

Northwest National Marine Renewable Energy Center

University of Washington, Seattle, WA 98195

Research Cruise Report

Admiralty Inlet, Washington

August 17-18, 2010

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



Survey Crew

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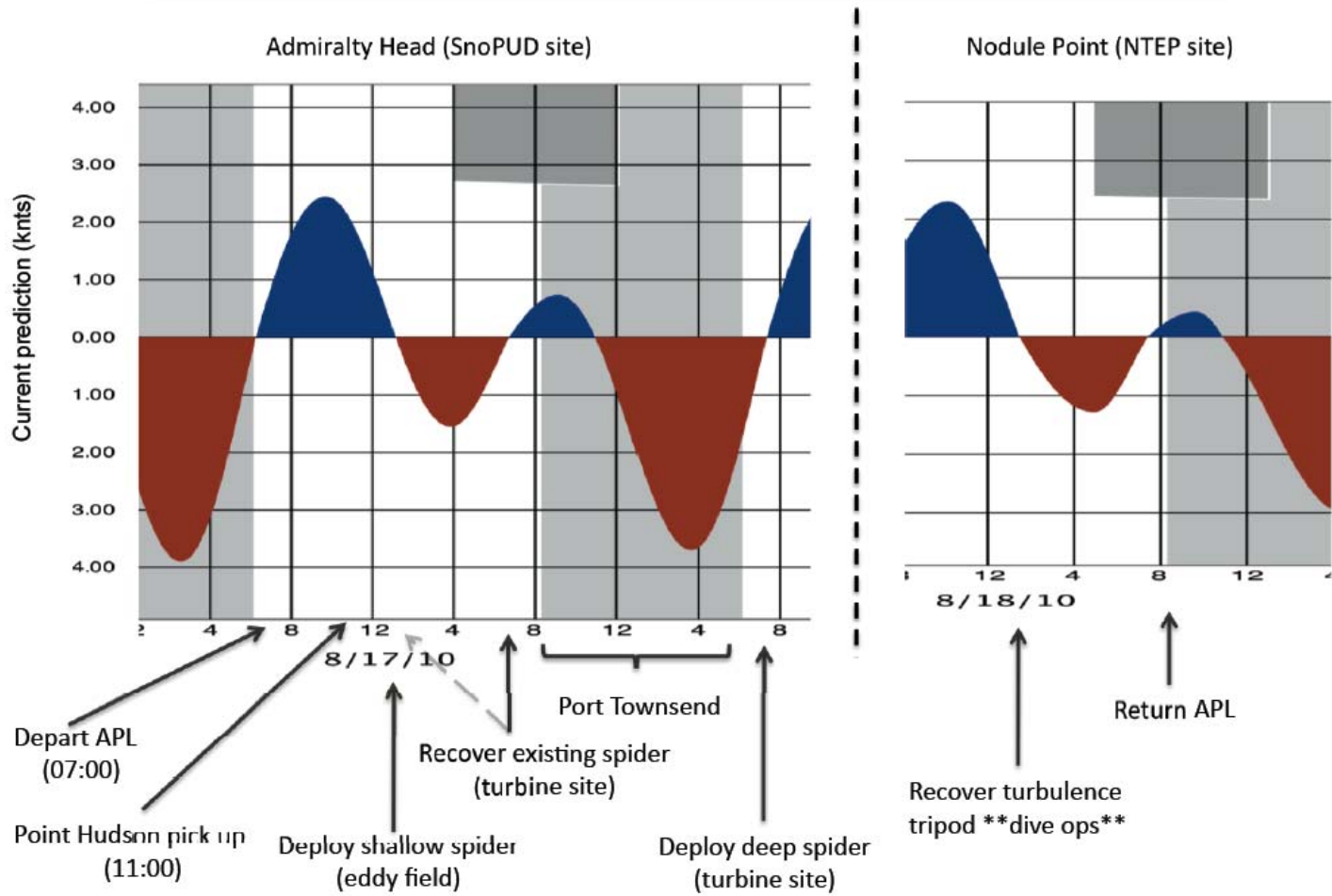
Cruise Summary

From August 17-18, 2010 the R/V Jack Robertson was on station in northern Admiralty Inlet for the retrieval and deployment of instrumentation in support of Snohomish Public Utility District's license application for the deployment of two OpenHydro hydrokinetic turbines. The Sea Spider recovered on August 17 was significantly fouled by red algae, sediment, and krill. Analysis of instrumentation data suggests the tripod was transported 90m to the northwest during an exceptionally strong turbulent burst 64 days into the 103 day deployment. Two new Sea Spiders were deployed, one in shallow water off Admiralty Head to gain a better understanding of ambient noise in the absence of pseudo-sound created by strong currents and the other at the center of the project area. On the afternoon of August 18, 2010 an attempt to recover the larger turbulence tripod off Marrowstone Island was not successful, although the tripod was successfully located and visually confirmed to be intact. All instrumentation had been recovered from this tripod during separate operations in late May.

Cruise Plan

Admiralty Inlet Survey & Turnaround

R/V Robertson, Northwest National Marine Renewable Energy Center (UW)



1 Daily Operations Summary

1.1 August 17, 2010

R/V Jack Robertson departed APL dock at 0600 and transited to Port Townsend. Picked up two representatives from WA Dept. of Ecology and one visitor from the White House Office of Science and Technology Policy.

On station off Admiralty Head at 1115 for Sea Spider deployment. Shallow water Sea Spider (Mark II) deployed at 1150 in approximately 30 meters of water.

Began retrieval operations for Sea Spider (Mark I) at 1205. Sea Spider back on deck at 1305. Problem with primary recovery buoy discussed under Lessons Learned.

Commercial ROV survey vessel also on site, starting at 1200. Unsuccessful hailing on VHF, called via cellular (206-235-5809) and spoke with chief surveyor Eric Crumpton. Agreed to coordinate future operations and provide location of new sea spiders.

Arrived back at Point Hudson Marina at 1330.

1.2 August 18, 2010

R/V Jack Robertson underway at 0550.

Deep water Sea Spider (Mark II) deployed at 0635 in approximately 55 meters of water. Deployment point was within 10 meters of previous deployment. Sent locations to ROV survey crew.

Successful range testing of new acoustic releases from 0700 to 0720, then departed area.

Anchored off Nodule Point on Marrowstone Island for turbulence tripod recovery operations at 0815. Dive operations at 1230 were successful in locating tripod and attaching recovery line. However, the line parted during retrieval and a second dive operation at 1310 was unsuccessful in locating the tripod due to increasing current strength. Recovery postpone indefinitely.

R/V Jack Robertson departed Nodule Point at 1510 and arrived back at the APL docks at 1930 after delay at the Ballard Locks.

2 Shipboard Surveys

No shipboard surveys were conducted during this cruise. Operations were limited to instrumentation deployment and recovery.

3 Sea Spiders

3.1 Instrument status

During this deployment, tripod instrumentation consisted of:

- ADCP (300 kHz RDI workhorse, 1:00 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 VR2): 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, 7 seconds continuous recording every 10 minutes): ambient noise

Upon recovery, all instruments were functional and data were offloaded successfully. However, several problems were subsequently identified:

- The CTD did not deploy correctly (software glitch or user error) and recorded pressure, conductivity, and temperature every 10 seconds, rather than every 10 minutes. The recorder memory filled 12 days into the deployment. Due to poor performance, the use of this device will be discontinued.
- The ADCP compass does not appear to have functioned correctly. After the tripod spun ten days into the deployment and achieved a more stable footing, the compass did not correctly account for the new orientation and measures a new principal axis for current direction. This was corrected during post-processing.
- The Sea Spider appears to have moved approximately 90 meters to the northwest 64 days into the deployment. Movement occurred during an exceptionally strong turbulent fluctuation when near-seabed velocities exceeded 2.8 m/s. Consequently, ADCP and acoustic data are analyzed as two separate data sets for this deployment.

3.2 Instrument replacement/reconfiguration

This recovery marked the end of service for the Mark I Sea Spider. Two Mark II Sea Spiders were redeployed as replacements. The primary deployment is at the center of the proposed deployment area for the two OpenHydro turbines and is intended to characterize the biological and physical environment which will be encountered by the turbine. The secondary deployment is in shallower water off Admiralty Head and is intended as a control location to characterize propagating underwater noise generated by strong currents in the central inlet.

Primary Sea Spider – deployed in 55m of water

- ADCP (475 kHz Nortek, 1:00 ensembles): velocity
- CTDO (SeaBird 16+): salinity, temperature, pressure, dissolved oxygen (on loan from WA Dept. of Ecology)
- Onset CT: temperature (salinity also recorded, but standard conditions exceed maximum range)
- Fish tag receiver (Vemco VR2W): fish tag detections
- Echolocation hydrophone (Chelonia TPod): analog echolocation hydrophone
- Echolocation hydrophone (Chelonia CPod): digital echolocation hydrophone
- Two hydrophones (Loggerhead, 7 seconds continuous recording every 10 minutes): ambient noise, focus on applying coherence method to remove pseudo-noise from recordings

Secondary Sea Spider – deployed in 30m of water

- ADCP (600 kHz Nortek, 1:00 ensembles): velocity and wave spectra
- Onset CT: temperature (salinity also recorded, but standard conditions exceed maximum range)
- Fish tag receiver (Vemco VR2W): fish tag detections
- Echolocation hydrophone (Chelonia CPod): digital echolocation hydrophone
- Hydrophones (Loggerhead, 7 seconds continuous recording every 10 minutes): ambient noise

3.3 Platform condition

The Sea Spider and instrumentation were heavily fouled during this deployment. While the May to August period is the most biologically active in Puget Sound, more biofouling was experienced than during the same period in 2009. This is likely indicative of annual, rather than spatial, variability, as the deployment location between 2009 and 2010 varied by only a few hundred meters. Several chitin, approximately 2" in length were attached to the fiberglass frame, lead ballast, and instrument pressure cases. The recovery buoys, fiberglass frame, composite material samples, and instruments were, in general, fouled by red algae, which served as an aggregation site for sediment and krill.

4 Tidal Turbulence Tripod

An attempt was made to recover the Tidal Turbulence Tripod (TTT) on August 18, 2010. This tripod was deployed in early May and instrumentation (ADV, ADCP, and CTD) recovered towards the end of the month. While the dive operation to locate and recover the tripod was successful, the recovery line unexpectedly parted while the tripod was being winched aboard. A second dive operation could not reach the tripod due to increasing current strength. Additional attempts to recover the tripod will be made in November, 2010.

5 Lessons Learned

5.1 Deployment operations

The current emphasis on collecting data at a single location over multiple deployments requires considerable precision and patience during tripod deployment. Due to the complexity of mounting dive cameras to the tripod, the present approach is to lower the tripod to within 5 meters of the seabed and allow the R/V Jack Robertson to drift with currents until nearly over the deployment mark, at which point the tripod is lowered the rest of the way to the seabed and released. During the deployment of the shallow water tripod, the ship's depth sounder was being used to track the tripod depth. However, this led to premature contact between the tripod and seabed because the depth sounder was getting a hard return off the acoustic release floats. These are mounted several meters above the tripod.

Subsequent operations, including the deep water tripod deployment, used two, independent measures of tripod depth. The first is the ship's echosounder, as this has been used successfully in several prior deployments. The second is markings in 5 meter increments on the deployment line. A similar check could be implemented with a meter wheel, if available.

5.2 Importance of redundancy

The Sea Spider incorporates a redundant recovery system. During recovery, a coded acoustic pulse is received and releases a float. This float trails a spectra line behind it and is used to pull the tripod back up on deck. During recovery operations for the Mark I Sea Spider, the primary float did not surface after multiple attempts. The backup release did function and the Sea Spider was recovered. Upon retrieval, it was determined that the primary release mechanism had functioned correctly, but that the float was connected to the wrong end of the retrieval line. Consequently, the float buoyancy was insufficient to pull cordage from the line canister (more than 100 pounds of force would have been required).

This problem was caused by operator error during preparation for deployment and is a relatively easy (though uncommon) mistake to make. This reinforces the need for redundant recovery systems as there

are several potential points of failure in each release system, but it is unlikely that both would simultaneously fail.

5.3 Sea Spider movement

Analysis of instrument data from the ADCP and CTDO indicate that the tripod was transported 90 meters to the northwest of its deployment location around the 64th day of deployment. While it is not unusual for strong currents to rotate the tripod on the seabed as the feet slide across cobbles, this degree of motion was unusual. Examination of the ADCP data (velocity and heading) indicates that tripod movement occurred during a turbulent spike in current velocity exceeding 2.8 m/s in close proximity to the seabed. It is possible that the additional drag associated with the composite material samples was sufficient to overcome friction with the seabed. In any case, this incident suggests that the current ballast on the Mark I Sea Spider is barely sufficient to hold it in place during periods when the near-seabed current exceeds 2.5 m/s. Because the Mark I is not likely to be redeployed in this location for the foreseeable future, the relevant question is whether the additional ballast on the Mark II (approximately 200 pounds more than the Mark I) is sufficient to overcome the additional drag due to the new style of instrument mounts. Tripod motion will be assessed prior to redeployment in November, 2010 and modifications made to the tripod, as necessary.

5.4 Annual variability in biofouling

From April 2009 – May 2010 various materials and coatings were deployed for static biofouling tests on the Sea Spider. In general, the results suggested that smooth surfaces were not likely to develop significant fouling, with edges and crevices at much higher risk. However, smooth surfaces of several materials were fouled during this deployment. The primary fouling mechanism appears to be red algae, which then acts as an aggregation site for krill and sediment. Barnacles were also present in higher density than previously observed. Because this fouling did not occur during the May-August deployment in 2009, there appears to be a strong annual variation in the type and degree of fouling. This variability poses a challenge for future *in-situ* biofouling experiments and suggests that durations should be greater than a year. At a minimum, a new battery of biofouling screening tests should be conducted during the May through August deployment in 2011.