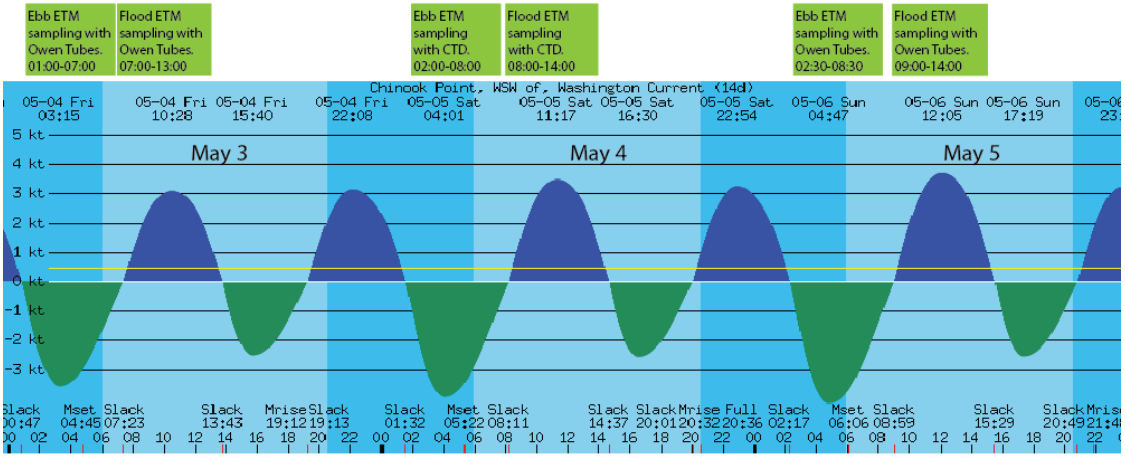
Owen Tubes
We are bringing a Standard Owen Tube, Quad Owen Tube, and a horizontal version of a General Oceanics bottle with a frame to hold it on deck

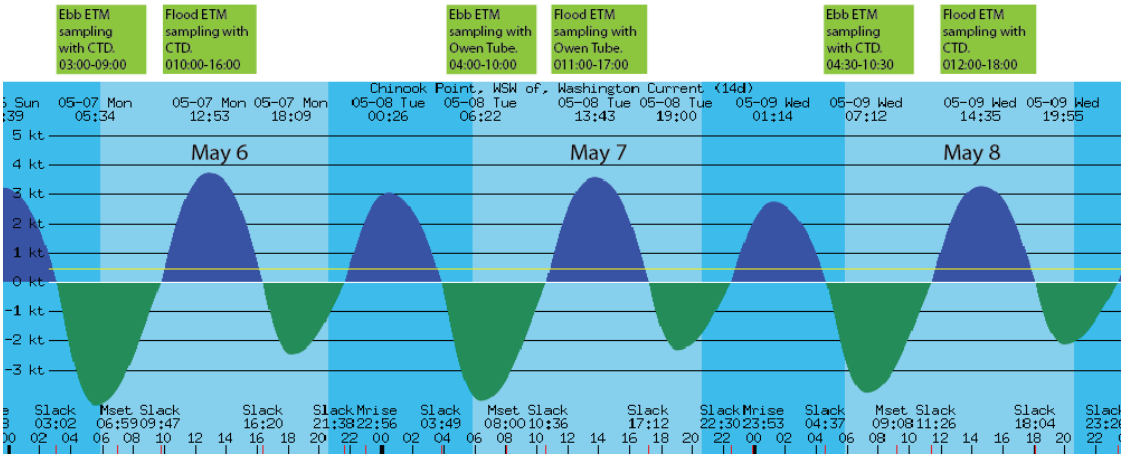
AUVs
Shown are: (A) the REMUS 100 Autonomous Underwater Vehicle; (B) navigation transponders, previously deployed in fixed locations on the south side of the north channel; (C) the 'Ranger', which is hung overboard while the AUVs are in water to allow acoustic communications with the vehicles and used 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.



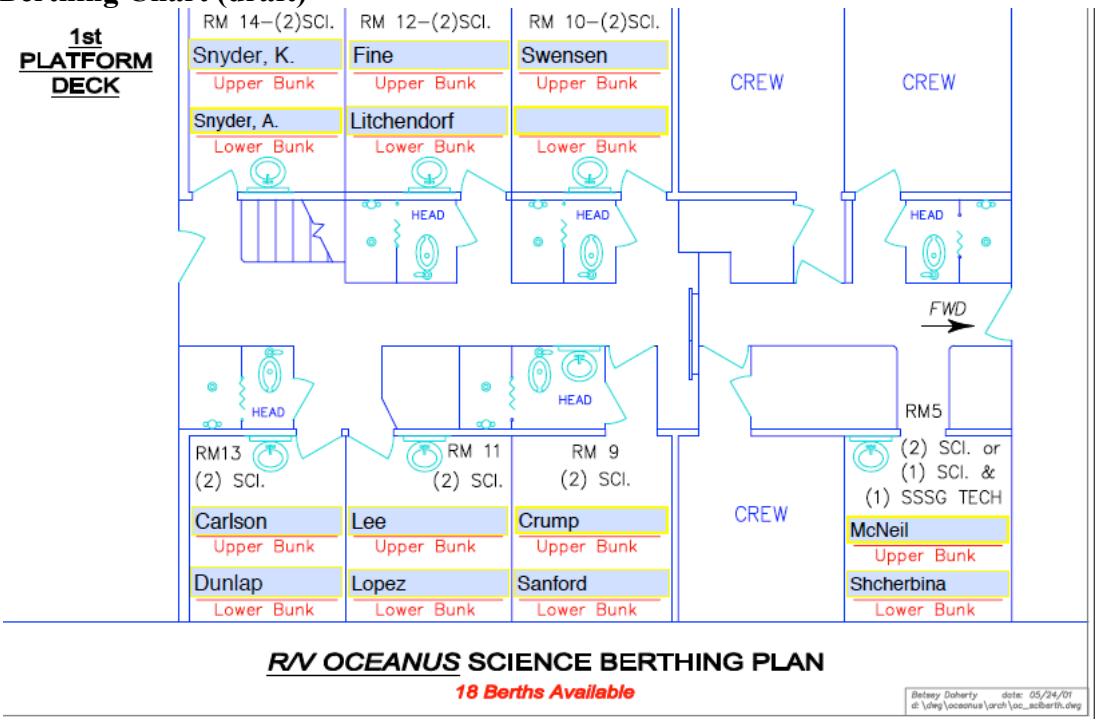
Current charts:







Berthing Chart (draft)



Lab Space arrangements