APPENDIX 2

CRUISE PLAN R/V *Oceanus*

Oregon State University
College of Oceanic & Atmospheric Sciences

FILING DATE:	22 October 2012
CRUISE NUMBER:	OC1210C
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 characteristics and transport, turbidity, optical and water properties, such as T, S and O_2
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:

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 that 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 equipped with the ship's sensor package and deployed with the stern A-Frame and a winch with conducting cable and a slip ring for power and data transfer. Tubing 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. An **Owen-style bottom withdrawal tube** (see picture below) will be deployed with the stern A-Frame and a winch (to be decided).
4. **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.
5. **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 (a) before, during and after ETM resuspension events using a Pacer pump linked to the small estuary CTD unit or (b) once during the ETM with an Owen-style bottom withdrawal tube.
6. **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).
7. **A Bio-Sonics 120 kHz backscatter system may be operated on a 2nd boom.**
8. 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 frame that houses an ADP, CTD and acoustic release, which will likely be deployed near the mouth of the N. Channel.

9. 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).
10. 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
Main crane (for deploying WP instrument package).
Knuckle crane for deployment of AUV and launch/recovery of Winched Profiler.
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
Winch with conducting cable for stern A-frame deployments

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
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:	Thomas Sanford (UW)
Other Scientist(s):	Craig McNeil (UW), Trina Lichendorf (UW), Nick Michel-Hart (UW), Tuomas Karna (OHSU)
Party Chief:	
Technicians:	James Carlson (UW), John Dunlap (UW), Avery Snyder (UW), Keaton Snyder (UW),
Grad Students:	Lindy Fine (UMCES), Michelle Stuart (UMCES), Nathan Lauffenburger (UW)
Undergraduate Students:	Kristina Remple (OHSU)
Observers:	Possible daytime visit by radio or TV personnel and Jeff Schilling of CMOP (daytime only)

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:	~1000 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*
25 October – 3 November 2012

Area of Operations: Columbia River estuary

Scientific personnel.

Name	Inst	Activity	Berth	Watch
Tom Sanford	UW	Chief Sci.	SR 9	TBD
Craig McNeil	UW	AUV lead	SR 5	TBD
John Dunlap	UW	WP engineer	SR 12	TBD
James Carlson	UW	WP engineer	SR 12	TBD
Avery Snyder	UW	WP engineer	SR 14	TBD
Keaton Snyder	UW	WP winch operator	SR 14	THD
Nate Lauffenburger	UW	WP grad student	SR 9	TBD
Trina Litchendorf	UW	AUV engineer	SR 13	TBD
Nick Michel-Hart	UW	AUV engineer	SR 5	TBD
Lindy Fine	UMCES	OT/CTD ops -lead	SR 11	TBD
Michelle Stuart	UMCES	OT/CTD ops	SR 11	TBD
Tuomas Karna	OHSU	Liaison OHSU	SR 05	TBD
Kristina Remple	OHSU	Tebo Stud sampler	SR 13	TBD
Daryl Swensen	OSU	Marine Technician	SR 10	TBD
BERTHS FILLED	14			
BERTHS OPEN	0 (Incl.,SR 5)			

Shifts and Activities

Watches: TBD, 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

26 October (Day 2): On arrival in the CRE, the ship will be conduct a brief fathometer survey to determine the deepest part of the channel (i.e. thalweg) near 46º 14.014'N, 123º 52.80'W, which is just west of the A-M Bridge Pier 11 (46.234981º N, 123.871947º W) where Saturn 01 is operating. The Sigma Profiler will be deployed during slack before ebb tide after 1200. Next the ship will be anchored in the thalweg, a bit downstream of the Sigma Profiler. say along meridian 123º 52.84'W (123.88ºW). This will be followed by profiling with the Winched Profiler and preparation for the biogeochemical sampling on the fantail. The purpose is to test the observational systems 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 (i.e., in the thalweg) about 46º 14.018'N, 123º 54.862'W, where we will conduct another brief fathometer survey to determine the deepest portion of the local channel. See diagram below.

October 27 (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.

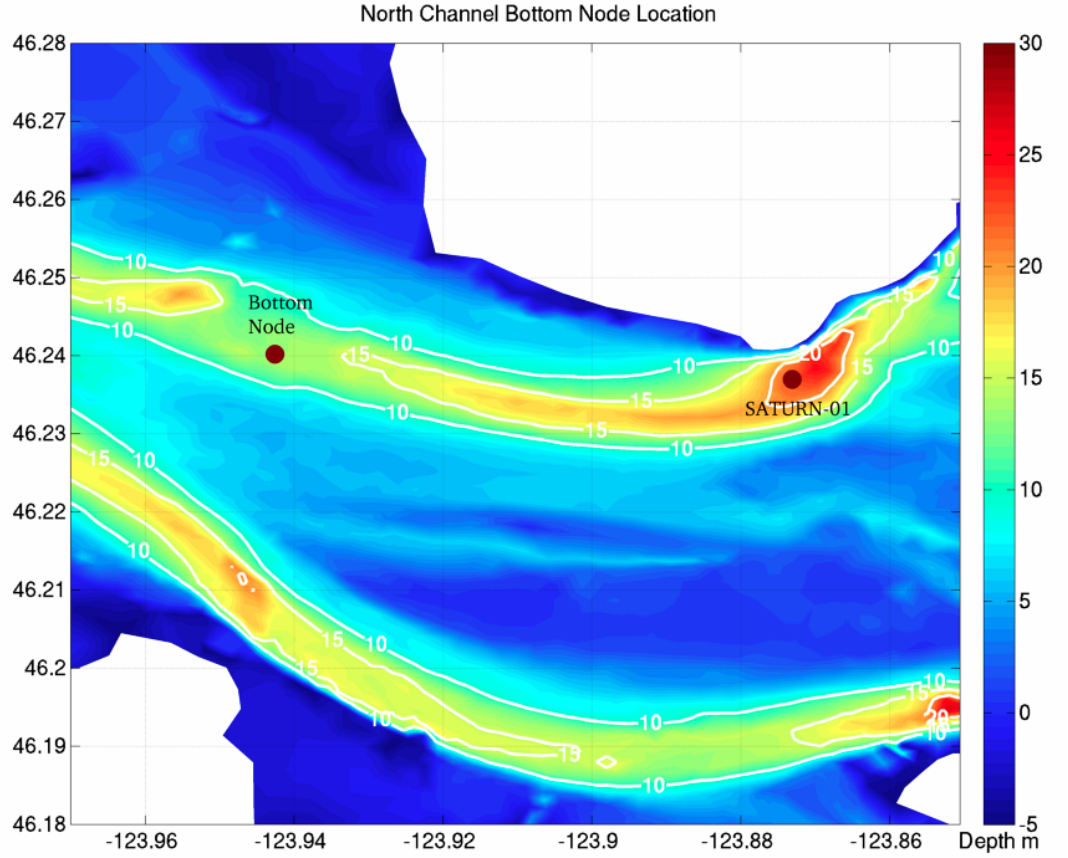


Figure 1

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° 52.84'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), Wet Labs FLNTU (turbidity), LISST-100X (sediment characterizations), 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.

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 instrument will be deployed from the R/V *Oceanus* just west of Saturn 01. In May the first anchor went in at 46° 13.986'N, 123° 52.720'W, and the second anchor went in at 46° 13.980'N, 123° 52.657'W.

Pacer Pump:
The Small Estuary CTD unit equipped with the Ship's SBE-43 CTD, C-Star transmissometer, WETStar fluorescence sensor, and either an OBS sensor or a Wetlabs FLNTU 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 unit will be deployed with a conducting cable and winch connected to the ship's computers to monitor sensor readings. 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. Water will be used for chemical and biological measurements, nucleic acid samples, and onboard analysis of samples 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 tube deployed with the stern A-frame and an air tugger winch. When the Owen Tube is 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 will target ETM events 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 October 25, 2012

The CMOP field team (POCs: Michael Wilkin, Katie Rathmell 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 characterize our anchor station. 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/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 26 October.
- **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 25 Octobr.

- **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 25 October or early on 26 October.
- **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.

23 Oct. 2012 Tuesday

20:00 APL WP group arrives, leaves flatbed truck at Hatfield Marine Facility, checks into Shilo Inn,

24 Oct. 2012 Wednesday

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
15:00 (or sometime in afternoon).
20:00 Scientists sleep on board ship

25 Oct. 2012 Thursday

08:00 OSU Radiation Safety Officer Rainier Farmer delivers isotopes to ship.
09:00 Deadline for all hands on board. Anyone not shipping out should be off the ship.
10:00 Throw off lines and leave dock
10:30 Conduct boat drills and safety lecture – perhaps before leaving harbor. All science party must try on survival suits once per year on the R/V *Oceanus*

26 Oct. 2012 Friday

On arrival in N. Channel: Anchor at near 46° 14.0'N, 123° 53.4'W or jog in place

05:00 Conduct bathy survey to locate N. Channel thalweg on meridians: 123° 53.4'W and 123° 52.8'W
08:00 Test winched platform (WP) system, including real time display; Set up Owen tubes, CTD and Pacer pump.
1000-1400 Deploy AUV acoustic transponders on S side of N. Channel using ship's RHIB
1200 Deploy Sigma Profiler in thalweg near Saturn 01 on A-M Bridge in early ebb flow
1300 Anchor vessel and operate WP in thalweg along meridian 123° 52.84'W for continuous profiling and fixed height modes and test water sampling equipment during slack tide and continuing into the next day.

27 Oct. – 01 Nov. 2012 First AUV deployments will occur Oct 27 (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. The Winched Profiler will be operated as much as possible, with interruptions to repair sensors or when operations would interfere with vessel movements or other program requirements. CTD-pump assembly and Owen Tubes will be cast from the A-frame during alternate days and tides based on this tentative schedule to capture stronger floods and ebbs:

26 Oct. CTD-Pump targeting flood ETM starting at ~20:00
27 Oct. CTD-Pump targeting ebb ETM starting at ~12:00
28 Oct. Owen Tube targeting flood ETM starting at ~21:00
29 Oct. Owen Tube targeting ebb ETM starting at ~13:00
30 Oct. CTD-Pump targeting flood ETM starting at ~22:00
31 Oct. CTD-Pump targeting ebb ETM starting at ~14:00
1 Nov. Owen Tube targeting flood ETM starting at ~23:00
2 Nov. Owen Tube targeting ebb ETM starting at ~15:00

02 Nov. 2012 Friday

10:00 In anticipation of slack tide at 1120, 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.

1800 Depart Columbia River – time depends on bar conditions

03 Nov. 2012 Saturday

08:00 Arrive Newport – arrival time depends on CR departure and Newport bar conditions
Demob operations begin when vessel is secured,

04 Nov. 2012 Sunday

08:00 Demob continues as needed

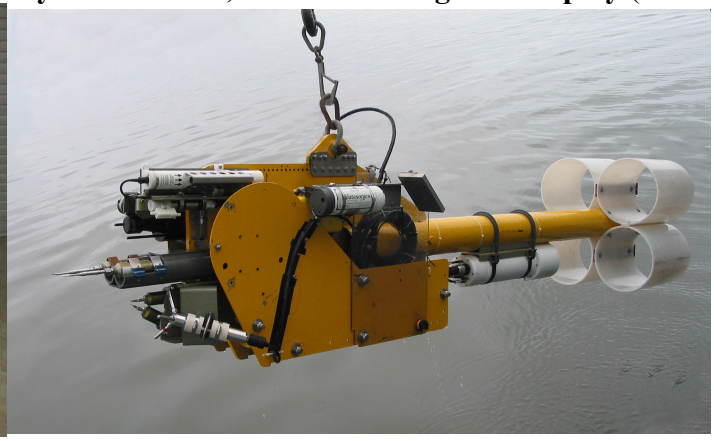
Data details:

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 with complement of sensors

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 maximu
m deployment depth in the estuary is approximately 25m.

Owen Tubes

We are bringing a horizontal version of a General Oceanics bottle with a frame to hold it on deck. This bottle comes with a steel rack that will be attached to the deck with deck screws.

AUVs

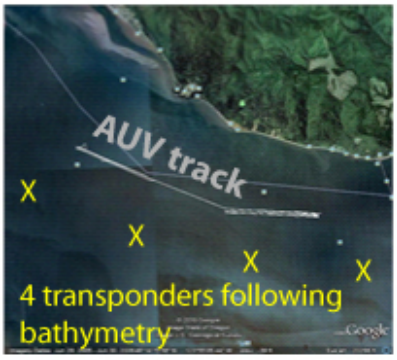
Shown are: (A) the REMUS 100 Autonomous Underwater Vehicle; (B) navigation transponders, previously deployed in fixed locations on the south side of the north channel; (C) the 'Ranger', which is hung overboard while the AUVs are in water to allow acoustic communications with the vehicles and used on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

A

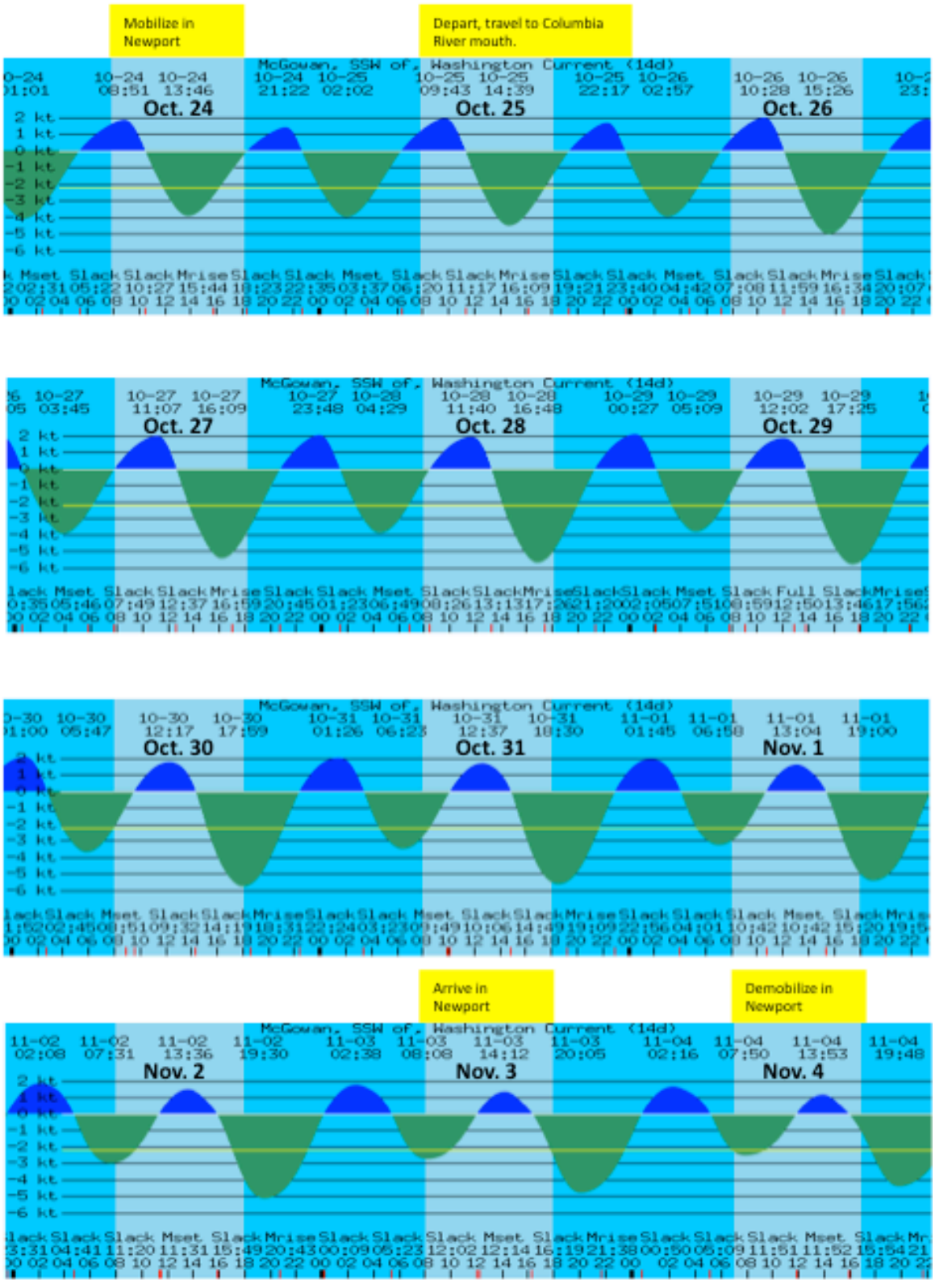
B

C

D

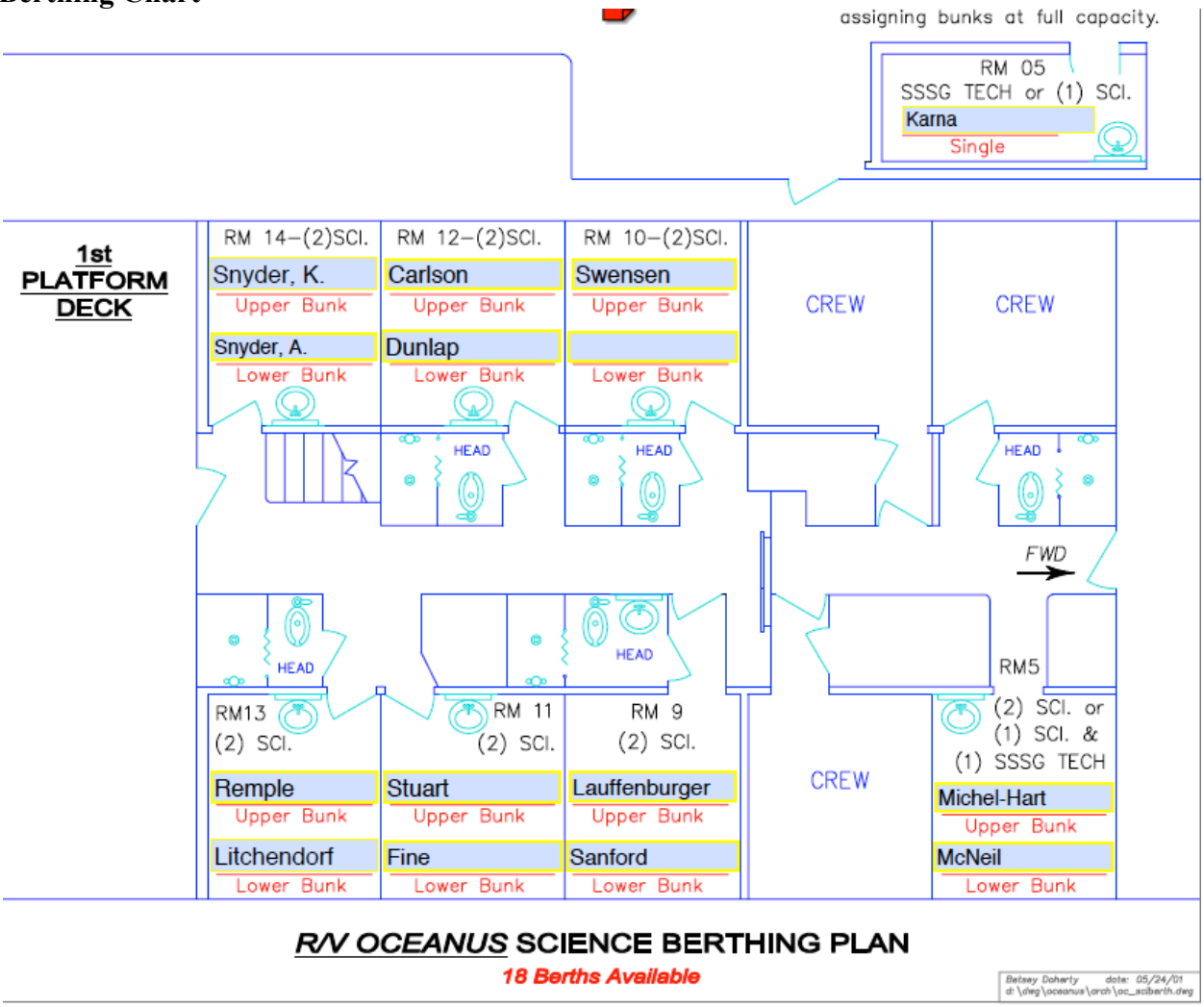


Current charts:



McGowan tidal currents near A-M bridge. Time is local (PDT)

Berthing Chart



Lab Space arrangements