Northwest National Marine Renewable Energy Center

University of Washington, Seattle, WA 98195

Research Cruise Report

Admiralty Inlet, Washington

June 2011

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

Survey Crew

Capt. Andrew Reay-Ellers, University of Washington, Applied Physics Lab

Jim Thomson, University of Washington, Applied Physics Lab (PI)

Brian Polagye, University of Washington, Mechanical Engineering (co-PI)

Joe Talbert, University of Washington, Applied Physics Lab

Alex DeKlerk, University of Washington, Applied Physics Lab

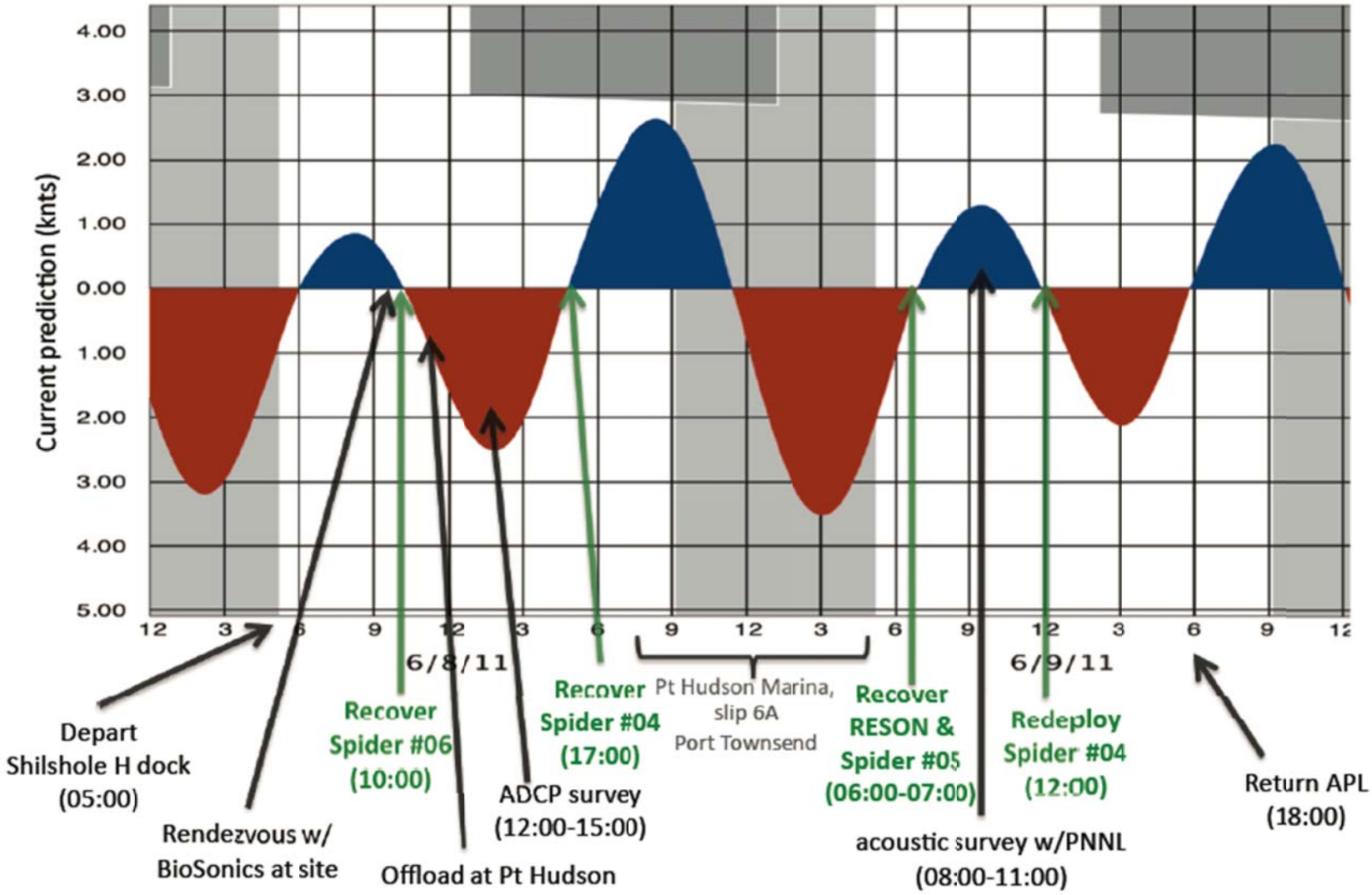
Chris Bassett, University of Washington, Mechanical Engineering

Michael Palodichuk, University of Washington, Mechanical Engineering

Cruise Summary

The R/V Jack Robertson conducted a short research cruise in northern Admiralty Inlet on June 8 and 9, 2011. The purpose of this cruise was the recovery of the three hydroacoustic sonars. These were deployed in early May in a stand-alone configuration to evaluate the effectiveness with which different sonars (split-beam, multi-beam, and acoustic camera) can detect, classify, and identify aquatic species in the vicinity of marine renewable energy projects. On June 8, all three sonars and a Sea Spider (#04) were recovered in good condition. A velocity survey in support of Snohomish Public Utility District' pilot demonstration project was also conducted. During the latter half of the day, personnel from DOE HQ came aboard to observe operations and discuss research plans. On June 9, Sea Spider #04 was redeployed and an acoustic survey conducted in cooperation with personnel from Pacific Northwest National Laboratory.

Cruise Plan


Current prediction (knts)
4.00
3.00
2.00
1.00
0.00
1.00
2.00
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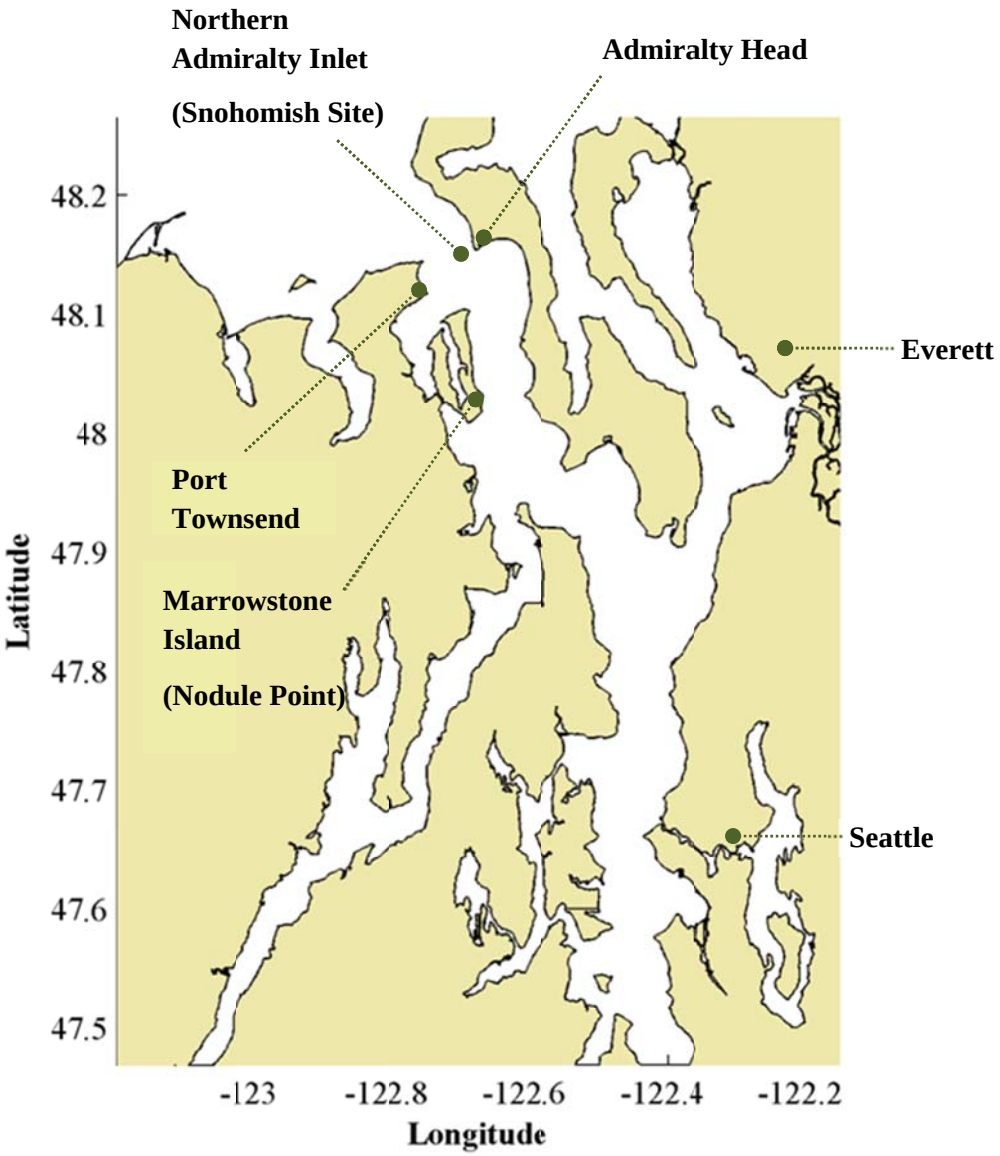
12
3
6
9
12
3
6
9
12
3
6
9
12
3
6
9
12
6/8/11
6/9/11
Depart
Shilshole H dock
(05:00)
Rendezvous w/
BioSonics at site
Recover
Spider #06
(10:00)
Offload at Pt Hudson
ADCP survey
(12:00-15:00)
Recover
Spider #04
(17:00)
Pt Hudson Marina,
slip 6A
Port Townsend
Recover
RESON &
Spider #05
(06:00-07:00)
acoustic survey w/PNNL
(08:00-11:00)
Redeploy
Spider #04
(12:00)
Return APL
(18:00)

Cruise Map



Additional detail on recovery and deployment locations for instrumentation packages is given at the start of Section 3.

1 Daily Operations Summary

June 7, 2011

1900 R/V Jack Robertson departed APL dock in Seattle, WA.

2020 Arrived at Shilshole marina, west of the Ballard Locks.

June 8, 2011

0500 R/V Jack Robertson departed from Shilshole marina.

0830 On station in northern Admiralty Inlet.

0848 Begin velocity survey with Robertson holding station over Sea Spider #04 (within 50 m radius).

0914 End velocity survey.

0930 Sea Spider #05 (Sound Metrics DIDSON) recovered.

0950 Sea Spider #06 (BioSonics DTX) recovered.

1010 RESON instrument sled recovered.

1045 R/V Jack Robertson arrived at Point Hudson marina.

1145 DOE HQ visitors aboard, departing from Point Hudson

1219 Begin velocity survey with Robertson holding station over one of five designated locations (within 50 m radius).

1607 End velocity survey (six complete circuits).

1620 Recover Sea Spider #04

1700 R/V Jack Robertson arrived at Point Hudson marina.

June 9, 2011

0600 R/V Jack Robertson departed Point Hudson marina.

0629 Sea Spider #04 redeployed to southeast of Sea Spiders #02 and #03 (deployed in May)

0720 Begin acoustic survey with PNNL.

1045 End acoustic survey.

1115 R/V Jack Robertson arrived at Point Hudson marina to offload PNNL team.

1300 R/V Jack Robertson departed Port Townsend.

1730 R/V Jack Robertson arrived at Shilshole marina.

1900 R/V Jack Robertson arrived at APL dock in Seattle, WA.

2 Shipboard Surveys

Two velocity surveys were carried out. The first survey involved holding station over Sea Spider #04 (prior to recovery) for nearly 30 minutes. During this time, the Robertson was within 50 m of the Sea Spider. This was achieved by holding the Robertson into the currents with thrust from the propeller acting

to counteract the drag from the currents. The purpose of this survey was two-fold: (1) to generate a time series for comparison between an ADCP deployed on a Sea Spider and a shipboard ADCP and (2) to establish the duration of survey required to average out turbulence and instrument noise in data collected from a shipboard ADCP. The survey concluded that a surface vessel should hold station for at least five minutes while collecting data to achieve this objective. This information was put to use in a second survey where the Robertson held station to within 50 m of five different marks (Figure 1): over Sea Spiders #02, #03, and #04 and over two alternative turbine deployment locations approximately 100 m ESE of the current installation target. These alternate sites may be preferable for the logistics of deploying turbines and power cables.

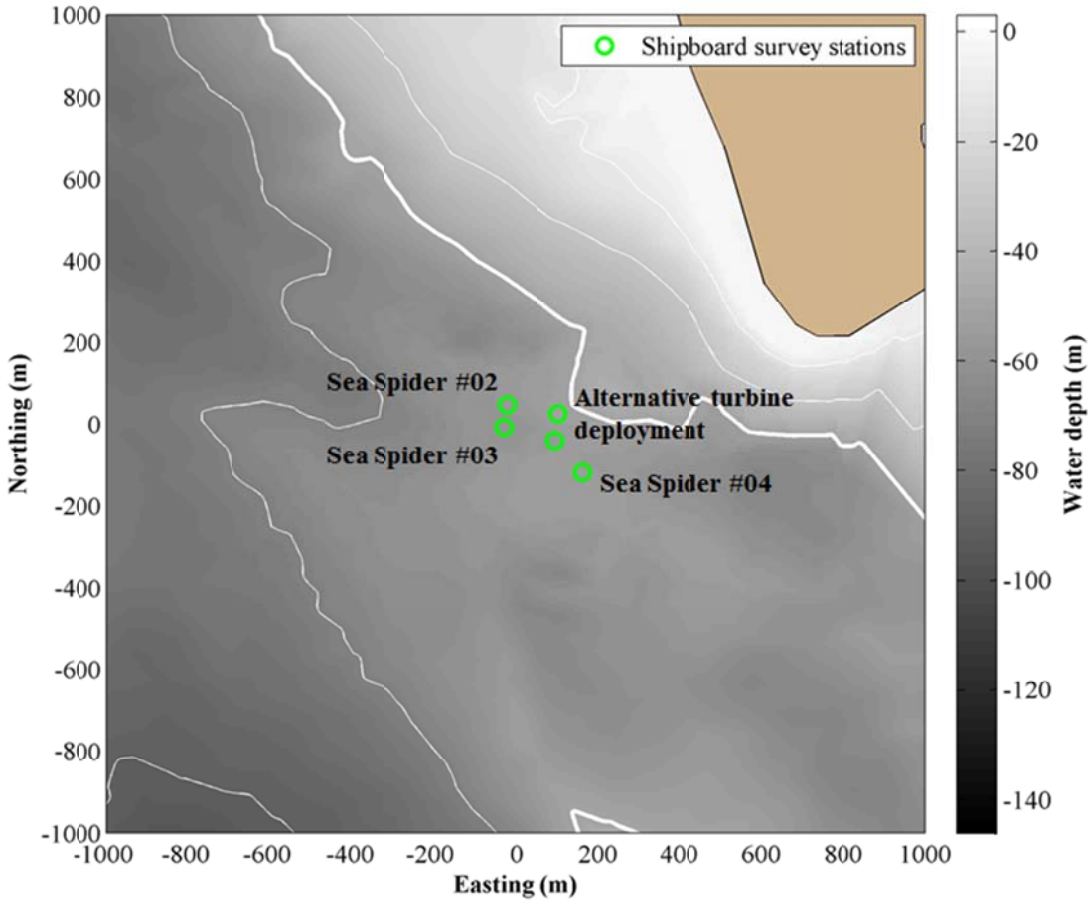


Figure 1 – Shipboard survey locations

An acoustic survey was conducted in collaboration with engineers from Pacific Northwest National Laboratory. During these surveys, the Robertson drifts with the predominant direction of the wind or currents with engines and generators switched off. Hydrophones are deployed at depths from 10 m to 40 m and cabled back to data acquisition computers aboard the Robertson. The purpose of these surveys is to compile additional background information regarding sound that might affect the operation of an active and passive acoustic detection system for Southern Resident killer whales. Such a system is proposed to be incorporated into pilot scale hydrokinetic projects to mitigate the impacts to this endangered species.

3 Instrumentation Recovery and Deployments

Instrumentation locations prior to recovery and after redeployment are shown in Figure 2 and Figure 3, respectively.

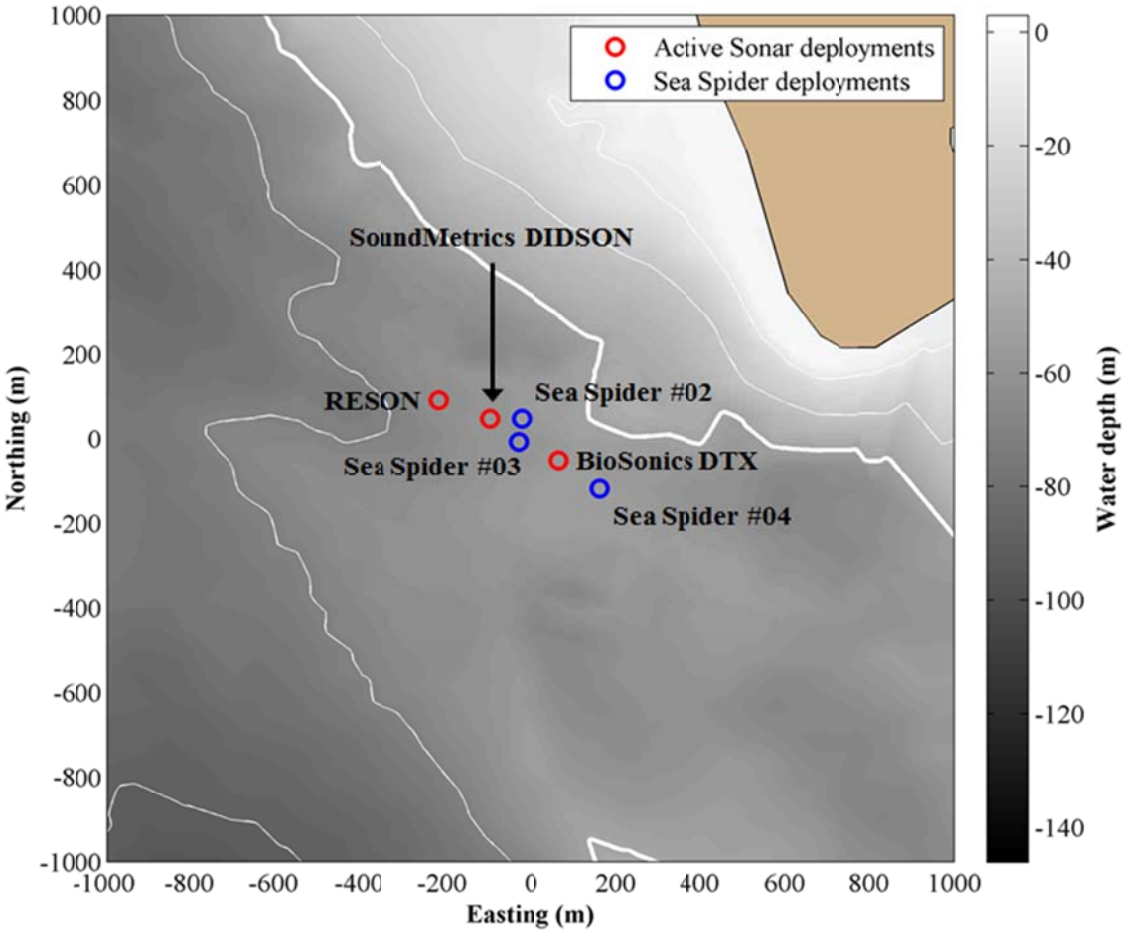


Figure 2 – Locations of recovered instruments (deployment from May 2011 to Jun 2011).

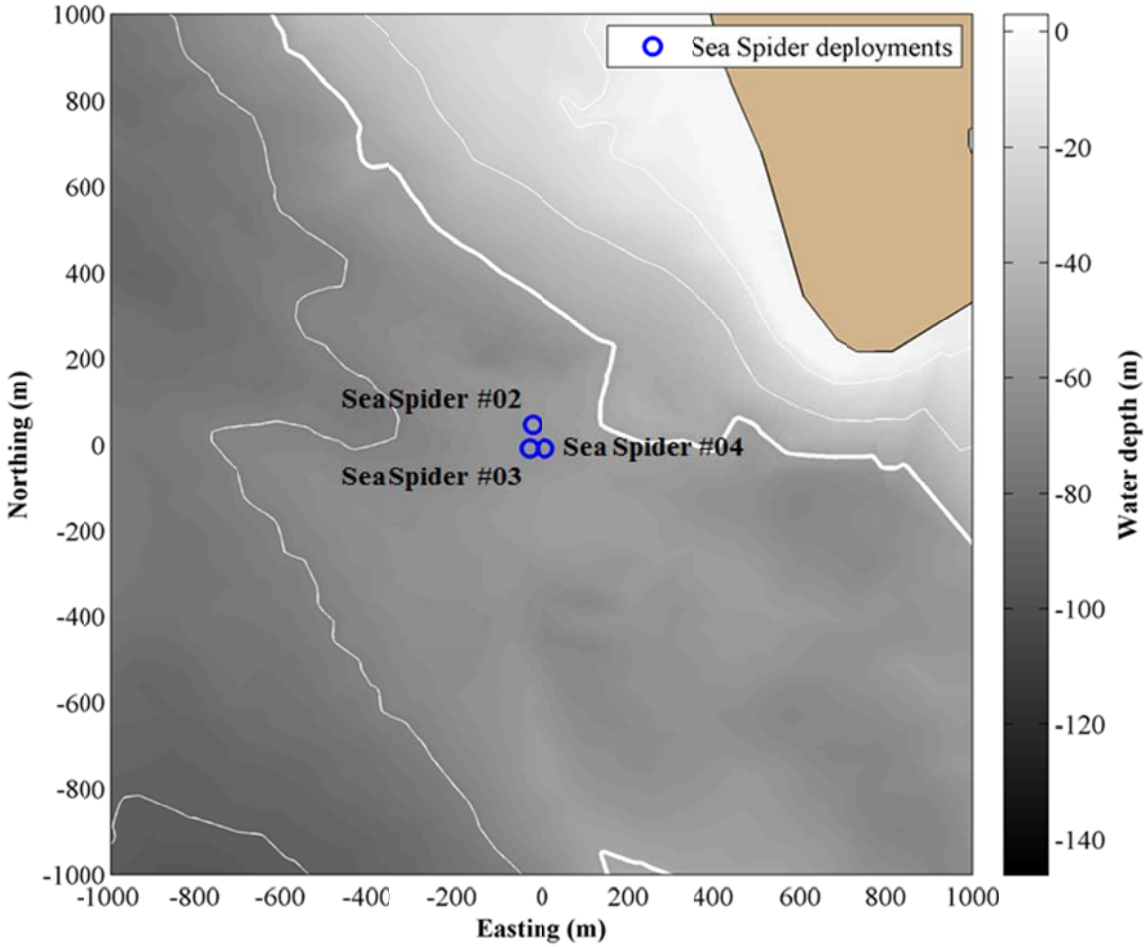


Figure 3 – Locations of deployed instruments (Jun 2011 – Aug 2011).

3.1 Sea Spider #04

May 2011 – June 2011

- Location: In-line with hydroacoustic sonars (Figure 2)
- Mission:
  - Provide contextual velocity information to hydroacoustic sonar tests
  - Collect high-resolution (1 Hz) velocity data to characterize turbulence
  - Test the endurance of the hydrophone flow shield first deployed in February, 2011

June 2011 – August 2011

- Location: Close proximity to Sea Spiders #02 and #03 (Figure 3)
- Mission:
  - Collect high-resolution (1 Hz) velocity data to characterize turbulence
  - Verify instrument comparability between three CPods
- Instrumentation Hardware and Configuration (changes from previous in italics)
  - Acoustic Doppler current profiler (1000 kHz Nortek AWAC): 1 s ensembles over 1 m vertical bins
  - Recording hydrophone (Loggerhead DSG): 7 s recording at 80 kHz every 10 min

- Echolocation hydrophone (Chelonia CPod): *no clicks/min limit, 40 kHz threshold*[1]
- Echolocation hydrophone (Chelonia CPod): *no clicks/min limit, 40 kHz threshold*
- Echolocation hydrophone (Chelonia CPod): *no clicks/min limit, 20 kHz threshold*
- Fish tag receiver (VEMCO VR2W)

Very little biofouling was observed on the body of the Sea Spider or instruments. Corrosion was also quite minor. The hydrophone flow shield was intact and very little bioaccumulation was noted. Because of the concern that the porous foam would "fish" for krill, a polyethylene mesh was wrapped around the flow shield prior to deployment in early May. This appears to have been an effective measure. The August recovery of Sea Spider #02 will provide for further endurance testing.

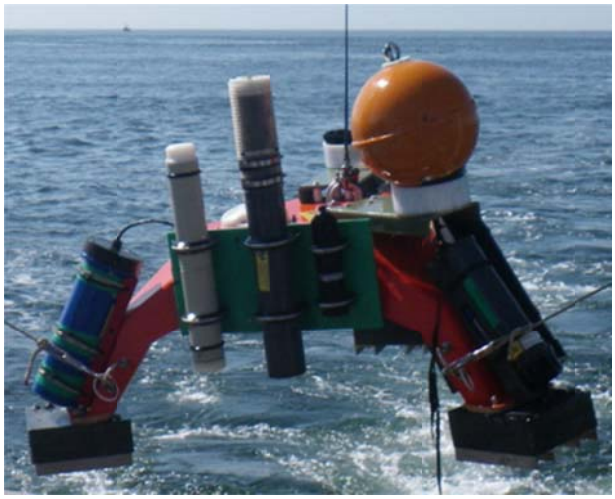


Figure 4 – Sea Spider #04 – as recovered

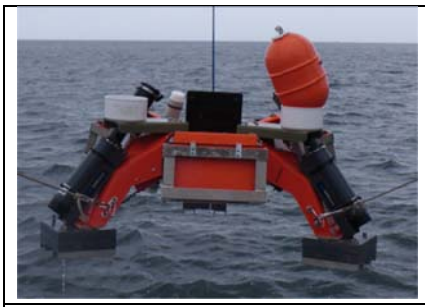
3.2 Hydroacoustic Sonars

May 2011 – June 2011

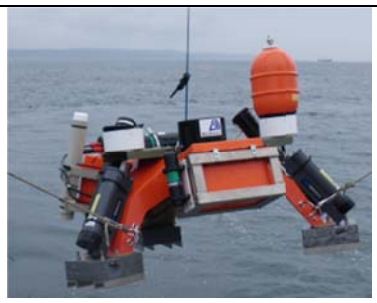
- Location: SW of Admiralty Head, in the vicinity of the Snohomish County project (Figure 2)
- Mission:
  - Evaluate the degree to which different hydroacoustic sonars are able to detect, classify, and identify aquatic species
- Instrumentation Hardware and Configuration
  - Echolocation hydrophone (Chelonia CPod): 4096 clicks/min limit, 40 kHz threshold
  - Fish tag receiver (VEMCO VR2W)
  - Hydroacoustic sonar (SoundMetrics DIDSON, BioSonics DTX, or RESON)

All three hydroacoustic sonars were recovered without incident during a single slack tide (Figure 5). The BioSonics and SoundMetrics packages functioned throughout the deployment, sampling for 12 minutes every two hours. The timing circuit on the RESON package malfunctioned and collected data continuously from the time it was deployed, until the battery voltage dropped below minimum thresholds. Data from all instruments have been offloaded and will be analyzed as part of a NOPP BAA, co-funded by BOEMRE, NOAA, and DOE.

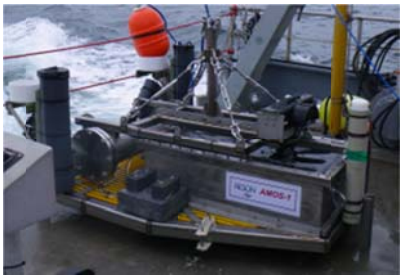
[1] These three CPods, along with the CPods deployed on Sea Spider #02 and #03 will be used to verify inter-instrument comparability (i.e., recorded echolocation activity is consistent between all instruments with the same settings).



(a) SoundMetrics DIDSON



(b) BioSonics DTX



(c) RESON

Figure 5 – Recovery of hydroacoustic sonar packages.

4 Lessons Learned

4.1 Velocity Surveys

In May, a new type of velocity survey was attempted, driving slow survey tracks in a figure-8 pattern to resolve spatial variability to a greater degree than was possible in previous survey methodologies. Results suggested operationally significant (e.g., ± 20% variability in current amplitude over spatial scales less than 100 m). However, based on results from the June surveys, this appears to be turbulent motion, rather than true variations in the underlying harmonic currents. By holding station for at least five minutes, the effect of turbulence can be effectively "averaged out", allowing an investigation of variability in the underlying currents.

4.2 Sea Spider Recovery

The Mark II Sea Spiders continue to function well. The capability of the acoustic releases on the Mark II units to receive, as well as transmit, allowed for a efficient recovery of hydroacoustic instrumentation at a rate of one package every 20 minutes around slack water.