

Northwest National Marine Renewable Energy Center

University of Washington, Seattle, WA 98195

Research Cruise Report

Admiralty Inlet, Washington

November 10-12, 2009

R/V Jack Robertson, University of Washington Applied Physics Lab



Survey Crew

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Cruise Summary

From November 10-12, 2009 the R/V Jack Robertson was on station in northern Admiralty Inlet conducting studies in support of Snohomish Public Utility District's license application for the deployment of 1-2 OpenHydro hydrokinetic turbines. In addition to the standard suite of measurements, several novel ship-based measurements were demonstrated. The instrumentation tripod was recovered from the seafloor and redeployed for continued site monitoring. There were several lessons learned, predominantly with respect to recovery and redeployment procedures for the tripod.

1 Daily Operations Summary

1.1 November 9, 2009

R/V Jack Robertson moved from APL dock (2130) to Shilshole marina (2230) for early transit to site.

1.2 November 10, 2009

R/V Jack Robertson underway at 0500 and on-station collecting shipboard ADCP data by 0930.

Temporary mooring deployed at approx. 0930 (for later use by BioSonics survey vessel).

Playback of Southern Resident Killer Whale (SRKW) vocalizations for 10 minutes (0952 – 1005) to test range of Port Townsend cabled hydrophone and sensitivity of Loggerhead (note: Loggerhead switched off due to depleted batteries shortly before calls were transmitted).

Initial attempts to trigger seafloor instrument tripod acoustic release mechanism for recovery float and line during 1030 – 1230 slack was not successful. Rough seas, with breaking waves and substantial transducer wire-angle caused by differential movement between ship (driven by winds) and transducer (driven by currents) likely hindered acoustic transmissions. Future operation in mixed seas might be improved by using a sea-drogue to align and slow the drifting vessel.

Conducted CTD cast from 1240 – 1315 to test instruments prior to bottle cast.

Second [unsuccessful] attempted instrumentation tripod acoustic release around 1430 when waves decreased temporarily, but currents flooding at 1.5 m/s, and associated flow noise, likely hindered acoustic transmissions .

Shipboard hydrophone survey from 1430 to 1610 (free drifting).

1.3 November 11, 2009

R/V Jack Robertson underway at 0605. Stephanie Downey aboard to assist with survey work as part of volunteer activity by Seattle Central Community College.

Conducted duplicate CTD casts around 0645. All wet chemistry complete by 0820.

Racetrack velocity survey (shipboard ADCP) with CTD cast at end of each lap. Seven laps and six casts. See notes under lessons learned regarding sensor configuration.

Opportunistic hydrophone survey of passing USN submarine at 1100.

Tripod recovery operations began at 1115 and instrument package back on deck by 1200. See notes under lessons learned regarding acoustic release sensitivity. Winch control failed during recovery, requiring that winch be actuated manually from below decks.

Nine additional racetrack surveys from 1320 to 1700.

Spar buoy deployed for free drift with ADCP and hydrophone from 1630 to 1715.

R/V Jack Robertson returned to Port Townsend at 1815.

1.4 November 12, 2009

R/V Jack Robertson underway at 1015.

Tripod redeployment operations began at 1153 and the tripod was redeployed at 1206, 145m SE of previous deployment at 48 08.862N 122 41.417W. See notes under lessons learned regarding tripod deployment.

Temporary anchor recovered at 1245.

Simulated SRKW call at 100m from tripod deployment at 1300.

Tested towfish equipped with CTD from 1300 to 1400, towing against current and with current.

R/V Jack Robertson departed Admiralty Inlet at 1410 and returned to APL dock at 1900.

2 Shipboard Surveys

2.1 Water velocity

Sixteen “racetrack” velocity surveys were conducted over two days. These surveys were repeated over a relatively short (600m x 400m) circuit in an attempt to better understand phase and amplitude variations in the tidal currents within the survey area.

2.2 Water quality

As with previous cruises, the main water quality cast involved a duplicate cast, during which water samples were collected near the seabed, at 30m from the surface, at 10m from the surface, and at 3m from the surface. Wet chemistry was performed on board to preserve the samples for transit back to the University of Washington’s marine chemistry lab. Additionally, during one set of racetrack surveys, water quality casts were conducted at the end of each circuit to quantify changes in stratification over the tidal cycle.

2.3 Ambient noise

Several ambient noise surveys were carried out over the side of the R/V Jack Robertson with the ship drifting with the currents. In particular, measurements on Tuesday, November 10, were obtained during a period of elevated ambient noise (white capping, strong wind). During ambient noise surveys, the AIS receiver (see section 2.4) logged the course and speed of large vessels transiting through Admiralty Inlet to accurately quantify the distance between noise sources and the receiving hydrophone.

Additionally, an underwater projector (supplied by Beam Reach) was used to play back calls from Southern Resident Killer Whales over two 10 minute periods. The objectives of the simulated calls were to (1) better understand the capability of the Loggerhead recording hydrophone on the tripod to hear SRKW calls and (2) determine whether the Port Townsend cabled hydrophone could hear SRKW calls in the project area. Playback was conducted during a period in which SRKW were understood to be far removed from the project area. The simulated calls were successfully detected by the Port Townsend hydrophone. Detection by the Loggerhead will be determined when it is recovered in Feb 2010.

2.4 AIS receiver

An AIS (Automatic Information System) receiver was tested throughout the cruise. AIS transponders are required by the US Coast Guard on all vessels greater than 300 tons gross weight. The receiver will be deployed on Admiralty Head and connected to a computer to log ship traffic throughout Admiralty Inlet starting in late November 2009. Receiver output agreed well with visual observations and the AIS receiver integrated into the R/V Jack Robertson’s navigation systems.

2.5 Spar buoy

A spar buoy equipped with an ADCP and hydrophone was deployed briefly during the cruise. This survey technique is intended to deploy a hydrophone in a drifting configuration so that measurements are not contaminated by flow noise, even during periods of high currents. Unfortunately, during the brief test, the hydrophone did not deploy and no acoustic data were obtained. However, the spar buoy infrastructure, including a prototype AIS transponder supplied by Shine Micro, Inc., performed well and the system will be redeployed during the February cruise.

2.6 Tow fish

A towfish, which is a fixed-pitch profiler towed over the vertical structure of the water column, was tested in expectation of future fundamental research studies. The primary objective was to understand the operational constraints on a towed array in a high speed, sheared flow. Data were logged by a SeaBird 19 during this test. During future deployments, it would be preferable to monitor the instrument's performance in real time using the R/V Jack Robertson's conducting winch. The towfish maintained substantial wire gage both with and against the current, and thus significant wire, up 1:10 ratio, will be required to obtain complete profiles. A towed body with real-time pitch control would be preferable.

3 Instrumentation Package

3.1 Instrument status

During this deployment, tripod instrumentation consisted of:

- ADCP (300 kHz RDI workhorse, 2:15 ensembles): velocity
- CTD (Star Oddi DST): salinity, temperature, pressure
- CTDO (SeaBird 16+): salinity, temperature, pressure, dissolved oxygen (on loan from WA Dept. of Ecology)
- Fish tag receiver (Vemco VR2W): fish tag detections (on loan from NOAA: National Marine Fisheries Service)
- Echolocation hydrophone (Chelonia TPod): analog echolocation hydrophone
- Echolocation hydrophone (Chelonia CPod): digital echolocation hydrophone
- Hydrophone (Loggerhead, 1% duty cycle, 1 stuttered min every 10 mins): ambient noise

Upon recovery, all instruments were functional and data were offloaded successfully. As with other deployments, the housing for the CTD was somewhat fouled by sediment, but the conductivity sensor contacts were clear.

3.2 Instrument replacement/reconfiguration

Several pieces of instrumentation were changed out or reconfigured:

- Fish tag receiver exchanged for an identical unit from NMFS
- CTDO exchanged for identical unit from WA Dept. of Ecology
- ADCP exchanged for identical unit from WA Dept. of Ecology and reconfigured to store ensembles every 0:45
- Hydrophone reconfigured to record noise at 80 kHz continuously over 7 seconds every 10 minutes to better resolve low frequency ambient noise (i.e., no stutter)
- Sediment trap added to instrumentation matrix

3.3 Platform condition

The tripod platform was visibly less fouled than during the May-August deployment, possibly due to reduced biological productivity in the fall months; minimal barnacle growth, fewer snails and krill. One large mollusk was attached to the underside of the frame. Stainless steel mounting hardware showed little corrosion. Aluminum mounting rails continued to corrode, with the mount for the CTDO corroding at a faster rate than the mounts for the retrieval lines. Eye thimbles on recovery lines showing some corrosion after > 200 days deployment and were replaced.

4 Dockside Tests

4.1 Flow noise mitigation

Analysis of hydrophone data obtained during May-Aug deployment indicated that above 1.5 m/s recordings were contaminated by self-noise (i.e., the noise you hear when riding a bicycle). In other situations where this has been identified as a problem, researchers have suggested that covering the hydrophone with porous foam significantly reduces self-noise. This approach was tested and determined to result in a non-linear distortion of received sound. Therefore, a decision was made to redeploy the hydrophone without any foam covering.

5 Lessons Learned

5.1 Acoustic release sensitivity

On Tuesday, November 10, attempts to trigger Benthos acoustic releases on the instrumentation tripod were unsuccessful, because of significant ambient noise and a high wire angle for the transducer relative to the R/V Jack Robertson due to differential movement of the transducer and vessel. The Robertson's movement was dominated by wind, while the transducer's was dominated by drag on the transducer and cable. Conversations with other researchers and technicians at Benthos confirm the acoustic releases are sensitive to ambient noise.

On Wednesday, November 11, recovery operations began with currents > 1 m/s. Several passes over the tripod's deployed location appeared to not trigger the first release. Switched to second release as current velocity dropped and shortly thereafter both floats appeared at the water surface. Drag on the retrieval lines was sufficient to barely allow buoys to surface and thus made visual spotting difficult. Currents still at elevated levels during float retrieval, with significant drag on the recovery lines (1/4" spectra, 120 m in length).

Two lessons are learned here. (1) Attempting to recover the tripod in anything other than relatively quiescent conditions is unlikely to succeed and should not be attempted during future cruises. (2) Tripod recovery should not begin while currents are > 0.75 m/s and no attempts should be made to ping for the backup release until several passes have been made over the deployment site. While this recovery was successful, had the recovery lines of the two floats fouled badly, it is possible that neither buoy would have reached the surface. Of course, with such short periods low current at the site, it is as easy to be late for a recovery as it is to be early. Future cruises should be planned around periods of strong diurnal inequality, when slack water is effectively protracted well beyond the typical 10 min window.

5.2 Water sampling sensors

The fluorometer (chlorophyll) and OBS (turbidity) sensors were connected to the SeaBird 911+ using a Y-cable due to a lack of dedicated voltage channels. While the instruments appeared to function correctly during dockside tests and a test cast on November 10, subsequent removal of the OBS sensor and direct connection of the fluorometer to the 911+ revealed that the Y-cable impeded the function of both instruments. Bottle samples indicate turbidity throughout the water column of < 1 NTU, which calls into question the usefulness of deploying a sensor with a range of 0-2000 NTU. For quantities which are expected to be on the lower end of the detection range for instruments (which is the case for both chlorophyll and turbidity this time of year), dockside and shipboard tests may be misleading. A more robust testing procedure is desirable.

Problems with the water quality rosette, which have been experienced during several surveys, should be rectified by the purchase of dedicated equipment by the Applied Physics Lab prior to the February, 2010 research cruise.

5.3 Tripod deployment

On Thursday, November 12, deployment operations began with currents > 1 m/s. Consequently, when the tripod reached the seabed, the Robertson's speed over ground remained significant and the package was pulled along the seabed for a short time before the acoustic release fired (third attempt). Deployment was complicated by technical problems with dive camera mounted to the load bearing release. In future cruises, once an area of the seabed has been characterized by ROV surveys (as this deployment location has been), the dive camera should not be used, as it constitutes a significant distraction during deployment operations. Tripod deployment should also not be attempted until currents are < 0.5 m/s (water column average) to avoid pulling the instrumentation along the seabed prior to release and minimize the potential for flow noise to interfere with the acoustic release signal. Again, future operations should be scheduled to take advantage strong diurnal inequalities in Puget Sound tides.

The February cruise has been planned during a period of significant diurnal inequality, such that daylight hours will contain one strong tidal cycle and one very weak one, which will greatly increase the deployment/recovery window for the tripod, easing the time pressures experienced during this cruise.