CRUISE REPORT

DEPLOYMENT OF ADCP MOORINGS IN THE HANNA SHOAL REGION, CHUKCHI SEA

AUGUST 2011

Prepared for:

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EXECUTIVE SUMMARY

ASL has been contracted to examine current data in the Hanna Shoal region of the Chukchi Sea; this project is a collaboration between Shell, ConocoPhillips and Statoil.

In total, six moorings were successfully deployed by ASL personnel aboard the *MV Westward Wind* from 26 August - 28 August, 2011 (see Figure 2-1); each deployed mooring was equipped with one Teledyne RD Instruments WH 300 kHz Acoustic Doppler Current Profiler (ADCP).

Five of the six instruments were programmed with a 50 m ADCP configuration file and deployed in water depths ranging between approximately 40 and 49 metres (sites HS02 to HS06). The remaining instrument was programmed with a 60 m ADCP configuration file and deployed at a water depth of approximately 58 m (site HSO1). For a complete list of mooring locations and instrument depths, refer to Table 5-1.

ACKNOWLEDGEMENTS

Shell

Robert Raye	Project Manager
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Caryn Rea	Project Manager

Statoil

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Olgoonik-Fairweather

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Sheyna Wisdom	Project Manager
Christa Koos	Logistical Support
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MV Tukpuk

Bob Shears and Crew	Logistical Support at Wainwright

MV Westward Wind

Captain Steve Fogg and Crew	Exceptional skill and facilities. See Appendix A.

Aldrich Marine

Dave Aldrich and Marine Technicians	Logistics, mooring handling on the *Westward Wind.*

ASL Environmental Sciences

Rick Birch	Assistance
Jeremy Lawrence	Assistance
Wally Horniak	Assistance
Ben Garrett	Assistance
James Bartlett	Assistance
Carol Steward	Administrative Assistance
Des Buermans	Administrative Assistance
Bernadette Fissel	Administrative Assistance

TABLE OF CONTENTS

1 STUDY PROGRAM

In this collaborative project, ASL has been contracted to collect and examine current data in the Hanna Shoal region of the Chukchi Sea. To this end, ASL recently deployed six Acoustic Doppler Current Profilers (ADCPs) in August 2011. This report provides information on the individual deployments and any related technical issues (see map, Figure 1-1).

Figure 1-1: The location of the Chukchi Sea Planning Area for offshore oil and gas exploration.

2 INSTRUMENTATION

Six moorings of upward-looking Acoustic Doppler Current Profiler (ADCP) instruments were deployed along the northern Alaskan shelf, north-west of Wainwright. The ADCP instruments used in this study have been widely used in other parts of the world, including the greater Arctic Ocean region where sea ice is present for nearly the entire year and in marginal and seasonal ice zones.

The ADCP instruments were deployed using taut-line moorings in a near-bottom configuration near the target locations illustrated below in Figure 2-1.

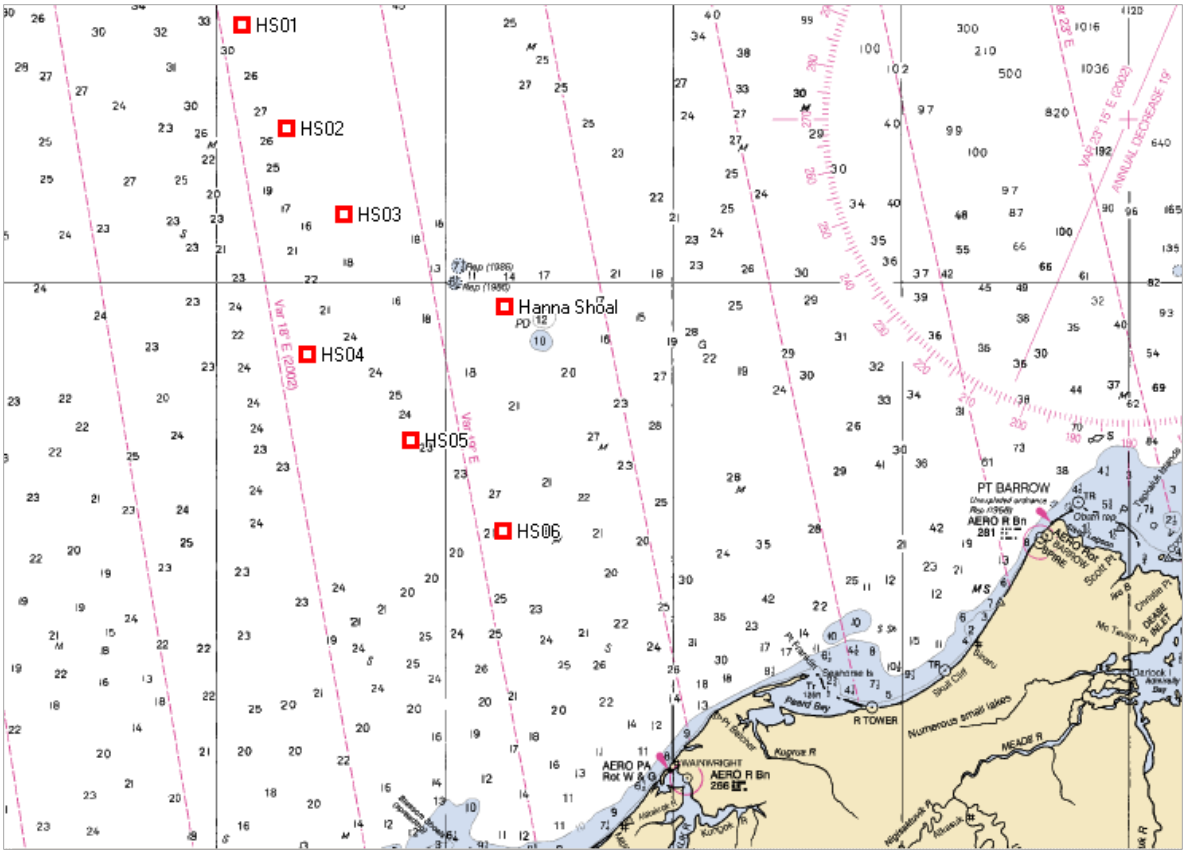


Figure 2-1 Target locations of the six Chukchi Sea ADCP moorings (August 2011).

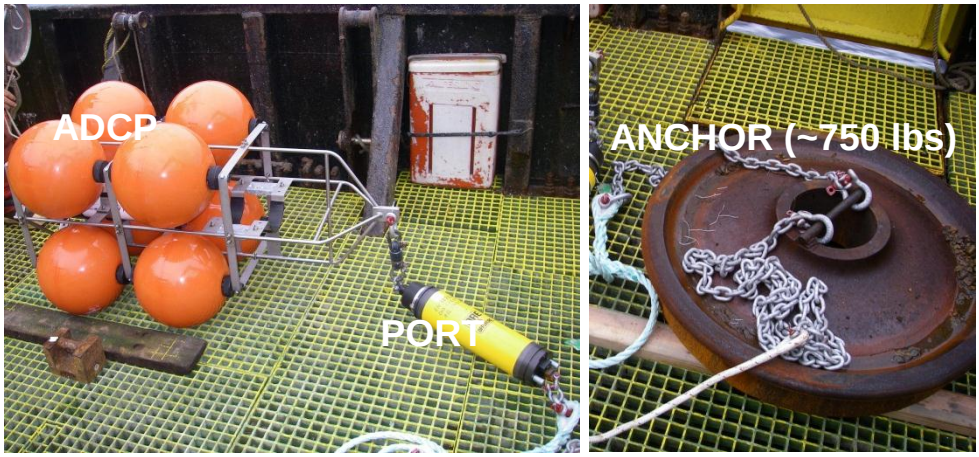


Figure 2-2: ADCP mooring components. In the water, the instrument sits at the top of the mooring with the acoustic-release (ORE PORT unit) located below.

Further diagrams of the mooring configurations can be found in Appendix B.

2.1 ACOUSTIC DOPPLER CURRENT PROFILER

The Acoustic Doppler Current Profiler (ADCP) Sentinel Workhorse series, manufactured by Teledyne RD Instruments of Poway, California, USA was used at all six sites. The ADCP technology is widely used for oceanic environmental monitoring applications. Mounted near the sea bottom, the ADCP unit provides precise measurements of ocean currents (both the horizontal and vertical components) at many levels within the water column, from near surface to near-bottom. In addition, the ADCP provides time series measurements of the velocity of the pack ice moving on the ocean's surface, as well as near-bottom ocean temperature data.

The ADCP instruments measure velocity by detecting the Doppler shift in acoustic frequency, arising from water current (or ice) movements, of the backscattered returns of upward (20º from vertical) transmitted acoustic pulses. The Doppler shift of the 300 kHz acoustic signals is used to determine water velocities at a vertical spacing of 2 m (2 m bins). The Sentinel ADCPs were modified by TRDI in 1996 to use the Doppler shift from the ice surface to measure the ice velocity as well [this is now a standard option].

The measurements are stored internally on a PCMCIA recorder card(s). In the past, external battery packs (doubles) were used to extend the deployment to 12-months; however, persistent problems with the corrosion of y-cables have led to the development of new extended housings which can fit three ADCP battery packs. All six ADCP instruments deployed on the August 2011 cruise featured these new extended housings with three

internal battery packs. An instrument specification sheet for the ADCP instruments used in this project is included in Appendix C: Instrument Specifications.

2.2 ACOUSTIC RELEASES

To recover each ADCP mooring, ASL installed an ORE Push Off Release Transponder (PORT, Figure 2-3) featuring a High Torque Motor driven push off mechanism. With a release load rating of 350 kg, a lift load rating of 1000 kg, a maximum depth rating of 3500 metres and a battery lifetime of two years, they are ideal for the deployments in the Chukchi Sea.

Figure 2-3: ORE Push Off Acoustic Release (PORT).

The PORTs also have a ranging capability that assists in relocation of the moorings during recovery procedures. The instrument specification sheet for the ORE PORT instrument used in this project is included in Appendix C: Instrument Specifications.

3 COMPASS CALIBRATIONS

ASL boarded the research vessel, the *MV Westward Wind*, in Wainwright, Alaska. Six ADCPs with fresh batteries were brought aboard for deployment. However, before the vessel boarding , the ADCP compasses required calibration in as similar a magnetic field as they would experience once deployed. These compass calibrations were carried out near the beach in Wainwright (70° N 38.586', 160°W 01.623'). Calibrations for all ADCPs were completed on 25 August, 2011.

A walk through of the immediate calibration area with a handheld compass indicated no appreciable influences due to iron. We would have preferred to set up farther away from nearby metal propane tanks and buildings (Figure 3-1 below, right); however, due to a polar bear sighting on the beach the previous day, we were instructed to stay as close as possible to the town. Our calibrator was set up approximately 25 m from the propane tanks and 15 m from our truck.

Figure 3-1: Setting up for compass calibrations in Wainwright, Alaska.

In total, eight ADCPs featuring new extended housings were calibrated; each of the housings contained three internal battery packs. Only one ADCP instrument (s/n 11189) showed unusual behaviour when field calibrating to remove the hard iron error. In this instance, despite a slow and steady physical rotation of the instrument through 360˚, the compass read-out was initially unresponsive and then behaved as if it had experienced a series of extremely rapid short rotations. This was unusual as the initial test compass rotation for this instrument yielded satisfactory results. When the hard iron calibration failed a second time, we reset the internal compass to its factory default settings and tried again for a third time, without success. As we only needed six of the eight ADCPs for our deployment, we did not use the instrument with the failed calibration. The seven remaining instruments calibrated without incident.

4 MOBILIZATION OF THE MV WESTWARD WIND

The mobilization process aboard the *Westward Wind* (Figure 4-1) was initiated following the compass calibrations on 25 August, 2011. The science crew was given an orientation of the ship, and the ship's emergency procedures were reviewed. The equipment was then located and examined to ensure that it had not been damaged in transit.

Figure 4-1: *MV Westward Wind.*

Cruise sites were visited based on weather considerations and other constraints which were introduced by other scientific programs being conducted by the vessel. A summary of the general cruise mission is given in Table 4-1.

Table 4-1: General mission outline for the recovery/deployment cruise.

Program / Representatives	*Activity*	*General Location*
Tom Weingartner (Leech and Kelly)	Retrieve 6 ADCPs	Off Wainwright
JASCO (Evans and O'Neil)	Deploy 6 overwintering recorders	On/around Hanna Shoal
ASL (English and Reitsma)	Deploy 6 ADCPs	On/around Hanna Shoal
Tom Weingartner (Leech and Kelly)	Deploy 6 ADCPs	Off Wainwright

5 DEPLOYMENT

5.1 ADCP SETUP

Two ADCP configurations were used: one designed for 50 m water depth and another designed for 60 m water depth. Site HS01 utilized the 60 m deployment configuration; sites HS02 through to HS06 utilized the 50 m deployment configuration (Figure 2-1).

The 50 m configuration setup specifies 28 water bins (2 m bin size) and 10 seconds between pings. The 60 m configuration setup specifies 32 water bins (2 m bin size) and 12 seconds between pings. It should be noted that each configuration setup file takes into account a safety factor of 5 m or more to guard against losing near-surface data. In both configuration cases, bottom tracking is enabled.

5.2 DEPLOYMENT DETAILS

A summary of deployment locations and times is given below in Table 5-1. See Table 5-2 for a list of instrument serial numbers for each site. Seas were calm throughout the cruise, and ice was not seen.

Table 5-1: Hanna Shoal mooring deployment location details.

Site	*Instrument Deployment Time*	*Latitude*	*Longitude*	*Water Depth (m)***
HS01	17:53:00 UTC 28 Aug 2011	72 39.822 N	163 46.098 W	57.9
HS02	20:20:00 UTC 28 Aug 2011	72 25.398 N	163 23.702 W	42.4
HS03	09:45:56 UTC 28 Aug 2011	72 11.320 N	162 53.785 W	39.9
HS04	06:24:31 UTC 28 Aug 2011	71 48.561 N	163 12.675 W	43.2
HS05	05:14:34 UTC 27 Aug 2011	71 34.191 N	162 18.116 W	44.8
HS06	01:57:36 UTC 27 Aug 2011	71 18.086 N	161 26.790 W	48.8

** Note that the water depth recorded here is equal to the depth sounder reading plus 3.0 m to account for the depth of the transducer below the surface.

Table 5-2: Serial numbers of instruments present at each mooring site.

Site	*ADCP S/N*	*PORT Release S/N*
HS01	10985	34785
HS02	16229	34786
HS03	12913	34784
HS04	16188	34788
HS05	11017	34787
HS06	1089	34602

APPENDIX A: SHIPS' CREW AND SCIENTISTS

Ship's Crew for August 2011

	Name	*Position*
1	Steve Fogg	Captain
2	Nick Garay	First Mate
3	Richard Foote	Chief Engineer
4	Phillip Gray	AB
5	Dustin Harrison	AB
6	Josh Mumm	Data Manager/AB
7	Justin Fairchild	Data Manager
8	Michael Coons	Data Manager
9	Cindy Swan	Cook

Scientists for August 2011

	Name	*Position*
1	Sheyna Wisdom	Project Manager
2	Dave Aldrich	Metocean Buoy/AB
3	Herbert Tagarook	Communicator
4	Scott Nelson	Medic
5	Randy Martinez	HSE
6	John Groberg	HSE
7	Sasha McFarland	Marine Mammal Observer
8	Caitlin O'Neill	Acoustics
9	Craig Evans	Acoustics
10	Dave English	ADCP Tech
11	Janine Reitsma	ADCP Tech
12	James Kelly	ADCP Tech
13	David Leech	ADCP Tech
14	Caryn Rea	Sponsor
15	Steinar Eldoy	Sponsor
16	John Collogi	Sponsor

APPENDIX B: ADCP MOORINGS

Hanna Shoal

300 kHz ADCPs at 40-50 m depth — water depth **45**

	Water	Net water	Comp. Length	Dist off bottom	Depth
	Wt (lb)	Wt (lb)	(m)	(m)	(m)
Dual Viny 12B3	-80	-80			
Dual Viny 12B3	-80	-160			
Dual Viny 12B3	-80	-240			
Dual Viny 12B3	-80	-320			
ASL Dual Cage	50	-270	1.00	4.0	41.0
300 kHz WH ADCP w/ Extended Case (3 BP)	22	-248			
shackles	1	-247			
ORE Port Acoustic Release	10.7	-236	1	3.0	42.0
2 m drop line (3/4" Polysteel)	0	-236	2	2.0	43.00
3/8" chain&shackles	10	-226			
				0.0	45.0
Train Wheel (~750 lb air)	**652.5**	**426**			

Q:\739_Fairweather_2011\2_Field_Work\1_Equipment_and_Shipping\Mooring Diagrams\PR739 Hanna Shoal Taut-Line mooring diagram_v2_editJR.xlsx

APPENDIX C: INSTRUMENT SPECIFICATIONS

Teledyne RD Instruments 300 kHz ADCP Specification

Workhorse Sentinel

SELF-CONTAINED 1200, 600, 300 kHz ADCP

Technical Specifications

Water Profiling						
Depth	*Typical Range[2] 12m*		*Typical Range[2] 50m*		*Typical Range[2] 110m*	
Cell Size[1]	1200kHz		600kHz		300kHz	
Vertical Resolution (m)	Range[3] (m)	Std. Dev.[4] (cm/s)	Range[3] (m)	Std. Dev.[4] (cm/s)	Range[3] (m)	Std. Dev.[4] (cm/s)
0.25m	*11–14*	*12.9*				
0.5m	*13–16*	*6.1*	*39*	*12.9*	*see note [1]*	
1m	*14–18*	*3.0*	*43*	*6.1*	*92–71*	*12.8*
2m	*15–20[2]*	*2.0*	*47*	*3.0*	*102–78*	*6.1*
4m	*see note [1]*		*52[2]*	*2.0*	*113–86*	*3.0*
8m					*126–95[2]*	*2.0*

[1] User's choice of depth cell size is not limited to the typical values specified.
[2] Longer ranges available.
[3] Profiling range based on temperature values at 5°C and 20°C, salinity = 35ppt.
[4] BroadBand mode single-ping standard deviation (Std. Dev.).

Long Range Mode

	Range (m)	Depth Cell Size (m)	Std. Dev. (cm/s)
1200kHz	24	2	3.8
600kHz	70	4	4.2
300kHz	165	8	4.2

Profile Parameters

Velocity accuracy:
- **1200, 600:** 0.3% of the water velocity relative to the ADCP ±0.3cm/s
- **300:** 0.5% of the water velocity relative to the ADCP ±0.5cm/s

Velocity resolution: 0.1cm/s
Velocity range: **±5m/s (default)**
±20m/s (maximum)
Number of depth cells: 1–128
Ping rate: **2Hz (typical)**

Echo Intensity Profile

Vertical resolution: Depth cell size
Dynamic range: 80dB
Precision: **±1.5dB**

Transducer and Hardware

Beam angle: 20°
Configuration: **4-beam, convex**
Internal memory: **Two PCMCIA card** slots; one memory card included
Communications: Serial port selectable **by switch for RS-232 or RS-422. ASCII or** binary output at 1200-115,200 baud.

Standard Sensors

Temperature (mounted on transducer):
Range: -5° to 45°C
Precision: ±0.4°C
Resolution: 0.01°

Tilt:
Range: ±15°
Accuracy: ±0.5°
Precision: ±0.5°
Resolution: 0.01°

Compass **(fluxgate type, includes built-**in field calibration feature):
Accuracy: ±2° [5]
Precision: ±0.5° [5]
Resolution: 0.01°
Maximum tilt: ±15°

[5] ±1.0° is commonly achieved after calibration

Power

External DC input: 20–50VDC
Internal battery voltage: 42VDC new; 28VDC depleted
Battery capacity: @0°C: 450 watt hours

Environmental

Standard depth rating:
200m; optional to 6000m
Operating temperature: -5° to 45°C
Storage temperature*: -30° to 60°C
Weight in air: 13.0kg
Weight in water: 4.5kg
** Without batteries*

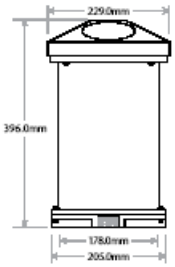
Software

Teledyne RDI's Windows™-based software included:
- **WinSC—Data Acquisition**
- **WinADCP—Data Display and Export**

Available Options

- **Memory: 2 PCMCIA slots, total 4GB**
- **Pressure sensor**
- **External battery case**
- **High-resolution water-profiling modes**
- **Bottom tracking**
- **AC/DC power converter, 48VDC output**
- **Pressure cases for depths up to 6000m**
- **Directional Wave Array**

Dimensions



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Specifications subject to change without notice.

ORE Push Off Release Transponder Specifications

ORE Offshore
An Affiliate of EdgeTech

PORT-LF

PUSH OFF RELEASE TRANSPONDER LOW FREQUENCY

KEY SPECIFICATIONS

MECHANICAL	
Release mechanism	High Torque Motor driven push off mechanism
Release load rating	350 kg (770 lbs)
Lifting load rating	1000 kg (2200 lbs)
Depth rating	3500 meters (11400 ft) (crush depth 4700 meters)
Length	66 cm (26 in)
Diameter	12.7 cm (5 in)
Weight in air	11.3 kg (25 lbs)
Weight in water	4.85 kg (10.7 lbs)
Exposed materials	Hard Coated Aluminum, Plastic Buna –N (O-rings) Ultem and Nylon (isolation hardware)
ELECTRICAL	
Command frequencies	9.3 kHz to 10.7 kHz
Command codes	BACS commands (ORE Offshore)
Transmit Source Level	192 dB re 1 micro Pascal
Receiver sensitivity	100 dB re-1uPascal-meter
Battery life Alkaline	2 year and 20,000 replies