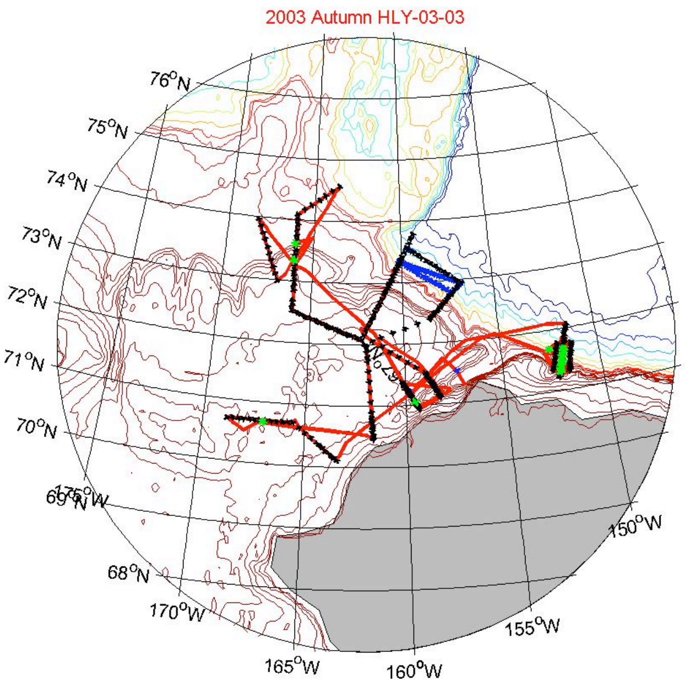
SBI MOORING CRUISE HLY-03-03
USCGC HEALY
Chukchi Sea, Chukchi and Beaufort Slopes 2003



Chief Scientist: Rebecca Woodgate, University of Washington

Barrow, Alaska, 11th September - Nome, Alaska, 18th October 2003

ONR N00014-02-1-0305/0317/0308; NSF OPP-0125082

University of Washington; Woods Hole Oceanographic Institute; University of Alaska, Fairbanks; Scripps Institution of Oceanography; Horn Point Laboratory; Brookhaven National Laboratory; Earth & Space Research; University of Delaware; Lamont-Doherty Earth Observatory; Louisiana State University; NOAA; University of California San Diego; University of New Hampshire; SBI Project Office, University of Tennessee

http://psc.apl.washington.edu/SBI2003.html

HLY-03-03 SUMMARY

A 5-week oceanographic cruise aboard the USCGC Healy in Autumn 2003 studied the processes of interaction between the shelf, slope and basin marine systems of the Chukchi and Beaufort seas. This cruise, one of 11 cruises of the NSF SBI (Shelf Basin Interaction) Program, had as a primary aim the recovery and redeployment of 12 oceanographic moorings deployed in the region in autumn 2003. These moorings, from UAF, UW and WHOI, study the outflows from the Chukchi Sea into the Arctic Ocean and the processes by which shelf-basin interaction occurs in the Beaufort slope region.

The secondary aim of the cruise was to run hydrographic lines (including nutrient, oxygen and chlorophyll sampling) and ADCP sections in support of the mooring arrays and the goals of understanding the physical and chemical system of the region. XBT sections were run to extend spatial coverage. Net tows and VPR (Video Plankton Recorder) casts were also taken both in support of other SBI projects and to help the links from the primarily physical oceanographic measurements to the biogeochemical system. A whale observing program, including deployment of moored recording hydrophones and the use of temporary passive listening devices, was also performed. Educational/public outreach was also done via school visits in Barrow and an educational website was maintained from the ship by a photojournalist.

Although climatologically, the ice cover expected on this cruise was 0-6/10th, very little ice (a few tenths for a few days) was encountered during the mission. Stormy autumn weather was a larger delaying factor, with ca. 3 working days being lost to wind and high seas. Despite this, a record number of measurements were made. A total of 14 moorings were recovered (12 for the SBI project, 1 for the whale acoustic program and 1 for the Chinese Arctic and Antarctic Administration) and 15 moorings were deployed (12 for the SBI project and 3 for the whale acoustic program). Some 321 CTD casts, yielding profiles of temperature, salinity, oxygen, transmissivity, fluorescence and, in parts, L-ADCP data, were taken throughout the Chukchi and Beaufort regions. This includes coverage of the main flows through the Chukchi and repeat sections over the Beaufort slope. Bottle samples were taken for salinity (1044 samples), nutrients (1036 samples), dissolved oxygen (839 samples) and chlorophyll (656 samples). Some 34 VPR casts and 11 net tows were performed and 63 XBTs and 69 Sonobuoys were deployed. Outreach activities include an educational website, updated daily from the ship, and school visits in Barrow pre cruise. (See also http://psc.apl.washington.edu/SBI2003.html.)

The data, which will be publicly archived via JOSS, yield an extensive spatial survey of the Chukchi and Beaufort regions in autumn, and illustrate the large spatial and temporal variability of the area and the rapid response of the shallow waters to local atmospheric forcing.

Acknowledgements

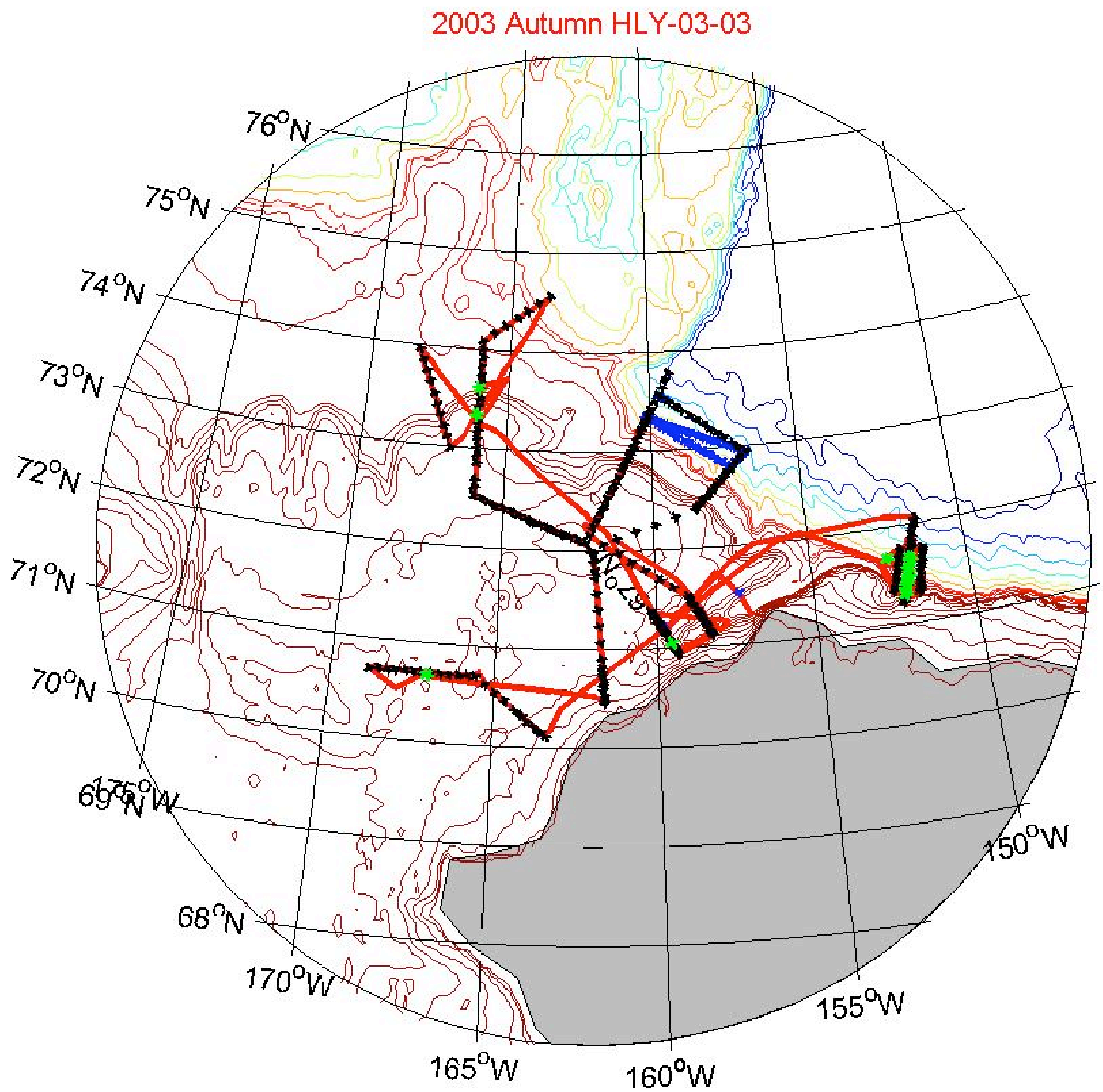
We are indebted to the Captain and crew of the USCGC Healy, for their tireless, enthusiastic, energetic and professional support of this cruise, which made it both extremely successful and enjoyable. We are grateful also to the USCG Science Liaison LCDR April Brown and Dave Forcucci for answering all our questions and needs pre-cruise.

Our sincere thanks go also to the Barrow Arctic Science Consortium (BASC) for their high-quality, dependable and adaptable logistical support of the cruise, both for our pre-cruise stay in Barrow, for the school visits in Barrow and for the variety of requests from sea.

Last, but certainly not least, we would like to thank the community in Barrow, for their interest in our work both at the community and school level. In particular, we would express our appreciation of the Barrow Whaling Captains for their understanding of our needs and, above all, their willingness for debate in the complex issues of combining science work with the needs of the local traditional hunting activities. Our visit was greatly enriched also by the support of teachers in all three schools in Barrow and by interactions with Robert Suydam, Craig George and Todd O'Hara from the North Slope Borough (NSB).

We are grateful for funding of the cruise (NSF-OPP) and individual projects (ONR and NSF).

HLY-03-03 CRUISE TRACK



Map shows the cruise track in red. Depth contours are from the IBCAO data base (10m, 20m, 30m, 40m, 50m, 60m, 70m, 80m, 90m, 100m, 200m, 300m, 400m, 500m, 1000m, 1500m, 2000m, 2500m, 3000m, 3500m, 4000m, 4500m, 5000m). Moorings are represented by green dots. CTD stations are marked as black dots. XBTs are marked as blue dots.

USCGC Healy SBI MOORING CRUISE 2003
HLY-03-03
Chief Scientist: Rebecca Woodgate, University of Washington

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Cover Photo: USCG

1. PARTICIPANTS

Scientific Personnel:

Rebecca Woodgate (PI)	University of Washington (UW)	Chief Scientist
Bob Pickart (SBI PI)	Woods Hole Oceanographic Inst. (WHOI)	Co-CS, CTD PI
Carin Ashjian (SBI PI)	Woods Hole Oceanographic Inst.	Net Tows & VPR
Dean Stockwell (SBI PI)	University of Alaska, Fairbanks (UAF)	Chlorophyll
Andreas Muenchow (SBI PI)	University of Delaware	Ship's ADCP
Jim Johnson	University of Washington	UW Moorings
David Leech	University of Alaska, Fairbanks	UAF Moorings
John Kemp	Woods Hole Oceanographic Inst.	WHOI Moorings
Ryan Schrawder	Woods Hole Oceanographic Inst.	WHOI Moorings
Marshall Swartz	Woods Hole Oceanographic Inst.	WHOI moored CTDs
Dan Torres	Woods Hole Oceanographic Inst.	LADCP
Rob Palomares	Scripps Inst. of Oceanography (SIO)	CTD and Oxygen
Dan Schuller	Scripps Inst. of Oceanography	Nutrients
Sarah Zimmermann	Woods Hole Oceanographic Inst./IOS	Data processing
Val Schmidt	Lamont Doherty Earth Observatory (LDEO)	SeaBeam
Christina Courcier	Woods Hole Oceanographic Inst.	Salinity
Jeremy Kasper	Woods Hole Oceanographic Inst./UAF	CTD (student)
Martha Delaney	Woods Hole Oceanographic Inst.	CTD (student)
Lisa Munger	Univ. of California, San Diego	Whale obs (student)
Chris Linder	Woods Hole Oceanographic Inst.	Educational Outreach

Ship's Personnel:

CAPT Dan Oliver	Commanding Officer
CDR Bill Rall	Executive Officer
LCDR Daryl Peloquin	Operations Officer
LTJG Neal Amaral	Marine Science Officer
MSTCS Glen Hendrickson	MST Senior

MST1 Bridget Cullers
MST2 Daniel Ganoa, Josh Robinson, MST3 Susanne Scriven
BM3 Scott Lussier, SM Trevor Hughes

Science Participants not aboard:

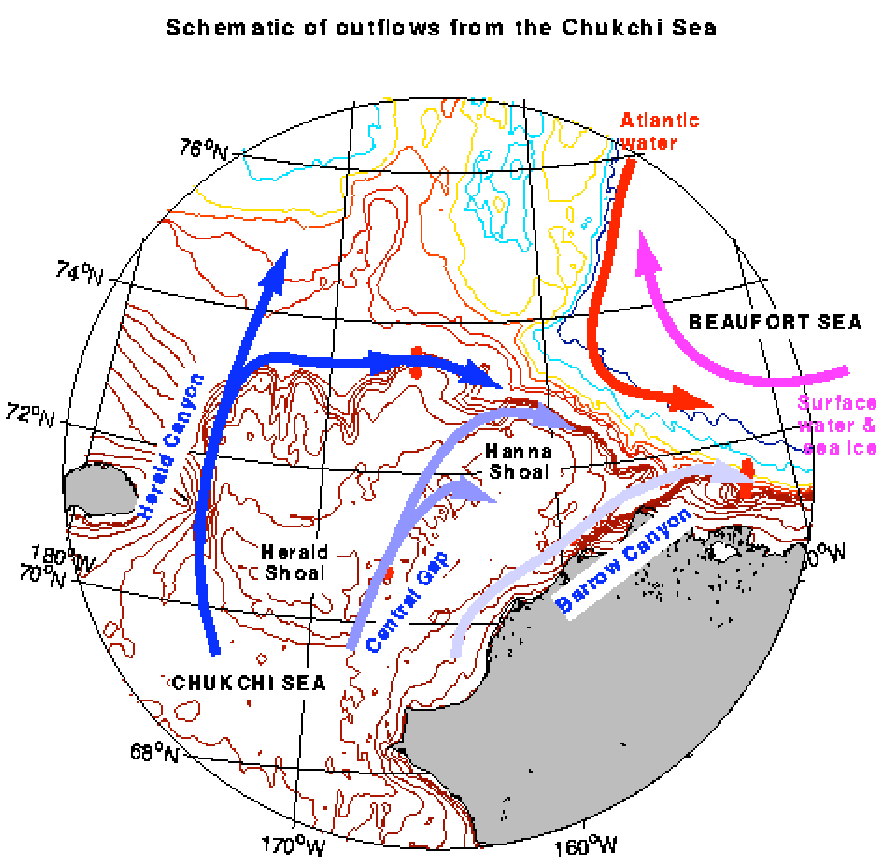
Tom Weingartner (SBI PI)	University of Alaska, Fairbanks	UAF Moorings
Knut Aagaard (SBI PI)	University of Washington	UW Moorings
Jim Swift (SBI PI)	Scripps Inst. of Oceanography	SBI Survey Team
Lou Codispoti (SBI PI)	Horn Point Laboratory	SBI Survey Team
Charlie Flagg (SBI PI)	Brookhaven National Lab	SBI Survey Team
Terry Whitledge (SBI PI)	University of Alaska, Fairbanks	SBI Survey Team
Laurie Padman (SBI PI)	Earth & Space Research	SBI Survey Team
Larry Mayer	University of New Hampshire	SeaBeam data
Dale Chayes	Lamont Doherty Earth Observatory	SeaBeam data
Scott Gallager (SBI PI)	Woods Hole Oceanographic Inst.	Net Tows and VPR
Ron Benfield (SBI PI)	Louisiana State University	Net Tows and VPR
Mark Ortmeyer	University of Washington	Website
Sue Moore	NOAA	Whale Acoustic Moorings
John Hildebrand	Univ. of California, San Diego	Whale Acoustic Mooring
Mike Schmidt		Satellite and SeaWiFs Imagery

2. OVERVIEW

Background

The SBI (Shelf Basin Interaction) project, funded by NSF-OPP and ONR, investigates the processes that link the Arctic shelves and deep basins, with an emphasis on physical biogeochemical processes and the manifestation of climate change in the shelf-slope basin region. Within the main 3-year field program, a series of 11 cruises will investigate the interdisciplinary oceanography of the Chukchi Sea and Beaufort Slope regions.

The Chukchi Sea marks the Pacific entrance to the Arctic Ocean. In the annual average about 0.8 Sv of Pacific waters enter through Bering Strait and are modified in the Chukchi Sea before heading into the shelf-slope-basin regions of the Arctic Ocean. The Pacific input to the Arctic is usually described in 3 main inflows, evident in the seasonal melt-back of ice. One inflow enters via Barrow Canyon in the east, one enters through the Central Channel in the centre of the Chukchi Sea, and the third flows through Herald Canyon in the western Chukchi Sea. Of these three inflows, the westmost (Herald Valley) is the richest in nutrients. The fate of Pacific waters in the Arctic depends on processes that are still to be determined. Some of the waters remain tightly tied to the slope region, while some detach from the slope and move into the high Arctic. Eddy formation, boundary current dynamics and plume mechanisms are some of the processes possibly involved in the transfer from shelf to slope and basin. The Pacific waters are observed exiting the Arctic both via the Canadian Archipelago and the Fram Strait.



Proposals supported

Major aims of the physical oceanographic projects of SBI are to quantify (in volume and properties) the outflows from the Pacific into the Arctic and the processes by which transfer occurs from the shelf to the slope and deep basin. Two main physical programs support these goals using a combination of moored instrumentation and ship-board measurements.

Weingartner (UAF), Aagaard (UW) and Woodgate (UW) [The Fate of a Large and Strongly Forced Arctic Shelf Outflow: Physical and Biochemical Process Studies, ONR funded] use an array of moorings carrying current meters, and temperature and salinity sensors to measure the main outflows from the Chukchi Sea. One mooring is placed at the head of Barrow Canyon, one is placed in the Central Channel, and two final moorings are placed on the Chukchi slope to measure the outflow from Herald Canyon as it traverses eastward along the shelf-slope break. (Herald Canyon lies within the Russian EEZ and in the absence of permission to place moorings in the Russian EEZ, the Herald Canyon outflow can only be measured at a downstream location.)

Pickart (WHOI) [Dynamics of Exchange in the Beaufort Sea Boundary Current System: Implications for Interior Ventilation, ONR funded] deploys a closely spaced array of 8 moorings in one line perpendicular to the Beaufort slope ca. 90 nm east of Barrow. This array, which includes both standard ADCPs and state-of-the-art moored profilers (instruments carrying velocity, temperature and salinity sensors which crawl up and down the mooring lines twice a day), aims to capture the eddy and frontal processes thought to transfer material from the shelf/slope regions into the deep basin.

Other SBI projects and SBI related work are also supported on this cruise.

Ashjian (WHOI), Gallager (WHOI) and Benfield (LSU) [Shelf-Basin Exchange of Biogenic Material Between the Chukchi and Beaufort Seas, NSF-funded]

Sherr (OSU), Sherr(OSU), Campbell (URI) and Ashjian (WHOI) [Mesozooplankton-Microbial Food Web Interactions in Western Arctic Shelf and Basin Regions, NSF-funded]

The hydrographic and underway measurement work on the cruise was undertaken as part of the Swift (SIO), Codispoti (UMD), Flagg (BNL), Whitledge (UAF), Stockwell (UAF), Padman (ESR) and Muenchow (UDE) [CTD/Hydrographic and Underway Service Measurements for the Shelf-Basin Interactions Phase II Field Project, NSF-funded] project, assisted by Pickart (WHOI). PIs Muenchow (ship's ADCP) and Stockwell (Chlorophyll) took part in the cruise.

SeaBeam data was collected by Val Schmidt (LDEO), supported by Larry Mayer (UNH).

A whale acoustic measurement program (both moored instrumentation and passive listening Sonobuoys) was undertaken by Munger (SIO), Hildebrand (SIO) and Moore (NOAA).

Linder (WHOI) provided photojournalism and an educational website for the cruise.

Cruise Summary

The main tasks of the 5-week SBI 2003 mooring cruise aboard the USCGC Healy were to recover and redeploy the 12 moorings supported by the SBI program and take hydrographic and ship's ADCP sections to support these mooring arrays. The mooring work went smoothly and in addition to the 12 SBI moorings, further mooring work was completed. One whale acoustic mooring was recovered and three whale acoustic moorings were deployed. One current meter mooring from Chinese Arctic and Antarctic Administration, a surface mooring abandoned by the Chinese research vessel XueLong due to bad weather, was also recovered. Exceptionally light ice coverage in the western Arctic (and the tireless dedication of the USCG crew and science team) allowed us also to complete an extensive survey of the northern Chukchi Sea and the Chukchi and Beaufort slope regions. A total of 321 CTD casts were taken, yielding profiles of temperature, salinity, oxygen, fluorescence, transmissivity and, at selected stations, velocity shear (L-ADCP data). The spatial coverage maps and criss-crosses the main flows through the US parts of the Chukchi Sea, (i.e., the central channel, the Alaska Coast Current, the Barrow Canyon flow) and the shelf-slope regions both in the west (the first entry of the Herald Canyon waters into the US EEZ), along the slope north and east of Hanna Shoal, and the Beaufort slope region east of Barrow. In the latter area, 7 CTD sections were run across the Beaufort slope at the location of the mooring line (5 of these exact repeats of each other taken just days apart) and even more ship's ADCP sections were taken of the same area. Bottle samples were taken and analyzed on board, 1044 salinity samples, 1036 nutrient samples, 839 dissolved oxygen samples and 656 chlorophyll samples. Some 34 VPR casts and 11 net tows were performed and 63 XBTs and 69 Sonobuoys were deployed. During the cruise, Mike Schmidt kindly monitored satellite imagery of the cruise region for useful SeaWiFs images. A summary of these images (which unfortunately are frequently obscured by clouds) can be found at http://halibut.ims.uaf.edu:8000/~mschmidt/ims_summary.html. As an outreach activity for the school children of Barrow (and those on board) 130 styrofoam cups were 'shrunk'.

Science Summary

The data, which will be publicly archived via JOSS (http://www.joss.ucar.edu/sbi/), yield an extensive spatial survey of the Chukchi and Beaufort regions in autumn, and illustrate the large spatial and temporal variability of the area and the rapid response of the shallow waters to local atmospheric forcing.

Whilst data analysis is only in its initial phase at time of writing, some dramatic results are already apparent. The close station spacing of most of the CTD lines illustrates the complex eddy-like structure of the shelf-waters. Frequently CTD casts were taken only to 600m to speed completion of the CTD section. Temporal variability is high, as is evident especially in the repeated sections over the Beaufort slope. In a 24-hr period, the warm (and cold) anomalies in the cold halocline layer (probably eddies with a shelf source), vary substantially at a particular location, indicating translation of these features. In the same region, CTD and ADCP sections measured the eastward intensification of the slope undercurrent as a response to increasing easterly winds. Both these results will be better described by the mooring data recovered in the region.

The importance of tides/inertial oscillations is evident over the slope in the western Chukchi, both from mooring and ship's ADCP data. Comparison with CTD data taken a few months earlier from the Palmer illustrates a transition in water properties in the slope current and the waters detaching from the slope. Again, the mooring data will greatly expand this analysis.

SeaBeam measurements of the seafloor indicated much increased complexity from the best available topography. Cross slope ridges extend across the Beaufort slope. Hypothesized ice berg scours were found in the Chukchi slope region.

Public Outreach

Several public outreach activities were associated directly with the cruise. This included visits to schools and communities in Barrow, visits to schools on the east coast and maintenance of two websites. The official cruise website is at http://psc.apl.washington.edu/SBI2003.html and contains a science summary, cruise track, chief scientist cruise reports and preliminary results. A second, educational website aimed at the general public and middle schools contains daily updates, questions and answers from school classes and a high level of photo journalism, see http://whoi.edu/ArcticEdge.

The following report combines individual cruise reports into one reference document.

3. MOORING PROGRAMS

(UAF: Dave Leech, Tom Weingartner, (Rob Palomaroes, Dan Schuller for NAS); UW: Jim Johnson, Rebecca Woodgate, Knut Aagaard; WHOI: John Kemp, Ryan Schrawder, Dan Torres, Marshall Swartz, Sarah Zimmermann; SIO: Lisa Munger)

The main objective of the cruise was to recover and redeploy the UAF/UW and WHOI moorings serving the SBI project. Additional mooring work was also performed for the Whale Acoustic group of SIO/NOAA (1 recovery, 3 deployments) and the Chinese Arctic and Antarctic Administration, CAAA (1 recovery).

Table of Moorings Recovered

ID	Lat (N) Long (W)	Depth (corr m)	Location	Inst.	Inst. Depth (~ m)	Record Length (~ days)	Owner
BC1	71 03.09 159 32.82	78	Barrow Canyon	ADCP SBE			UAF
CC1	70 40.39 167 03.85	51	Central Channel	ADCP SBE + Opt NAS			UAF
CS1 (SBI3-02)	73 20.33 166 03.59	68	Chukchi Slope	ADCP RCM7 SBE16	50 55 60	430 430 430	UW
CS2 (SBI4-02)	73 36.68 166 02.52	105	Chukchi Slope	ADCP SBE16 RCM7 SBE16	56 60 80 100	430 430 430 430	UW
BS1	71 18.49 152 08.00	57	Beaufort Slope				WHOI
BS2	71 21.13 152 05.88	81	Beaufort Slope				WHOI
BS3	71 23.69 152 02.87	147	Beaufort Slope				WHOI
BS4	71 26.18 152 00.23	200	Beaufort Slope				WHOI
BS5	71 29.09 151 58.29	283	Beaufort Slope				WHOI
BS6	71 31.91 151 56.04	600	Beaufort Slope				WHOI
BS7	71 34.07 151 54.84	793	Beaufort Slope				WHOI
BS8	71 39.98 151 50.12	1425	Beaufort Slope				WHOI
ARP	71 33.92 151 50.22	955	Beaufort Slope	ARP	945	0	SIO
CH-A	70 30.906 167 58.48	47	Herald Shoal	RCM9 RCM9	10 37	53 53	CAAA

ADCP = Acoustic Doppler Current Profiler, 300kHz, measuring water velocity at many levels
SBE/SBE16 = Seabird senor measuring temperature and conductivity
Opt= with optical sensors also NAS = Nutrient analyzer
RCM = Aanderaa Recording Current Meter, measuring water velocity at one level

Table of Moorings Deployed

ID	Lat (N) Long (W)	Depth (corr m)	Location	Inst.	Inst. Depth (~ m)	Record Length (~ days)	Owner
BC1-03	71 03.12 159 32.54	79	Barrow Canyon	ADCP SBE			UAF
CC1-03	70 40.63 167 03.50	52	Central Channel	ADCP SBE			UAF
CS1-03 (SBI3-03)	73 20.33 166 03.55	72	Chukchi Slope	ADCP RCM7 SBE16	50 55 60		UW
CS2-03 (SBI4-03)	73 36.66 166 02.55	107	Chukchi Slope	ADCP SBE16 RCM7 SBE16	56 60 80 100		UW
BS1	71 18.45 152 07.74	57	Beaufort Slope				WHOI
BS2	71 21.14 152 05.92	81	Beaufort Slope				WHOI
BS3	71 23.69 152 02.81	147	Beaufort Slope				WHOI
BS4	71 26.29 152 00.72	197	Beaufort Slope				WHOI
BS5	71 29.06 151 58.52	283	Beaufort Slope				WHOI
BS6	71 31.91 151 55.86	605	Beaufort Slope				WHOI
BS7	71 34.07 151 54.82	790	Beaufort Slope				WHOI
BS8	71 39.97 151 50.08	1423	Beaufort Slope				WHOI
ARPW- 03	71 41.34 152 32.69	325	Beaufort Slope	ARP	315		SIO
ARPN-03	71 39.33 151 48.00	1258	Beaufort Slope	ARP	1248		SIO
ARPS-03	71 28.28 151 55.99	309	Beaufort Slope	ARP	299		SIO

Moorings were recovered and deployed off the fantail. For recoveries, a small boat was used to take a messenger line from the aft A-frame and hook into the released moorings. Deployments were done using the ship's capstan with the line fair-led from the capstan through a block attached to the deck just aft of the towing bitts and up to a block on the aft A-frame. Deployments were generally done anchor last, with the exception of BS3.

Mooring operations generally went very smoothly. Only one speed (ca. 10m/s) was available on the ship's capstan and this slowed the deeper recoveries. Although both releases on mooring SBI3-02 (also known as CS1-02) confirmed release, the mooring did not come to the surface. The first attempt at dragging (using ca. 300m of trawl wire with grapple and sinker) was however successful in knocking the mooring and allowing it to break free from the anchor.

Mooring positions for the UW and UAF moorings were taken from a hand-held GPS on the fantail. Mooring positions for the WHOI moorings were taken off the ship's aft A-frame and adjusted according the results of surveying in the moorings using the WHOI program and ranges taken from the ship's Knudsen/Bathy transducer. Mooring positions for the ARPs were taken off the ship's aft A-frame.

Most of the mooring instrumentation performed very well. The UW ADCPs, the SBEs and most of the RCMs collected a full deployment (ca. 14 months) of data. The ADCPs show some evidence of lack of scatterers in the winter. The transmissometer on CC1 gave no data and the RCMs on CC1 and BC1 ran out of batteries after ca. 8 months. The NAS on CC1 flooded and the ARP (deployed in 2002 on delayed start as no technician was available to ride the ship) failed to turn on. The 'crawlers' on the WHOI moorings were generally working on recovery, although further details on data return from the WHOI moorings was not available at the time of finalizing this report.

Mooring CHA was recovered for Chinese colleagues from the CAAA who had deployed the mooring in August from the Chinese vessel XueLong but were unable to retrieve the mooring due to bad weather. This surface mooring had no release mechanism and the surface radar reflector had been torn from the mooring presumably by the storm. Although the only remaining surface expression of the mooring was a 12 inch white float, the mooring was spotted on location and successfully recovered.

4. HYDROGRAPHIC PROGRAM

(Bob Pickart, Sarah Zimmermann, Rob Palomares, Marshall Swartz, Dan Torres, Dan Schuller, Christina Courcier, Jeremy Kasper, Martha Delaney, Lisa Munger)

At the time of finalizing this report, the CTD post-cruise report was still unavailable from Pickart, WHOI. As further details become available, they will be added to the cruise website (http://psc.apl.washington.edu/SBI2003.hmtl). Detailed CTD information should also be accessible with the cruise data via the SBI webpage at JOSS, i.e. http://www.joss.ucar.edu/sbi/.

The Healy's Seabird CTD with 24-bottle rosette was used for this cruise. The CTD package included dual temperature and conductivity sensors, an SBE43 oxygen sensor, a transmissometer, a fluorometer and an altimeter. Both down and up cast data were recorded, with bottles being fired only on the up-cast. Bottle samples were taken for salinity, oxygen and nutrients. An L-ADCP package was also attached to the CTD on some casts (see below).

No major problems were encountered with the CTD. In the shallow waters worked, which contain large vertical gradients in water properties, it was found that the wake effect of the CTD significantly affected the up-cast of the CTD. Thus, occasionally (e.g. casts 81-90), bottles were removed from the CTD to reduce its drag. On one cast (180), the CTD hit bottom, but was apparently undamaged. A winch problem was encountered and cured near the end of the cruise.

Special calibration CTD casts were performed for the calibration of the WHOI moored FSI sensors, both post and pre-deployment. Further details are available from Marshall Swartz, WHOI.

CTD Operations

(Bob Pickart, Sarah Zimmermann, Rob Palomares, Marshall Swartz, Dan Torres, Christina Courcier, Jeremy Kasper, Marther Delaney, Lisa Munger)

A total of 321 CTD casts were taken, as per the map above. The data will be quality controlled, post-calibrated and archived by Pickart, WHOI and the SBI Service Team. Preliminary sections are in the appendices and are available via the science website, http://psc.apl.washington.edu/SBI2003.html.

Water samples for salinity (S), Nutrients (Nut), Chlorophyll (Ch) and dissolved oxygen (O) were taken on most, but not all casts (see below). For part of the cruise, bottle depths were only poorly controlled and over the slope the temperature maximum and nutrient maximum cores may not have been sampled. Thus, particular attention should be given during science analysis as to the depths sampled. Note that a large storm before cast 212 stirred up sufficient sediment as to degrade samples from the shallowest casts on this line. Also there was a problem with the oxygen reagents from stations ca. 298 to 309 (probably just 308 and 309).

List of main CTD sections

Stations	Name	Bottle sampling
1 to 17	Barrow Canyon (head)	S, Nut, Ch, O
20 to 29	Chuk Slope west	S, Nut, Ch, O
31 to 56	Chuk Slope	S, Nut, Ch, O
(31 to 37	Chuk Slope north	S, Nut, Ch, O)
56 to 72	Chuk Slope to Hanna Shoal (HS)	none
72 to 90	Hanna Shoal to Alaska	none
92 to 106	Central Channel	S, Nut, Ch, O
106 to 117	Central Channel to Alaska	S, Nut, Ch, O
129 to 143	Beaufort Slope line (1: 28 Sept)	none
147 to 161	Beaufort Slope line (2: 29 Sept) (600m only)	none
162 to 175	Beaufort Slope east (30 Sept) (600m only)	none
176 to 186	Beaufort Slope west (30 Sept) (600m only)	none
187 to 199	Beaufort Slope line (3: 1 Oct) (600m only)	none
200 to 209	Beaufort Slope line (4: 5 Oct) (600m only)	none
212 to 226	Beaufort Slope line (5: 8/9 Oct)	S, Nut, Ch, O
227 to 231	Beaufort Slope extension (600m only)	none
232 to 247	Mid Barrow Canyon	none
248 to 254	Barrow Canyon/to HS	S, Nut, O
254 to 268	Hanna Shoal northwards	S, Nut, Ch, O
267 to 284	Slope to NorthWind Ridge	S, Nut, O
285 to 297	Cross Chukchi Slope (XBT lines)	S, Nut, O
298 to 317	Eastern Slope to HS	S, Nut, O
318 to 321	West Hanna Shoal	S, Nut, Ch, O (Nut & Ch frozen)

Table of CTD casts

#	Start date (GMT)	Start time (GMT)	Lat (N) (deg min)	Long (W) (deg min)	Corr Depth (m)*	Max Press (dbar)	Height off bot (m)	# bot. -les
1	Sep 14 2003	00:21:08	71 22.91	160 9.83	45	42.16	5.09	5
2	Sep 14 2003	04:20:18	71 21.29	160 6.67	46	41.56	4.82	5
3	Sep 14 2003	05:49:10	71 19.50	160 3.53	49	45.11	4.68	4
4	Sep 14 2003	06:48:38	71 17.91	160 0.10	50	47.9	3.69	5
5	Sep 14 2003	07:42:42	71 16.17	159 56.82	57	54.41	3.82	4
6	Sep 14 2003	08:37:33	71 14.47	159 53.51	57	52.85	3.04	5
7	Sep 14 2003	09:30:09	71 12.83	159 50.39	53	50.8	2.64	5
8	Sep 14 2003	10:21:15	71 11.11	159 47.23	59	56.6	2.01	5
9	Sep 14 2003	11:53:47	71 9.41	159 44.12	79	76.55	1.98	6
10	Sep 14 2003	13:23:30	71 7.92	159 41.35	60	57.53	2.88	5
11	Sep 14 2003	14:31:09	71 6.02	159 37.53	61	57.75	3.55	5
12	Sep 14 2003	15:34:42	71 4.44	159 34.68	76	73.28	3.85	5
13	Sep 14 2003	16:36:18	71 2.80	159 31.37	77	72.72	3.24	6
14	Sep 14 2003	17:42:52	71 1.02	159 28.21	68	66.72	2.88	5
15	Sep 14 2003	18:46:58	70 59.33	159 25.55	55	51.59	3.01	5
16	Sep 14 2003	19:54:15	70 57.74	159 22.27	47	46.43	2.83	4
17	Sep 14 2003	20:47:13	70 56.20	159 19.57	36	34	2.34	5
18	Sep 14 2003	23:27:11	71 3.00	159 31.16	75	72.57	2.8	0
19	Sep 15 2003	18:13:18	73 20.27	166 4.58	68	66.59	2.09	0
20	Sep 16 2003	09:49:00	72 59.97	166 54.52	68	67	2.6	5
21	Sep 16 2003	11:25:00	73 06.23	167 2.98	62	58	2.9	4
22	Sep 16 2003	12:53:00	73 12.53	167 12.30	65	62	3.3	5
23	Sep 16 2003	14:16:00	73 18.89	167 21.06	80	77	4	7
24	Sep 16 2003	15:41:00	73 25.37	167 29.57	104	100	2.6	8
25	Sep 16 2003	17:02:00	73 31.79	167 38.53	120	119	2.4	10
26	Sep 16 2003	19:01:00	73 38.24	167 47.77	141	137	4.4	8
27	Sep 16 2003	20:41:00	73 44.79	167 57.51	161	159	2.6	8
28	Sep 16 2003	22:27:00	73 51.18	168 07.11	175	170	2.1	9
29	Sep 17 2003	00:39:00	73 57.58	168 16.51	188	185	2.8	8
30	Sep 17 2003	16:07:00	73 36.97	167 02.33	106	103	3.5	0
31	Sep 18 2003	07:49:04	74 34.19	163 35.51	1013	1010.94	4.18	15
32	Sep 18 2003	10:27:43	74 29.48	163 59.90	619	618.59	4.11	8
33	Sep 18 2003	12:30:20	74 24.72	164 24.58	426	423	4.34	6
34	Sep 18 2003	14:19:01	74 19.89	164 48.67	339	341.08	5.67	6
35	Sep 18 2003	16:06:26	74 14.92	165 12.50	291	286.39	6.05	6
36	Sep 18 2003	17:45:42	74 10.01	165 36.50	235	236.38	4.76	7
37	Sep 18 2003	19:32:36	74 5.12	166 0.36	212	210.22	2.87	7
38	Sep 18 2003	21:02:47	74 0.24	165 59.69	170	169.23	2.77	6
39	Sep 18 2003	22:23:22	73 55.29	165 59.77	153	154.11	2.98	6
40	Sep 19 2003	00:18:04	73 50.33	166 0.24	136	133.8	1.99	6
41	Sep 19 2003	01:49:31	73 45.16	165 59.81	119	118.17	2.58	6
42	Sep 19 2003	02:58:48	73 40.38	166 0.10	112	111.62	2.01	6
43	Sep 19 2003	04:21:59	73 36.38	166 2.11	104	103.24	2.73	6
44	Sep 19 2003	05:41:19	73 30.47	165 59.91	89	87.83	2.19	6
45	Sep 19 2003	06:52:43	73 25.57	165 59.91	78	76.28	2.78	5
46	Sep 19 2003	08:59:32	73 20.15	166 2.93	70	67.69	1	5
47	Sep 19 2003	10:36:55	73 15.74	166 0.10	68	63.43	1.87	6
48	Sep 19 2003	11:57:33	73 10.85	166 0.13	64	59.3	3.89	6
49	Sep 19 2003	13:34:32	73 5.81	166 0.07	61	57.08	3.74	6

50	Sep 19 2003 14:49:10	73 0.90	165 59.97	61	55.93	3.34	6
51	Sep 19 2003 16:23:28	72 56.02	165 59.16	60	53.16	4.01	0
52	Sep 19 2003 17:28:29	72 50.99	165 59.06	59	52.91	3.61	5
53	Sep 19 2003 18:33:56	72 46.17	165 59.87	59	52.02	3.46	0
54	Sep 19 2003 19:40:48	72 41.24	166 0.08	53	51.25	2.61	5
55	Sep 19 2003 21:26:01	72 36.31	166 0.15	55	50.03	2.27	0
56	Sep 19 2003 22:28:40	72 31.45	165 59.85	52	48.28	2.63	5
57	Sep 19 2003 23:37:02	72 29.58	165 44.11	52	47.29	2.78	0
58	Sep 20 2003 00:39:01	72 27.69	165 29.52	52	47.19	2.46	0
59	Sep 20 2003 01:43:01	72 25.83	165 14.36	51	47.02	1.89	0
60	Sep 20 2003 02:37:22	72 24.07	164 59.10	50	45.96	2.61	0
61	Sep 20 2003 03:30:32	72 22.27	164 43.38	49	44.49	2.08	0
62	Sep 20 2003 04:30:16	72 20.40	164 28.46	50	43.03	2.06	0
63	Sep 20 2003 05:30:49	72 18.65	164 13.55	Bathy 46	41.69	1.68	0
64	Sep 20 2003 06:29:25	72 16.85	163 58.39	Bathy 45	40.48	1.27	0
65	Sep 20 2003 07:25:17	72 15.14	163 43.38	Bathy 43	38.2	2.49	0
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71	Sep 20 2003 13:16:07	72 4.78	162 14.92	Bathy 53	25.18	4.58	0
72	Sep 20 2003 16:04:41	72 0.06	162 4.39	34	29.79	3.3	0
73	Sep 20 2003 16:58:29	71 58.31	161 59.10	33	30.9	3.6	0
74	Sep 20 2003 18:05:30	71 53.40	161 57.77	40	34.81	3.43	0
75	Sep 20 2003 19:05:05	71 48.39	161 56.41	43	38.74	3.57	0
76	Sep 20 2003 19:58:51	71 43.33	161 55.56	43	40.84	2.1	0
77	Sep 20 2003 21:42:36	71 33.63	161 53.04	46	42.59	2.55	0
78	Sep 20 2003 23:19:35	71 23.67	161 50.74	42	40.11	2.28	0
79	Sep 21 2003 00:48:03	71 13.98	161 48.55	48	44.9	2.31	0
80	Sep 21 2003 02:15:41	71 3.94	161 46.33	43	42.48	2.85	0
81	Sep 21 2003 03:45:44	70 54.32	161 44.25	43	42.28	2.75	0
82	Sep 21 2003 04:49:41	70 48.85	161 43.50	44	41.76	1.83	0
83	Sep 21 2003 05:33:47	70 46.18	161 42.32	42	40.84	1.77	0
84	Sep 21 2003 06:21:00	70 43.36	161 41.79	41	39.17	2.29	0
85	Sep 21 2003 07:06:30	70 40.81	161 41.09	41	38.98	2.03	0
86	Sep 21 2003 08:00:35	70 38.11	161 40.78	40	37.16	2.64	0
87	Sep 21 2003 08:57:34	70 35.43	161 40.97	Bathy 36	33.42	2.49	0
88	Sep 21 2003 10:26:03	70 32.63	161 39.62	x	27.09	2.15	0
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90	Sep 21 2003 11:54:26	70 27.33	161 38.61	x	19.41	4.08	0
91	Sep 21 2003 21:21:34	70 40.50	167 4.73	Bathy 53	47.8	4.32	5
92	Sep 22 2003 06:10:40	70 42.13	168 50.18	Bathy 56	29.14	1.54	3
93	Sep 22 2003 07:54:34	70 42.07	168 33.70	39	36.58	1.49	4
94	Sep 22 2003 08:58:08	70 41.94	168 16.94	43	41.69	1.68	5
95	Sep 22 2003 10:26:09	70 41.85	168 0.83	46	44.01	2.14	5
96	Sep 22 2003 11:53:33	70 42.06	167 44.41	Bathy 53	48.92	3.05	5
97	Sep 22 2003 13:21:21	70 41.92	167 28.37	Bathy 55	50.43	2.86	5
98	Sep 22 2003 14:25:57	70 41.88	167 11.80	Bathy 54	50.12	3.28	5
99	Sep 22 2003 15:54:47	70 42.05	166 55.18	Bathy 49	45.13	2.6	5
100	Sep 22 2003 17:37:09	70 40.74	167 3.69	Bathy 53	48.47	2.64	0
101	Sep 22 2003 18:25:24	70 42.07	166 55.62	Bathy 49	45.4	3.69	5
102	Sep 22 2003 19:38:09	70 42.10	166 39.39	45	43.47	2.87	4
103	Sep 22 2003 21:05:59	70 41.65	166 22.50	40	38.56	1.85	4
904	Sep 22 2003 22:03:21	70 41.71	166 5.88	40	37.8	2.25	0

104	Sep 22 2003 22:29:02	70 41.99	166 5.76	40	38.15	2.58	4
105	Sep 22 2003 23:47:32	70 41.83	165 49.79	40	39	2.24	4
106	Sep 23 2003 00:50:07	70 41.96	165 34.17	43	40.88	2.63	4
107	Sep 23 2003 03:15:20	70 37.27	165 16.00	43	40.84	2	4
108	Sep 23 2003 04:29:03	70 32.38	164 58.24	44	41.15	1.77	4
109	Sep 23 2003 05:48:44	70 27.45	164 40.27	47	43.26	2.55	4
110	Sep 23 2003 07:05:23	70 22.70	164 22.86	44	40.67	1.5	4
111	Sep 23 2003 08:01:53	70 20.54	164 14.23	41	38.56	1.47	4
112	Sep 23 2003 08:50:46	70 18.16	164 5.59	38	36.31	2.37	4
113	Sep 23 2003 09:37:39	70 15.61	163 57.24	37	34.62	1.63	4
114	Sep 23 2003 10:25:29	70 13.25	163 48.09	Bathy 35	31.67	1.73	4
115	Sep 23 2003 11:15:21	70 10.85	163 39.56	Bathy 28	27.34	2.4	3
116	Sep 23 2003 11:56:00	70 8.61	163 31.49	x	26.45	3	3
117	Sep 23 2003 12:46:40	70 6.39	163 22.80	x	25.42	2.98	3
118	Sep 24 2003 08:21:02	71 32.02	151 56.67	599	582.47	2.4	0
119	Sep 25 2003 03:56:15	71 50.02	151 40.06	2217	2233.16	9.51	16
120	Sep 25 2003 08:55:42	71 49.56	151 41.00	2180	1002.78	>200	10
121	Sep 26 2003 03:00:04	71 34.05	151 54.68	834	809.31	9.89	0
122	Sep 26 2003 05:38:50	71 49.63	151 41.02	2180	2192.03	15.14	12
123	Sep 26 2003 09:38:04	71 40.09	151 49.95	1466	1001.59	>200	13
124	Sep 27 2003 10:34:56	71 40.11	151 49.37	1432	1001.26	>200	0
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129	Sep 28 2003 11:13:18	71 50.23	151 40.85	2197	2216.68	8.5	0
130	Sep 28 2003 13:29:38	71 47.67	151 42.85	2088	2083.89	4.85	0
131	Sep 28 2003 15:34:50	71 45.00	151 45.18	1840	1855.35	4.79	0
132	Sep 28 2003 17:23:13	71 42.42	151 47.64	1610	1622.86	5.14	0
133	Sep 28 2003 19:09:26	71 39.81	151 49.62	1409	1400.56	3.93	0
134	Sep 28 2003 20:54:15	71 37.23	151 51.80	920	901.11	3.61	0
135	Sep 28 2003 22:18:34	71 34.70	151 54.95	827	825.8	3.04	0
136	Sep 28 2003 23:44:10	71 32.10	151 56.50	601	595.55	2.69	0
137	Sep 29 2003 01:01:11	71 29.16	151 58.66	290	285.26	3.98	0
138	Sep 29 2003 02:11:36	71 26.66	152 1.39	201	199.34	3.83	0
139	Sep 29 2003 03:15:35	71 24.04	152 3.46	158	156.41	2.57	0
140	Sep 29 2003 04:25:02	71 21.45	152 5.80	76	74.5	1.3	0
141	Sep 29 2003 05:14:44	71 18.87	152 7.78	60	56.86	2.24	0
142	Sep 29 2003 06:04:42	71 16.19	152 10.22	49	43.67	2.19	0
143	Sep 29 2003 06:48:19	71 13.63	152 11.79	43	39.73	2.2	0
144	Sep 29 2003 10:22:31	71 39.86	151 49.85	1425	1001.01	>200	0
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146	Sep 29 2003 14:50:15	71 39.84	151 50.02	1413	101.33	>200	0
147	Sep 29 2003 22:54:39	71 50.22	151 40.83	2187	608.35	>200	0
148	Sep 30 2003 00:12:34	71 47.60	151 43.24	2046	608.68	>200	0
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150	Sep 30 2003 02:12:05	71 42.43	151 47.38	1601	608.24	>200	0
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153	Sep 30 2003 05:18:14	71 34.62	151 54.49	815	603.9	>200	0
154	Sep 30 2003 06:22:55	71 32.03	151 56.63	588	592.33	2.95	0
155	Sep 30 2003 07:26:18	71 29.30	151 58.78	294	287.92	2.42	0
156	Sep 30 2003 08:20:45	71 26.74	152 1.06	205	204.79	2.27	0
157	Sep 30 2003 09:17:53	71 24.08	152 3.31	160	157.57	2.12	0
158	Sep 30 2003 10:04:11	71 21.53	152 5.45	82	79.53	1.91	0

159	Sep 30 2003 10:48:17	71 18.75	152 7.50	59	57.04	2.43	0
160	Sep 30 2003 11:28:52	71 16.27	152 9.83	49	47.14	2.46	0
161	Sep 30 2003 13:48:46	71 13.71	152 12.12	45	39	2.67	0
162	Sep 30 2003 15:35:04	71 18.76	151 40.55	64	60.94	2.41	0
163	Sep 30 2003 16:14:00	71 19.86	151 39.33	66	65	2.08	0
164	Sep 30 2003 16:55:47	71 21.26	151 38.76	124	117.77	3.42	0
165	Sep 30 2003 17:52:03	71 22.76	151 37.84	167	167.04	2.54	0
166	Sep 30 2003 18:43:00	71 23.99	151 36.89	189	182	2.89	0
167	Sep 30 2003 19:43:55	71 25.34	151 35.80	220	214.22	3.65	0
168	Sep 30 2003 20:39:27	71 26.73	151 34.63	288	285.72	2.88	0
169	Sep 30 2003 21:36:08	71 29.18	151 32.73	777	608.9	185.45	0
170	Sep 30 2003 22:40:03	71 31.97	151 30.70	1340	609.89	>200	0
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181	Oct 01 2003 13:27:48	71 33.59	152 15.68	217	212.95	3.74	0
182	Oct 01 2003 14:31:16	71 31.00	152 18.94	155	149.58	2.7	0
183	Oct 01 2003 15:50:02	71 28.50	152 21.13	236	118.18	4.82	0
184	Oct 01 2003 17:31:52	71 26.08	152 23.81	143	133.49	3.36	0
185	Oct 01 2003 18:32:53	71 23.20	152 25.70	113	113.59	3.14	0
186	Oct 01 2003 19:49:14	71 20.74	152 28.98	Knudsen 80	67.45	9.84	0
187	Oct 02 2003 01:42:51	71 13.79	152 12.71	Knudsen 43	36.2	5.88	0
188	Oct 02 2003 02:31:21	71 15.99	152 10.98	Knudsen 49	42.53	5.31	0
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191	Oct 02 2003 05:27:41	71 24.15	152 3.49	158	154.03	10.62	0
192	Oct 02 2003 06:29:09	71 26.65	152 1.42	198	189.16	9.77	0
193	Oct 02 2003 07:47:06	71 29.25	151 58.83	285	270.5	10.09	0
194	Oct 02 2003 09:18:10	71 32.06	151 56.81	591	570.71	10.86	0
195	Oct 02 2003 10:28:38	71 34.57	151 54.69	820	827.01	3.4	9
196	Oct 02 2003 12:08:30	71 37.38	151 51.69	Knudsen 754	601.54	>200	0
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207	Oct 04 2003 18:38:07	71 31.89	151 56.34	599	592.98	6	0
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212	Oct 08 2003 05:08:55	71 13.74	152 12.22	42	38.22	3.06	4
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216	Oct 08 2003 10:30:23	71 24.15	152 3.41	160	157.36	2.66	7
217	Oct 08 2003 13:08:29	71 26.66	152 1.22	200	198.72	2.73	9
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220	Oct 08 2003 23:14:31	71 34.69	151 54.40	820	818.52	2	12
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222	Oct 09 2003 03:36:19	71 39.77	151 49.52	1388	1398.04	2.84	12
223	Oct 09 2003 06:12:18	71 42.27	151 47.61	1585	1606.69	3.06	14
224	Oct 09 2003 08:48:32	71 44.96	151 45.36	1784	1824.99	8.49	17
225	Oct 09 2003 11:43:08	71 47.51	151 42.65	2049	2076.81	2.76	18
226	Oct 09 2003 15:07:58	71 50.44	151 40.82	2187	2224.21	3.58	18
227	Oct 09 2003 18:44:05	71 52.80	151 38.76	2290	602.05	>200	0
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234	Oct 10 2003 23:45:54	71 10.47	158 20.96	47	45.88	2.54	0
235	Oct 11 2003 00:28:08	71 11.99	158 24.08	69	69.69	1.67	0
236	Oct 11 2003 01:04:03	71 13.53	158 26.94	96	95.26	2.82	0
237	Oct 11 2003 02:05:46	71 15.22	158 30.30	110	109.98	2.38	0
238	Oct 11 2003 02:52:39	71 16.86	158 33.16	110	109.77	2.05	0
239	Oct 11 2003 03:37:34	71 18.48	158 35.98	108	107.64	1.71	0
240	Oct 11 2003 04:18:56	71 20.21	158 38.52	78	76.34	2.85	0
241	Oct 11 2003 05:00:34	71 21.83	158 41.10	57	54.87	2.28	0
242	Oct 11 2003 05:37:31	71 23.16	158 44.30	56	54.46	1.68	0
243	Oct 11 2003 06:15:06	71 24.85	158 47.82	62	60.44	1.61	0
244	Oct 11 2003 06:55:43	71 26.53	158 51.03	54	52.27	2.58	0
245	Oct 11 2003 07:39:57	71 28.46	158 54.24	53	51.73	2.31	0
246	Oct 11 2003 08:10:36	71 29.81	158 57.30	53	50.64	2.16	0
247	Oct 11 2003 08:41:02	71 31.33	159 0.12	52	50.6	1.89	0
248	Oct 11 2003 10:01:45	71 36.83	159 26.17	51	47.68	2.32	4
249	Oct 11 2003 11:20:39	71 42.05	159 51.99	49	47.66	2.59	4
250	Oct 11 2003 12:50:28	71 47.36	160 18.48	50	44	3.14	4
251	Oct 11 2003 14:16:23	71 52.59	160 44.53	43	38.18	4.01	4
252	Oct 11 2003 15:40:59	71 58.03	161 10.88	34	33.1	3.56	3
253	Oct 11 2003 17:05:21	72 3.45	161 38.84	29	26.09	3.99	3
254	Oct 11 2003 18:34:38	72 9.20	162 6.91	27	24.21	4.82	3
255	Oct 12 2003 03:38:10	72 13.76	162 0.81	33	31.68	2.25	3
256	Oct 12 2003 04:54:27	72 18.17	161 53.02	40	36.81	1.55	3
257	Oct 12 2003 06:17:26	72 22.69	161 46.04	44	39.74	2.12	4
258	Oct 12 2003 07:23:40	72 26.96	161 38.19	40	41.08	2.67	4
259	Oct 12 2003 08:23:47	72 31.46	161 30.87	45	42.4	3.15	4
260	Oct 12 2003 09:24:34	72 35.81	161 23.70	49	42.79	2.27	4
261	Oct 12 2003 10:18:51	72 40.09	161 15.53	51	45.35	2.11	4
262	Oct 12 2003 11:10:21	72 44.45	161 7.55	54	48.41	2.23	4
263	Oct 12 2003 12:15:51	72 48.82	161 0.01	54	49.59	2.7	4
264	Oct 12 2003 13:11:01	72 51.18	160 56.23	58	49.57	4.05	4
265	Oct 12 2003 14:02:43	72 53.52	160 51.48	55	50.83	4.8	4
266	Oct 12 2003 14:53:09	72 56.11	160 47.84	71	64.89	2.27	4
267	Oct 12 2003 15:49:00	72 58.37	160 43.73	75	72.27	2.9	5
268	Oct 12 2003 17:34:04	73 0.98	160 39.59	140	134.23	3.33	6

269	Oct 12 2003 18:40:36	73 3.37	160 35.46	160	156.86	2.82	6
270	Oct 12 2003 19:47:07	73 5.63	160 31.22	Bathy 211	201.69	2.25	11
271	Oct 12 2003 21:19:00	73 8.18	160 26.75	264	262.52	2.04	7
272	Oct 12 2003 23:32:04	73 10.46	160 23.06	300	306.1	2.07	8
273	Oct 13 2003 00:52:01	73 12.94	160 18.39	416	419.96	2.64	8
274	Oct 13 2003 02:46:55	73 15.27	160 14.30	828	791.09	4.44	8
275	Oct 13 2003 04:27:16	73 17.63	160 10.05	1103	1112.82	11.11	8
276	Oct 13 2003 06:12:08	73 20.11	160 5.44	1316	1319.86	8.85	10
277	Oct 13 2003 08:07:15	73 22.47	160 1.51	1476	1462.21	10.21	10
278	Oct 13 2003 10:25:06	73 24.96	159 56.97	1625	1617.01	9.95	12
279	Oct 13 2003 12:50:45	73 29.25	159 49.23	1951	1958.82	6.03	12
280	Oct 13 2003 15:53:43	73 33.65	159 41.29	2256	2255.34	6.36	12
281	Oct 13 2003 18:39:50	73 33.62	159 41.34	2259	300.64	>200	6
282	Oct 13 2003 20:25:45	73 38.00	159 33.22	2499	2523.5	3.48	13
283	Oct 14 2003 01:13:26	73 42.43	159 25.34	2742	2781.02	3.8	12
284	Oct 14 2003 04:41:46	73 46.72	159 17.02	2978	3012	14.98	12
285	Oct 14 2003 09:14:56	73 32.25	159 34.17	2250	600.87	>200	4
286	Oct 14 2003 11:00:01	73 29.29	159 19.43	2300	610.54	>200	4
287	Oct 14 2003 12:53:35	73 26.33	159 5.24	Bathy 2204	602.33	>200	4
288	Oct 14 2003 14:25:15	73 23.47	158 51.19	2187	600.75	>200	4
289	Oct 14 2003 15:56:59	73 20.51	158 36.58	2129	608.54	>200	4
290	Oct 14 2003 17:23:11	73 17.31	158 22.52	2174	598	>200	4
291	Oct 14 2003 19:01:57	73 14.57	158 8.22	Bathy 2331	600.91	>200	4
292	Oct 14 2003 20:30:08	73 11.71	157 54.15	2475	612.15	>200	4
293	Oct 14 2003 21:57:56	73 8.83	157 40.29	2449	623.14	>200	5
294	Oct 14 2003 23:32:15	73 5.80	157 26.42	2651	599.31	>200	4
295	Oct 15 2003 00:54:33	73 2.68	157 12.38	2558	609.17	>200	4
296	Oct 15 2003 02:19:09	72 59.80	156 58.40	2364	601.66	>200	4
297	Oct 15 2003 03:36:14	72 56.90	156 44.16	2449	603.28	>200	4
298	Oct 15 2003 19:16:08	72 56.93	156 43.78	2428	2481.39	3.55	11
299	Oct 15 2003 22:21:18	72 53.25	156 56.24	2098	603.23	>200	6
300	Oct 15 2003 23:51:41	72 49.86	157 8.12	1729	603.73	>200	6
301	Oct 16 2003 01:21:08	72 46.52	157 19.01	1113	605.12	>200	6
302	Oct 16 2003 03:20:47	72 44.62	157 26.17	567	534.54	4.07	6
303	Oct 16 2003 04:34:58	72 42.57	157 32.40	408	391.45	5.76	6
304	Oct 16 2003 05:50:30	72 40.57	157 38.92	352	341.4	4.84	6
305	Oct 16 2003 06:53:19	72 38.75	157 44.93	296	288.25	5.57	6
306	Oct 16 2003 08:08:15	72 36.87	157 51.44	246	237.49	5	6
307	Oct 16 2003 09:19:20	72 35.13	157 57.21	200	189.39	8.73	6
308	Oct 16 2003 10:23:35	72 33.09	158 3.41	165	152.08	10.62	6
309	Oct 16 2003 11:49:43	72 31.07	158 10.37	108	99.41	2.74	6
310	Oct 16 2003 12:47:15	72 29.21	158 16.44	71	66.21	3.35	6
311	Oct 16 2003 13:43:44	72 27.32	158 22.88	61	56.73	2.68	6
312	Oct 16 2003 14:52:36	72 25.31	158 29.45	56	52.9	3.27	5
313	Oct 16 2003 15:44:31	72 23.39	158 35.09	54	51.27	3.04	4
314	Oct 16 2003 17:41:09	72 19.33	159 15.99	49	44.12	5.54	4
315	Oct 16 2003 19:17:54	72 15.31	159 55.19	47	41.24	2.9	4
316	Oct 16 2003 20:39:35	72 11.19	160 34.53	40	35.4	4.95	3
317	Oct 16 2003 22:13:23	72 7.23	161 13.72	28	27.71	1.68	3
318	Oct 17 2003 00:13:27	72 6.48	162 28.91	34	31.8	3.06	4
319	Oct 17 2003 01:21:00	72 9.84	162 59.25	39	34.57	4.02	4
320	Oct 17 2003 02:32:58	72 13.47	163 28.95	37	35.08	3.61	4
321	Oct 17 2003 03:43:47	72 17.03	163 58.88	Bathy 36	38.2	3.45	4

* Depth data taken from Seabeam unless otherwise stated.

Salinity, Oxygen and Nutrient Analysis

(Rob Palomares, Dan Schuller, Christina Courcier)

Salinity:

1044 salinity samples were analyzed.

Salinity Materials and Methods

Salinity samples were drawn into 200 ml high alumina borosilicate bottles, which were rinsed three times with sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This container provides very low container dissolution and sample evaporation.

A Guildline Autosal 8400B #65-715, standardized with IAPSO Standard Seawater (SSW) batch P-141, was used to measure the salinities. Prior to the analyses, the samples were stored to permit equilibration to laboratory temperature, usually 8-20 hours. The salinometer contained a Guildline-supplied interface with ODF-developed acquisition software for computer-aided measurement. The salinometer was standardized with a new vial of standard seawater at the beginning and end of each run. The SSW vial at the end of the run was used to check for drift. The salinometer cell was flushed until two successive readings met software criteria for consistency; these were then averaged for a final result. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 psu relative to the particular standard seawater batch used. A cursory review of the salinity data has been performed post-cruise. There are a couple questionable salinity runs and the data needs further investigation.

Salinity Laboratory Temperature

The temperature stability in the salinometer laboratory was fair, sometimes varying as much as 4.5ºC during a run of samples. The laboratory temperature was generally 1-2ºC lower than the Autosal bath temperature.

Oxygen:

839 samples were analyzed for oxygen.

Oxygen Materials and Methods

Dissolved oxygen analyses were performed with an ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365 nm wavelength ultra-violet light. The titration of the samples and the data logging were controlled by PC software. Thiosulfate was dispensed by a Dosimat 665 burette driver fitted with a 1.0 ml burette. The ODF method used a whole-bottle modified-Winkler titration following the procedure of Carpenter (1965) with modifications by Culberson (1991), but with higher concentrations of potassium iodate standard (approximately 0.012N) and thiosulfate solution (55 g/l). Standard KIO_3 solutions prepared ashore were run at the beginning of each run. Reagent and distilled water blanks were determined, to account for presence of oxidizing or reducing materials.

Oxygen Sampling and Data Processing

Samples were collected for dissolved oxygen analyses soon after the rosette was brought on board. Using a Tygon drawing tube, nominal 125ml volume-calibrated iodine flasks were rinsed, then filled and allowed to overflow for at least 3 flask volumes. The sample draw temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice to ensure thorough dispersion of the precipitate, once immediately after drawing, and then again after about 20 minutes. The samples were usually analyzed within a few hours of collection. Thiosulfate normalities were calculated from each standardization and corrected to 20ºC. The 20ºC normalities and the blanks were plotted versus time and were reviewed for possible problems. New thiosulfate normalities were recalculated as a linear function of time, if warranted. The oxygen data were recalculated using the smoothed normality and an averaged reagent blank. Some problems were encountered during standardizations, however deletion of errant standard values during post cruise data processing revealed an analytical error of less than one percent for the Thiosufate normality (and thus the samples). Oxygens were converted from milliliters per liter to micromoles per kilogram using the sampling temperature.

Oxygen Volumetric Calibration

Oxygen flask volumes were determined gravimetrically with degassed deionized water to determine flask volumes at ODF's chemistry laboratory. This is done once before using flasks for the first time and periodically thereafter when a suspect bottle volume is detected. The volumetric flasks used in preparing standards were volume-calibrated by the same method, as was the 10 ml Dosimat burette used to dispense standard iodate solution.

Oxygen Standards

Potassium iodate was obtained from Johnson Matthey Chemical Co. and was reported by the supplier to be >99.4% pure.

Nutrients:

1036 samples were analyzed for nutrients.

Nutrients Materials and Methods

Nutrient analyses (nitrate+nitrite, nitrite, ortho-phosphate, and silicate) were performed on an ODF-modified 4-channel Technicon AutoAnalyzer II, generally within a few hours after sample collection. Occasionally samples were refrigerated for longer periods and the data are annotated if it was felt that the storage time had a significant effect. The analog outputs from each of the four channels were digitized and logged automatically by computer (PC) at 2-second intervals.

A modification of the Armstrong *et al*. (Armstrong 1967) procedure was used for the analysis of nitrate and nitrite. For the nitrate plus nitrite analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitatively reduced to nitrite. The stream was then passed through a 15mm flowcell and the absorbance measured at 540 nm. The same technique was employed for nitrite analysis, except the cadmium column was bypassed, and a 50mm flowcell was employed. Periodic checks of the column efficiency were made by running alternate equal concentrations of NO2 and NO3 through the NO3 channel to ensure that column efficiencies were high (> 95%). Nitrite concentrations were subtracted from the nitrate+nitrite values to obtain nitrate concentrations.

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms (Bernhardt, 1967) procedure. The reaction product was heated to ~55ºC to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820m.

Silicate was analyzed using the procedure of Armstrong *et al*., (Armstrong, 1967). The sample was passed through a 15mm flowcell and the absorbance measured at 660 nm.

Nutrients Sampling and Data Processing

Nutrient samples were drawn into 45 ml polypropylene, screw-capped "oak-ridge type" centrifuge tubes. The tubes were cleaned with 10% HCl and rinsed with sample three times before filling. Standardizations were performed at the beginning and end of each group of analyses (typically 6-24 samples) with an intermediate concentration mixed nutrient standard prepared prior to each run from a secondary standard in a low-nutrient seawater matrix. The secondary standards were prepared aboard ship by dilution from primary standard solutions. Dry standards were pre-weighed at the laboratory at ODF, and transported to the vessel for dilution to the primary standard. Sets of 7 different standard concentrations covering the range of sample concentrations were analyzed periodically to determine the deviation from linearity, if any, as a function of concentration for each nutrient analysis. A 3^{rd}-order correction for non-linearity was applied to the final nutrient concentrations when necessary. After each group of samples was analyzed, the raw data file was processed to produce another file of response factors, baseline values, and absorbances. Computer-produced absorbance readings were checked for accuracy against values taken from a strip chart recording. A stable deep seawater check sample was run frequently as a substandard check.

Nutrients, when reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at 1 atmosphere pressure (0 db), *in situ* salinity, and an assumed laboratory temperature of 25ºC.

Nutrient Standards

Na_2SiF_6, the silicate primary standard, was obtained from Johnson Matthey Company and Fisher Scientific and was reported by the suppliers to be >98% pure. Primary standards for nitrate (KNO3), nitrite ($NaNO_2$), and phosphate (KH_2PO_4) were obtained from Johnson Matthey Chemical Company. The supplier reported purities of 99.999%, 97%, and 99.999%, respectively.

References

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Culberson, C. H., Knapp, G., Stalcup, M., Williams, R.T., and Zemlyak, F., "A comparison of methods for the determination of dissolved oxygen in seawater," Report WHPO 91-2, WOCE Hydrographic Programme Office (Aug 1991).

Chlorophyll Sampling

(Dean Stockwell)

Chlorophyll samples were taken both from the CTD rosette on selected casts and from the ship's sea water intake (for calibration of the underway fluorometer).

Sampling from the ship's underway intake started on 21st September 2003 after in-line fluorometer was turned on and terminated on 17th October 2003. Samples were collected approximately 4 times a day at 0500, 1100, 1700, and 2300 local time. A total of 108 samples were collected and frozen. Samples will be analyzed ashore.

Five hundred and forty-eight (548) samples were taken from CTD casts on major sections, i.e. head of Barrow Canyon (CTD1-17), westmost sections across the Chukchi Slope (CTD31-56), across the Central Channel to the Alaskan continent (CTD92-117), across the Beaufort Slope (CTD212-223), and across the Chukchi Slope north of Hanna Shoal (CTD255-267. A few stations were also taken west of Hanna Shoal (CTD318-321). Forty-eight (48) of these samples were frozen for analysis ashore. The sample analysis protocol followed as per the SBI process cruise outlined on the JOSS webpage, http://www.joss.ucar.edu/sbi/.

Processing and Quality Control

(Bob Pickart, Sarah Zimmermann)

Post-cruise data calibration and quality control will be undertaken by Pickart, WHOI/ the SBI service team.

5. LOWERED ACOUSTIC DOPPLER CURRENT PROFILER (LADCP) WORK

(Dan Torres)

LADCP (Lowered Acoustic Doppler Current Profiler) data were collected at selected CTD casts to yield a full water column profile of absolute velocity.

Instrumentation Configuration

The instrumentation consisted of a dual upward and downward facing 300 kHz Workhorse ADCP configuration (s/n 1411 and 1412). These were mounted onto the CTD rosette and powered by a single 48 Volt 8.2 Amp hour lead-acid rechargeable battery pack (also mounted on the CTD frame). A Master and Slave deployment procedure was used in which the downward ADCP was set up as the master and the upward ADCP was a slave. Using a set of ping synchronization commands, the two instruments would ping at roughly 1 Hz with a 1/2 second delay in order to minimize interference from each instruments pings. Each instrument was mounted in such a way that it had an unobstructed view of the water. The upward facing ADCP was mounted as far out as possible on the CTD package and oriented to minimize wire interference.

Deployment and Recovery

A five-connector Star cable was used for power and communication between the two instruments, battery pack and computer. Two connectors went to each instrument, one to the battery pack, and two to the data acquisition computer (dummied off during a cast). The procedure consisted of sending a set of deployment commands to the slave and then the master. The master would then synchronize the pings between the two. Once the ADCPs were pinging, they would be dummied off and ready for deployment. Once the cast was complete, the package was hosed off with fresh water and the data communication cables were reconnected. An American Reliance LPS-305 programmable power supply was used to recharge the batteries through the same data communication cables. Once battery recharge commenced, each instrument was stopped in reverse order before commencing data download (simultaneous to battery recharge).

Data processing

Shortly after a cast was completed, initial processing of the data was performed to verify proper functioning of the instruments and to monitor package dynamics. The heading, pitch, and roll sensors in the ADCPs provide a time series of the orientation and tilt of the package throughout the cast. The software used was the LADCP Processing Software package from Martin Visbeck of the Lamont-Doherty Earth Observatory of Columbia University. Data was collected using RD Instruments Workhorse Data Acquisition Software on a Windows-based PC. Once collected, data was backed up to an external hard drive and sent via ftp to a Linux based PC for further data processing. Data was additionally backed up to another network drive via an ethernet connection on the data acquisition PC.

Once data were present on the Linux PC, they were ready to be processed using the Matlab-based LADCP processing software. Initial processing only required start and end times and positions from the user, which were routinely entered on the CTD/LADCP log-sheets. Final processing will involve integrating CTD data for speed of sound and depth correction, and ship's navigation data for start and end position correction.

Where water depths were less than ca. 300m, the water velocity could be measured by the ship's ADCP, and thus LADCP data were collected on only a subset of the total number of casts. Specifically, LADCP data was collected only at the following stations: 20-118, 210-227, 254-317.

6. VIDEO PLANKTON RECORDER (VPR) PROGRAM

(Carin Ashjian and Sarah Zimmermann)

The primary purpose of the VPR study was to obtain a description of the distribution of plankton and particles across the Beaufort Shelf and Slope at high horizontal (2.5 km) and vertical (<1m) resolution. Coupled with velocity estimates from the acoustic Doppler current profiler, these data will elucidate what is in the water exchanged between shelf and basin and how this exchange may impact the transfer of biogenic material at this dynamic boundary.

The VPR is essentially an underwater microscope. A camera and strobe are mounted on two arms, with the camera focused on a point midway between the arms. The strobe illuminates the imaged volume (13mm x 10mm x 17mm or ~ 2 ml) 60 times per second. Images are recorded internally using wavelet compression. A CTD is used to obtain pressure, temperature, and salinity measurements that are incorporated into the VPR data file. The instrument is mounted in a stainless steel cage and is deployed from the fantail on 3/8" non-conducting cable from near-surface to 10 m off the bottom or 300 m, if the bottom depth exceeds 300 m. After each cast, the data files are transferred from the subsea PC104 to a desktop computer via Ethernet. Data files then are run through an image analysis program that selects in focus portions of each field, when present, and saves the images to .tif files. These images then are identified to taxa or type either manually or using an image identification and analysis program.

Thirty-four VPR casts were conducted during the cruise. Of these, five collected no data and three did not contain video images. Casts were conducted primarily at three locations: Herald Valley, the Central Channel, and across the Beaufort Sea shelf near the Beaufort mooring line. Operations were smooth for much of the cruise, however degrading weather conditions during the start of the Beaufort Sea transect resulted in the VPR impacting the fantail during the first cast of the transect. At the second station, it was discovered that the VPR was writing empty files. Luckily, the worsening weather brought a halt to all sampling activities so that trouble shooting to the VPR could occur. After a ~36 hour weather day, sampling of the transect started again. However, the VPR was beset with intermittent, random, and increasingly frequent occurrences of no data being written to the file. Troubleshooting measures included reseating connections and boards, correspondence by phone and e-mail with shore side experts, battery voltage record keeping, lining the inside of the can with plastic insulation, and just plain luck. Eventually, it appears that Sarah Zimmerman's suggestion of just waiting for at least four minutes every time we power up or power down the PC104 before moving on to the next step may have helped because eight successful casts were obtained in succession at the end of the transect.

The VPR data showed some dramatic differences between adjacent stations in the taxa present across the Central Channel transect. Data for the Beaufort Sea and Herald Valley transects presently are being analyzed.

The whole science party helped with the VPR operations and with trouble-shooting the instrument. In particular, Marshall Swartz was cheerful even when woken from slumber to help trouble shoot. This cooperative effort contributed greatly to the success of the project.

Table of VPR casts

Station	VPR Tow	Lat (N) Deg. Min.		Long (W) Deg Min		Bot. Z (m)	Cast Z (m)	Local (2003) Date and Time	Start	End	GMT (2003) Date and Time	Start	End
39	1	73	55.35	165	59.59	150	135	9/18	1501	1513	9/18	2301	2313
45	2	73	25.59	165	59.73	77	65	9/18	2327	2338	9/19	727	738
46	3	73	20.15	166	2.61	68	55	9/19	125	138	9/19	925	938
48	4	73	10.97	166	0.53	65	55	9/19	423	430	9/19	1223	1230
91	5	70	40.52	167	4.64	53	42	9/21	1346	1350	9/21	2146	2150
92	6	70	42.59	168	51.94	29	18	9/21	2240	2246	9/22	640	646
94	7	70	42.63	168	15.95	44	26	9/22	121	130	9/22	921	930
96	8	70	42.65	167	44.61	53	40	9/22	420	427	9/22	1220	1227
98	9	70	42.17	167	13	55	45	9/22	648	654	9/22	1448	1454
102	10	70	42.06	166	39.19	45	35	9/22	1208	1211	9/22	2008	2011
104	11	70	42.4	166	6.13	40	30	9/22	1457	1502	9/22	2257	2302
106	12	70	42.2	165	33.32	44	30	9/22	1712	1717	9/23	112	117
210	13	71	13.86	152	12.99	40	30	10/5	2254	2258	10/6	654	658
211	14	71	16.43	152	9.9	50	40	10/5	2344	2350	10/6	744	750
211	15	71	16.44	152	9.99	50	40	10/6	34	41	10/6	834	841
212	16	71	13.68	152	12.59	40	30	10/7	2030	2035	10/8	430	435
213	17	71	16.33	152	9.8	48	38	10/7	2235	2238	10/8	635	638
214	18	71	18.9	152	7.87	60	50	10/7	2312	2317	10/8	712	717
215	19	71	21.6	152	5.49	78	65	10/8	112	117	10/8	912	917
216	20	71	24.15	152	3.46	157	140	10/8	203	325	10/8	1003	1025
216	21	71	24.07	152	3.42	157	140	10/8	336	346	10/8	1136	1146
217	22	71	26.68	152	1.104	205	190	10/8	443	455	10/8	1243	1255
218	23	71	22.62	152	8.52	205	190	10/8	635	650	10/8	1435	1450
218	24	71	29.29	151	58.87	290	280	10/8	739	800	10/8	1539	1600
219	25	71	29.29	151	58.82	290	275	10/8	1005	1027	10/8	1805	1827

7. NET TOW PROGRAM

(Carin Ashjian)

Net tows were conducted next to each Beaufort mooring that was equipped with an ADCP (i.e. BS1, BS2, BS3, BS4, BS5 and BS6). The purpose of the net tows was to collect animals to use in ground-truthing the ADCP backscatter intensity from the adjacent moored instrument. Eleven tows were conducted in total, ten along the mooring line and 1 on the Chukchi Shelf to the west of Barrow Canyon as a test tow. Tows were conducted using a 1 m^2, ring net equipped with 150 μm mesh nets. The first three tows were done with the nets fishing vertically so that plankton were collected only during the upcast of the net. However, high winds and the low ice conditions necessitated changing the collection method to oblique tows, with nets fishing during both the up and down casts, since the ship drifted at a significant rate during the cast. Most tows were highly successful, with only one being discarded because a large Medusa was captured in the net. The samples will be analyzed for size-specific taxonomic composition upon return to the laboratory. This information will be used with sound scattering models to predict the backscatter that should have resulted from insonification of that portion of the water column. This predicted backscatter will then be compared to actual backscatter from the ADCPs.

Table of Net Tows

Tow #	Location	Lat. Deg. N Min. N	Long. Deg. W Min. W	Bot. Z (m)	Tow Wire Out	Wire ang.	Calc. Depth (m)	Local (2003) Date and Time			GMT (2003) Date and Time		
									Start	End		Start	End
1	None	71 34.6	158 7.45	60	40	20	37.6	9/23	1430	1440	9/23	2230	2240
2	BS6	71 31.8	151 57.35	600	100	10	98.5	9/24	104	114	9/24	904	914
3	BS6	71 31.8	151 57.25	600	100	25	90.6	9/24	140	151	9/24	940	951
4	BS5	71 29.05	151 58.94	285	100	45	70.7	9/24	235	250	9/24	1235	1250
5	BS4	71 26.14	152 0.84	200	75	45	53.0	9/24	345	357	9/24	1145	1157
6	BS3	71 23.71	152 3.78	150	75	50	48.2	9/24	444	455	9/24	1244	1255
7	BS2	71 21.02	152 6.22	75	50	50	32.1	9/24	534	547	9/24	1334	1347
8	BS1	71 18.44	152 8.51	56	47	45	33.2	9/24	619	629	9/24	1419	1429
9	BS6	71 32.23	151 56.64	600	100	30	86.6	9/25	650	655	9/25	1450	1455
10	BS5	71 28.93	151 57.49	600	60	45	42.4	9/26	451	458	9/26	1251	1258
11	BS1	71 18.47	152 6.8	58	50	30	43.3	9/27	1337	1342	9/27	2137	2142

8. XBT WORK

(Rebecca Woodgate)

A total of 63 XBT casts were taken during the cruise. The first three of these were taken at the start of the cruise to obtain sound speed corrections for the SeaBeam data. The remaining 60 were thrown on two lines in the Chukchi slope region, as part of a large-scale survey to assess the number of warm core eddies in the region. Of the 63 casts, 23 were Deep Blue probes provided by the science party. The remainder were T-7 probes kindly made available to the science party by the USCG. Some probes of each type were thrown in conjunction with CTD casts to assess the accuracy of the temperature sensors and the drop-rate algorithms. Initial results are promising, indicating agreement to ca. 5m in depth and ca. 0.03 deg C.

Within the two ca. 110 km lines (see map above and XBT sections in the appendices), several incidences of warm core eddies are found in the halocline. The closeness of the casts (2.5 nm) allows us to crudely map some of these features.

Table of XBT casts

#	GMT Date and time		Ref #	Lat. (N)	Long. (W)	Max Depth (m)		Serial #	File name
1	9/12	7:11	91	71 30.79	157 20.55	120	T-7	1004545	T7_00091.RDF
2	9/13	2:30	92	71 13.72	159 48.87	80	T-7	1004544	T7_00092.RDF
3	9/13	2:32	93	71 14.25	159 49.88	80	T-7	1004546	T7_00093.RDF
4	10/14	8:38	94	73 33.59	159 41.37	760	DB	0	03_00094.RDF
5	10/14	8:44	95	73 33.40	159 40.01	760	DB	907469	TD_00095.RDF
6	10/14	10:06	96	73 32.24	159 32.77	760	DB	907473	TD_00096.RDF
7	10/14	10:28	97	73 30.88	159 27.08	760	DB	907466	TD_00097.RDF
8	10/14	11:42	98	73 29.24	159 18.80	760	DB	907467	TD_00098.RDF
9	10/14	12:04	99	73 27.91	159 19.60	760	DB	907468	TD_00099.RDF
10	10/15	5:56	99	72 47.64	157 19.45	760	T-7	1004553	T7_00099.RDF
11	10/15	6:15	100	72 49.48	157 28.64	760	DB	907470	TD_00100.RDF
12	10/15	6:30	101	72 50.90	157 35.78	760	T-7	1004551	T7_00101.RDF
13	10/15	6:45	102	72 52.39	157 43.32	760	DB	907474	TD_00102.RDF
14	10/15	7:00	103	72 53.76	157 50.25	760	T-7	1004550	T7_00103.RDF
15	10/15	7:18	105	72 55.48	157 58.89	760	DB	907475	TD_00105.RDF
16	10/15	7:29	106	72 56.55	158 4.30	760	T-7	1004549	T7_00106.RDF
17	10/15	7:47	107	72 58.29	158 13.18	760	DB	907476	TD_00107.RDF
18	10/15	8:01	108	72 59.57	158 19.70	760	T-7	64196	T7_00108.RDF
19	10/15	8:15	109	73 0.93	158 26.54	760	DB	907472	TD_00109.RDF
20	10/15	8:30	110	73 2.35	158 33.78	760	T-7	64195	T7_00110.RDF
21	10/15	8:45	111	73 3.77	158 41.04	760	DB	907461	TD_00111.RDF
22	10/15	9:00	112	73 5.20	158 48.33	760	T-7	64194	T7_00112.RDF
23	10/15	9:15	113	73 6.58	158 55.39	760	DB	907457	TD_00113.RDF
24	10/15	9:30	113	73 8.02	159 2.75	760	T-7	64197	T7_00113.RDF
25	10/15	9:45	115	73 9.45	159 10.11	760	DB	907453	TD_00115.RDF
26	10/15	9:59	116	73 10.87	159 17.41	760	T-7	64199	T7_00116.RDF
27	10/15	10:16	117	73 12.50	159 25.75	760	DB	907462	TD_00117.RDF
28	10/15	10:32	118	73 14.00	159 33.51	760	T-7	64198	T7_00118.RDF
29	10/15	10:49	119	73 15.56	159 41.53	760	DB	907463	TD_00119.RDF
30	10/15	11:06	121	73 17.11	159 49.49	760	T-7	64201	T7_00121.RDF
31	10/15	11:15	122	73 17.98	159 54.04	760	DB	907458	TD_00122.RDF

32	10/15	11:33	123	73 19.62	160 2.45	760	T-7	64202	T7_00123.RDF
33	10/15	11:46	123	73 20.84	160 8.82	760	DB	907454	TD_00123.RDF
34	10/15	12:00	124	73 20.60	160 8.90	760	T-7	64203	T7_00124.RDF
35	10/15	12:15	125	73 19.66	160 1.19	760	DB	907459	TD_00125.RDF
36	10/15	12:31	126	73 18.71	159 52.78	760	T-7	64204	T7_00126.RDF
37	10/15	12:46	128	73 17.82	159 45.01	760	DB	907455	TD_00128.RDF
38	10/15	13:03	130	73 16.71	159 35.30	760	T-7	64205	T7_00130.RDF
39	10/15	13:15	131	73 16.00	159 29.07	760	DB	907460	TD_00131.RDF
40	10/15	13:30	132	73 15.08	159 20.95	760	T-7	64216	T7_00132.RDF
41	10/15	13:46	133	73 14.14	159 12.76	760	DB	907464	TD_00133.RDF
42	10/15	14:01	134	73 13.21	159 4.67	760	T-7	64217	T7_00134.RDF
43	10/15	14:16	135	73 12.31	158 56.82	760	DB	907456	TD_00135.RDF
44	10/15	14:32	136	73 11.32	158 48.19	760	T-7	64215	T7_00136.RDF
45	10/15	14:48	137	73 10.41	158 40.29	760	T-7	64213	T7_00137.RDF
46	10/15	15:01	138	73 9.58	158 33.05	760	T-7	64214	T7_00138.RDF
47	10/15	15:16	139	73 8.72	158 25.44	760	T-7	64210	T7_00139.RDF
48	10/15	15:31	140	73 7.83	158 17.78	760	T-7	64211	T7_00140.RDF
49	10/15	15:44	141	73 7.12	158 11.59	760	T-7	64208	T7_00141.RDF
50	10/15	16:01	142	73 6.13	158 3.12	760	T-7	64207	T7_00142.RDF
51	10/15	16:18	143	73 5.17	157 54.69	760	T-7	64206	T7_00143.RDF
52	10/15	16:35	144	73 4.14	157 45.87	760	T-7	64209	T7_00144.RDF
53	10/15	16:45	145	73 3.60	157 41.15	760	T-7	64212	T7_00145.RDF
54	10/15	17:01	146	73 2.67	157 33.14	760	T-7	64302	T7_00146.RDF
55	10/15	17:15	147	73 1.89	157 26.43	760	T-7	64303	T7_00147.RDF
56	10/15	17:31	148	73 0.97	157 18.28	760	T-7	64304	T7_00148.RDF
57	10/15	17:48	149	72 59.98	157 9.85	760	T-7	64305	T7_00149.RDF
58	10/15	18:00	150	72 59.31	157 4.13	760	T-7	64306	T7_00150.RDF
59	10/15	18:16	151	72 58.34	156 55.71	760	T-7	64307	T7_00151.RDF
60	10/15	18:32	152	72 57.39	156 47.52	760	T-7	64309	T7_00152.RDF
61	10/15	21:09	153	72 56.90	156 45.88	760	T-7	64309	T7_00153.RDF
62	10/15	23:05	154	72 53.15	156 57.67	760	T-7	64310	T7_00154.RDF
63	10/16	0:41	155	72 50.09	157 8.31	760	T-7	64313	T7_00155.RDF

9. SHIP'S ADCP DATA

(Andreas Muenchow)

(Detailed technical cruise reports on both the 75kHz and the 153kHz system are to be found at http://newark.cms.udel.edu/~muenchow/HEALY-2003. Preliminary copies of these reports are included in the appendices to this cruise report.)

The USCGC Healy contains two separate and independent hull-mounted acoustic Doppler current profiler systems. The systems are a 75 kHz phased array (Ocean Surveyor) and a regular 4-beam 153 kHz transducer (BroadBand). Each system is mounted in its own well that is filled with anti-freeze solution and is separated from the water by an acoustic window. The 75 kHz system performed exceptionally well, is fully operational, and requires minimal operator interference if it is setup and maintained correctly. During this cruise is performed without any of the problems reported in prior years (see Flagg's, 2002 SBI-ADCP report) or even this year (see Münchow's 2003 CATS-ADCP report on HLY-03-01). The same cannot be said for the 153 kHz system which is not operational at the present time. Excessive mechanical and/or electromagnetic noise reduced water tracking range to less than 80 m and data quality below acceptable levels throughout the water column most of the time. The source of this 'noise' is not known, however, it is probably related to the 'hash' reported earlier by Hummon and Firing (2000). Since the 153 kHz was found to be interfering with the OS-75 system, the 153kHz system was turned off for the duration of the cruise.

The OS75 performed extremely well during the cruise when run NarrowBand mode using 15m vertical bins and 10m blanking. The water profiling range hovered around 400-450m depending on the presence of scatters in the water column. The OS75 tracked the bottom without any problems down to 900-1100m. Ship speeds below 15 knots had little effect on the systems performance and an optimum ship speed in waters may be 12-14 knots.

Midway through the cruise, a offset calibration procedure was undertaken and improved parameters calculated. With this calibration, GPS-derived and ADCP-derived vessel speeds. were indistinguishable and hence the ADCP bottom-track was switched off, to allow for doubling the water pings, thus increasing the horizontal resolution.

A potentially troublesome discovery during HLY-03-03 was a large and systematic discrepancy of underway and on-station data over the top 50-60 m of the water column in both vertical and horizontal velocities reaching about 10 cm/s. The source of this underway bias is still unclear, however, the ADCP data collected during HLY-03-03 will need to be scrutinized carefully for this effect that must be (a) understood and (b) removed/calibrated out in post-processing in order to obtain a data set suitable for dynamical analyses of surface waters in addition to those deeper in the water column.

Whilst much post-processing is still to be done, on-board analysis proved extremely enlightening, especially in the multiple repeats of the Beaufort slope line. In a series of 18 crossings of the slope at a time of significantly increasing easterly winds, the ADCP data showed a clear evolution of the boundary current's response to the wind. These images, reproduced in part in the appendices form the basis of an abstract submitted to the Ocean Sciences conference in Portland in 2004.

10. SEABEAM DATA

(Val Schmidt, Dale Chayes, Larry Mayer)

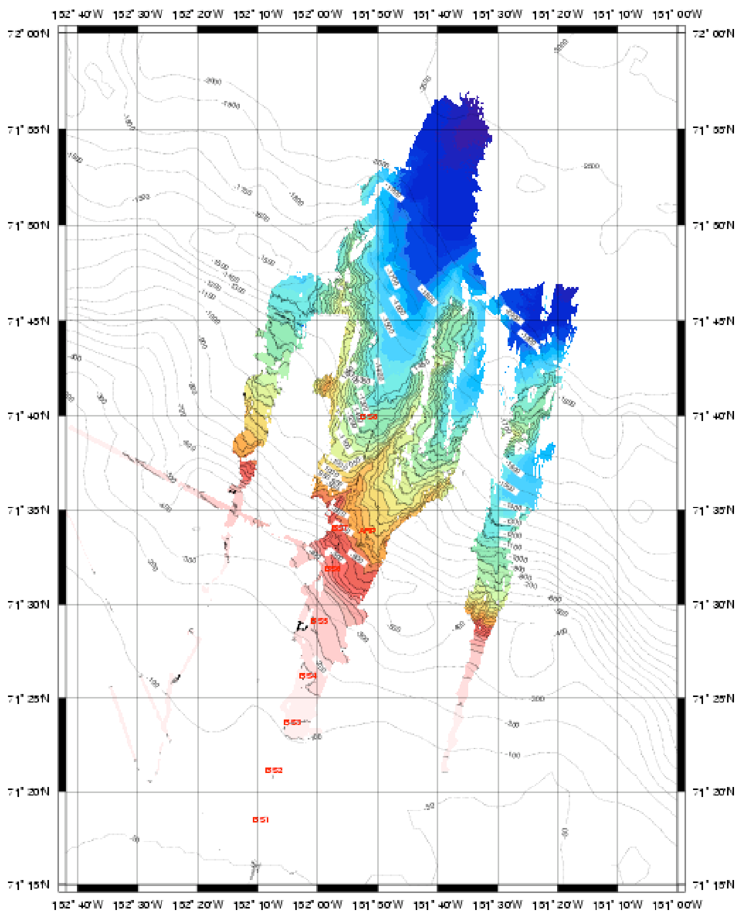
(A detailed technical cruise report on the SeaBeam system is available from Val Schmidt, LDEO. A preliminary copy of this report is included in the appendices to this cruise report.)

The SeaBeam 2112 sonar was operated continuously during the cruise. Only one dedicated SeaBeam expert (Val Schmidt, LDEO) was present on the ship, so monitoring the system was performed by Schmidt and by the MSTs at least every 6 hours and more usually every 3 hours. Sound speed at the keel input was monitored closely from a newly-developed near-real time plot. Only a single event occurred during which the forward TSG data was found to be suspect. This was remedied immediately. Sound speed profile analysis was conducted exclusively from CTD data, as some 320 CTD casts were made during the cruise. Generally new sound speed profiles were analyzed against recently collected bathymetry data using *mbvelocitytool* as the ship began new CTD lines, or when the ship began an extended operation in a new body of water. The exception to this rule was near the Alaska coast where the ship operated in a warm water current for brief, intermittent periods. Each time new sound speed profiles were applied, this was noted in the ship's Underway Science logbook.

Significant events in operation including Integrated Bridge System outages, system lockups, changes to operating parameters (gain, power levels, pulse-width, etc.) and application of new sound speed profiles were logged in the ship's Underway Logbook database. These entries have been extracted for this cruise and are part of the data package.

Most of the ship's operations during this cruise were in waters shallower than 150 meters, generally shallower than 80 meters. In these depths the SeaBeam operates in its 'near field' where traditional deep water processing assumptions no longer apply. Moreover, noise from the ship and the sonar itself are reflected from the sea floor and can saturate the system producing very low Signal to Noise ratios and subsequently, noisier sonar data. The sonar has difficulty tracking the bottom through even a moderate depth change in such conditions and thus frequently it was necessary to set gating limits manually, a process requiring increased watchstander input. Despite this, a reasonable approximation of the bottom depth (good to 5 or 10 %) is obtainable in this shallow water and an average of the 7 center multibeam sonar beams agrees to within 0.5m with the water depth obtained from the ship's ADCP, corrected for speed of sound. Another constraint in shallow water is ship speed, since due to maximum ping rate settings of the SeaBeam, a maximum ship speed of 5 knots is necessary to give full coverage. On this cruise, the slowest standard speed used was 10 knots. In water deeper than 400m, the sonar's tracking ability improves significantly.

Whilst no ping-editing was performed during the cruise, some regions of data were processed for real-time mooring positioning and to obtain an idea of the quality of the data. Some 240 hour of data collected from the region of the Beaufort slope yield the analysis presented in the figure above (which shows SeaBeam depths blue being deep, red being shallow). An automated flagging routing (described in the Schmidt report) rejected 68% if the data, mostly due to 'zero' beams (loss of bottom) due to, for example, operation in shallow water, improperly set depth gates, excessive noise from the bow thruster, bubbles under the hull in rough seas, etc..



Other losses of data occurred from loss of input data from peripheral systems, most notably the Integrated Bridge System (IBS) which provides position information to the SeaBeam. During this cruise, the IBS system failed in some manner (either loss of navigation data or time synch) no less than once a week, and sometimes as many as three or four times in a day. Most of these failures lasted less than an hour, yet they occasionally required a full system reboot of the sonar. The ship's thermosalinograph (TSG) is another input which, during operation in ice, has caused problems in the past. On this cruise, with almost no ice to be navigated, TSG problems were rare.

Although the SeaBeam system functioned well for this cruise, prior damage to the transducers and transducer windows should be repaired during the coming shipyard period. These repairs should include a complete survey of the transducers with respect to the ship's reference, a full set of impedance measurements on the repaired transducers for the ship's records, rewiring of the transducers to remove the shorts that have been inserted removing damaged transducers from the circuit, and two to three days of dedicated sea time with reasonable weather to conduct roll, pitch and heading biases and otherwise groom the system.

11. WHALE ACOUSTICS PROGRAM

(Lisa Munger, John Hildebrand, Sue Moore)

The objectives of marine mammal acoustics onboard SBI-03-03 were twofold:

1) to turnaround one Acoustic Recording Package (ARP) and deploy an additional two for a total of three ARPs in the Beaufort Sea, near the WHOI physical mooring array, and

2) to visually and acoustically observe marine mammals in real time while aboard the Healy.

The three Acoustic Recording Packages (ARPs) were successfully activated and then deployed at the following locations: 71-39.327 N, 151-48.001 W (ARP North=ARPN); 71-28.277 N. While underway, coast guard personnel and L. Munger watched for marine mammals from the bridge (at

70 feet above water level). Visual sightings are reported in table form below. In addition, L. Munger threw in sonobuoys (temporary hydrophones) and monitored them for marine mammal vocalizations. Acoustic detections are reported in table form below.

Table of Marine Mammal sightings

Sighting #, Date/Time	Species and group size	Location of ship	Distance and bearing to animal	Comments
1, 09/13 1338	Prob. gray whale (bowhead?) n=1	71-17.4 158-47.0	0.25 reticles, 30 degrees	Blow bushy, dark back
2, 09/13 1435	Prob. gray whale, n=1	71-21.8 160-04.7	0.45 reticles, 302 degrees	No dorsal fin, stubby tail stock
3, 09/13 1449	Resight of #2?		Off stern	
4, 09/13 2133	Pinniped, n=1	71-19.5 160-03.45	Off port bow	
5, 09/14 1055	Prob. fin whales, n=2-5	70-59.321 159-25.22	0 reticles, 211 degrees	Tall blows
6, 09/14 1245	Prob. gray whales, n=2			
7, 09/15 1409	Walrus, n=1	73-17.87 166-09.34	Off port bow	
8, 09/16 1105	Bearded seal, n=1	73-38.2 167-47.8	1.25 reticles, 102 degrees	Hauled out on ice
9, 09/16 1330	Polar bears, n=3			Female + 2 cubs
10, 09/19 1610	Walrus, n=2	72-28.1 165-32.8	500 yds off bow	
11, 09/19 1645	Pinniped, n=1			Only flipper seen
12, 09/19 1711	Walrus, n=4-7		Off bow	
13, 09/19 1808	Walrus, n=1		500 yds, 70 degrees	
14, 09/23 0855	Pinniped, n=1		Off bow	
15, 09/23 0907	Seals, n=~5 (occas. sightings of 1 at time)			Small-sized seals
16, 09/23 0950	Whales, n=2	70-40 160-05		Sighted from helicopter
17, 09/23 1120	Fin whales (?)			Tall skinny blows
18, 09/23 1156	Seal, n=1		356 degrees	Small, spotted?
19, 09/23 1243	Whales, n=2	71-24.57 158-52.34	0.1 reticles, 285 degrees	2 sep. blows- one tall & thin, one short & bushy

20, 09/23 1300	Resight of # 19?		Off port beam	
21, 09/23 1551	Seal, n=1			
22, 09/30 1503	Walrus, n=2	71-32.00 151-30.79	Directly off bow	One dove under boat
23, 09/30 1603	Walrus, n=1	71-34.65 151-28.19		Male?
24, 10/08 1509	Seal, n=1	72-03.11 151-28.13	100 yds off port	
25, 10/10 1100	Whales, n=~5	71-08.183 158-22.900	3-5 mi. to starboard (ship heading=70)	Spouts short, bushy, saw 1 black back, backs have knobs
26, 10/10 1202	Prob. grey whale, n=1	71-8.873 158-19.258	50 yds off	Resight?
27, 10/10 1258	Whales, n=2		150 yds off port beam	Spout medium-sized, bushy
28, 10/10 1340	Gray whale, n=1		150 yds off port beam	
29, 10/10 1500	Polar bear, n=1	71-08.78 158-18.72		Swimming
30, 10/10 1520	Gray whales, n=2	71-10.4? 158-20.89?	300 yds off port bow	Dark backs, pronounced blowhole, stubby flukes, head looked grey & barnacle-y

Table of Marine Mammal Acoustic Detections by Sonobuoy

Sonobuoy #	Date/Time	Location	Depth (m)	Comments
Sb-1	09/12 1525	71-04.5 159-33.6	70	
Sb-2 DIFAR	09/13 1444	71-21.8 160-04.7	37	Grey whales seen
Sb-3	09/15 0909	73-17.9 166-04.4	57	
Sb-4	09/16 1032	73-36.7 167-46.5	124	
Sb-5	09/17 0739	73-37.7 165-55.0	101	
Sb-6	09/17 1250	73-23.3 166-02.9	74	
Sb-7	09/18 1057	74-06.91 165-52.17	212	
Sb-8	09/18 1830	73-43.3 166-00.1	116	Heard: un-id. mammal
Sb-9	09/18 1958	73-35.8 166-00.6	103	Heard: possib. belugas & seals
Sb-10	09/19 0854	72-53.5 165-59.3	48	
Sb-11	09/19 1249	72-38.8 166-00.1	54	Heard: possib. walrus
Sb-12	09/19 1504	72-30.757 165-54.441	52	Seen: walrus
Sb-13	09/19 1616	72-28.1 165-32.8	41	Seen: more walrus Heard: possib. beluga
Sb-14	09/19 1950	72-22.1 164-41.1	37	Heard: belugas
Sb-15	09/19 2102	72-20.0 164-20.8	35	Heard: faint belugas
Sb-16	09/20 1020	71-53.58 161-58.81	37	Heard: possib. bearded seal
Sb-17	09/20 1222	71-43.26 161-55.35	34	
Sb-18	09/20 1437	71-27.521 161-51.591	36	

Sb-19	09/20 1749	71-06.901 161-46.961	36	
Sb-20	09/21 1240	70-40.065 166-49.933	40	
Sb-21	09/21 1739	70-33.114 167-48.884	39	
Sb-22	09/22 1335	70-41.870 166-17.438	31	
Sb-23	09/22 1958	70-34.7 165-06.3	43	Heard: un-id. sounds
Sb-24	09/23 0955	70-59.100 160-38.844	51	Heard: poss. seals?
Sb-25	09/23 1251	71-25.892 158-46.441	45	
Sb-26	09/23 2355	71-32.8 152-01.3	371	Heard: belugas, un-id. mammal, seals
Sb-27	09/24 1757	71-40.095 151-43.102	1222	Heard: seals
Sb-28	09/24 2236	71-50.95 151-46.227	2075	Heard: seals
Sb-29	09/26 0556	71-30.107 152-00.258	288	Heard: seals
Sb-30	09/28 1635	71-31.3 151-56.4	600	
Sb-31a	09/28 1847	71-25.969 152-02.359	190	Heard: seals (09/29 0007)
Sb-31b	09/28 2144	71-18.086 152-08.277	56	Heard: un-id. sounds
Sb-32	09/28 2305	71-14.116 152-12.271	42	
Sb-33	09/30 0001	71-28.598 151-59.453	262	Heard: seals
Sb-34	09/30 0355	71-13.772 152-11.100	43	
Sb-35	09/30 1519	71-32.39 151-30.811	1420	Seen: walrus Heard: seals
Sb-36	09/30 2200	71-42.6 151-23.2	1740	Heard: walrus, seals
Sb-37	10/01 0207	71-39.824	1015	Heard: seals

		152-10.513		
Sb-38	10/01 0709	71-29.121 152-19.711	124	
Sb-39	10/01 1104	71-22.15 152-26.254	104	
Sb-40	10/01 2310	71-29.109 152-00.162	256	
Sb-41	10/02 0400	71-37.324 151-51.614	915	
Sb-42	10/04 0056	71-42.608 151-46.722	1622	Heard: seals
Sb-43	10/04 0348	71-19.15 152-7.44	60	Heard: seals
Sb-44	10/05 0020	71-45.301 151-44.208	1953	
Sb-45	10/05 0210	71-26.623 152-00.852	215	Heard: seals
Sb-46	10/05 2145	71-16.980 152-09.280	50	
Sb-47	10/07 1908	71-18.963 152-9.611	152	
Sb-48	10/08 0138	71-21.9 152-05.1	79	
Sb-49	10/08 1830	71-37.749 151-51.627	1110	
Sb-50	10/09 1801	72-05.687 152-09.746	1736	Heard: seals
Sb-51	10/09 1931	72-03.764 154-28.078	800-1300	Heard: belugas, seals
Sb-52	10/09 2036	72-02.373 155-24.382	495	Heard: belugas, seals
Sb-53	10/09 2242	71-57.279 157-10.065	86	
Sb-54	10/10 0017	71-41.015 158-09.468	59	
Sb-55	10/10 0248	71-14.699 159-43.807	67	Heard: un-id. Sounds
Sb-56	10/10 1152	71-8.873 158-19.258	39	Seen: gray whales

Sb-57	10/10 2311	71-26.966 158-52.448	53	
Sb-58	10/11 1009	72-07.963 162-00.909	20	
Sb-59	10/11 2136	72-20.525 161-49.328	40	
Sb-60	10/12 0813	72-58.318 160-43.924	76	Heard: un-id.sounds
Sb-61	10/13 2256	73-46.602 159-17.881	2972	
Sb-62	10/14 1320	73-10.780 157-49.962	2557	
Sb-63	10/14 1902	72-59.8 156-56.0	2378	Heard: poss. seals
Sb-64	10/14 2144	72-47.68 157-15.4	1382	Heard: seals, un-id.sounds
Sb-65	10/14 2211	???		
Sb-66	10/15 0214	73-12.32 159-24.88	1240	Heard: seals
Sb-67	10/16 0416	72-30.789 158-11.222	91	
Sb-68	10/16 1909	72-15.193 163-44.827	42	
Sb-69	10/16 2259	71-55.701 165-02.231	41	Noisy in wake (steaming at 18 kn)

12. UNDERWAY SYSTEMS

(MSTs)

Whilst the SeaBeam and ADCP systems were tended primarily by members of the science party (see above), the remaining underway systems of the Healy were maintained and recorded by the MSTs as per standard operating procedures of the ship and logged by the SCS system.

Two salinity samples were drawn daily for Thermosalinograph calibration. Commencing on 20th September, chlorophyll samples (4 a day) were collected for calibration of the underway Fluorometer. The ship's air-sensor failed terminally on ca. 28th September. Air temperature records after this date can be obtained from the MSTs' 6-hourly weather logs or (to a lesser degree of accuracy) from the Bridge logs. During the storm of 6-7th October, discrepancies of 10 knots in wind speed were observed depending on ship heading. If the wind is from aft, the recorded wind speed is ca. 10 knots less than when the wind is on the bow.

Bottom depth data was taken using the SeaBeam system and both the Bathy and Knudsen systems. The latter two cannot be run simultaneously since they share the same transducers.

There was frequent switching between Bathy and Knudsen echosounders. In addition, the WHOI group attached their mooring acoustic equipment to the Bathy/Knudsen transducers resulting in further occasional downtime of the system. Both Bathy and Knudsen data are corrected for transducer depth and assume a standard sound speed of 1500 m/s. SeaBeam data is corrected for sound speed during collection.

Underway systems were logged to the SCS and are available as part of the data archive for the cruise. Terascan Satellite images were recorded when good. These data are also archived separately from the cruise data under an agreement between USCG and Dan Lubin, UCSD.

13. WEBSITES MAINTAINED DURING THE CRUISE

Cruise website for SBI and other science programs

(Rebecca Woodgate, Mark Ortmeyer)

A website, containing science overview, cruise track, chief scientist reports and preliminary science results, was maintained during the cruise at http://psc.apl.washington.edu/SBI2003.html
This website will remain active at the PSC and will be expanded to include results of data analysis.

Educational and photojournalism website

(Chris Linder, Bob Pickart)

A second, educational website was maintained daily from sea at http://whoi.edu/ArcticEdge. This project, part of a 3-year mission, contains daily accounts of life at sea and includes questions and answers from middle school classes on the east coast of the USA.

14. OUTREACH ACTIVITIES IN BARROW

(Rebecca Woodgate)

One rewarding feature of working via Barrow is the interest of the local community in the science projects that work or stage out of the area.

Interactions of SBI and the Whaling Communities

The SBI project (represented by Jackie Grebmeier, Terry Whitledge, Tom Weingartner and others) has built contacts in Barrow over the last 18 months. In 2003, visits to Barrow discussed the work to be performed on the SBI cruises this year. The timing of this mooring cruise overlapped unfortunately with the predicted timing of the fall Bowhead whaling hunt in Barrow. The exact dates of the hunt vary from year to year, but relate to the progress of the fall migration of the Bowhead whales westward along the coast of northern Canada and Alaska during the autumn, and also depend on the ice and weather conditions. Woodgate met with the Whaling Captains in Barrow pre-cruise to determine how best to organize the cruise track in light of concerns from Barrow. The course of the fall whale migration is believed to follow the tracks of the first whales (the leaders) that pass Barrow and the concern from Barrow was that the Healy, working east of Barrow, could divert the leaders north away from the coast and away from Barrow. At the same time the oil companies, who had been barging along the coast east of Barrow, had also asked for an extension into September for their barging operations. At the meeting, it was agreed that the Healy would work the moorings and CTDs west of Barrow first, and only commence working the areas east of Barrow after 1st October 2003. Also, transit past Barrow would occur over deeper water, away from the traditional hunting grounds (ca. 20-30 nm off Barrow, see map from BASC, see appendices) and work would commence at the deeper rather than the shallower end of the Beaufort line. About one week into the cruise, Woodgate received word from Barrow that the fall hunt was set to start on 6th October and since the whale leaders had now been sighted off Barrow it would be the preference of the Whaling Captains for the work east of Barrow to start immediately and be completed before the start of the hunt. This cruise-track change fitted admirably with the preferences of the science party, and the Healy transited deep around Barrow and started working the Beaufort line deep to shallow as previously agreed. In the event, bad weather prevented the line being completed before the nominal start of the whaling hunt on the 6th October, but as it happens, the hunt was also delayed by the same bad weather.

In response to concerns from Barrow that helicopter routings could also disturb the path of the whales, helicopter transfers into Barrow were conducted with the ship stood off to the west of Barrow. When safety issues were not a concern, flight paths were set so as to make ground fall southwest of Barrow and proceed to Barrow over land, the same routing being taken on return. The original transfers to the ship at the start of the cruise remained west of Barrow. The mid-cruise transfer of Johnson and Leech took place into Wainwright rather than Barrow. The mid-cruise transfer of Swartz, Kemp, Schrawder and Ashjian were initiated with the ship stood 30 nm off to the southwest of Barrow. Unfortunately, the preferred routing on these final transfers could not been maintained due to poor visibility in Barrow (which necessitated landing on instruments), high traffic levels and directions from the FAA to take off towards the north.

Educational visits to Schools in Barrow

On the 8th and 9th September 2003, BASC arranged for Woodgate to visit school classes in Barrow to introduce physical oceanography and the aims of the up coming cruise. An inflatable globe and slides of the ice-breakers of the USCG and the research equipment used by physical oceanographers were used to teach Middle School classes the basics of ocean circulation, including the concept of the 'accent' of seawater, i.e. how temperature and salinity can be used to determine the origin of a water mass. Classes made up their own solutions of ice-melt water (10 psu), Pacific Water (30 psu) and Atlantic water (35 psu) and via blind testing, illustrated that a 'human salinometer' (i.e. their tongues) could be used to tell the difference in salinity. A similar story about life at sea was told to the elementary school children. All three middle and elementary school classes colored-in styrofoam cups which were shrunk by ocean pressure on the deepest cast of the cruise (3000m) and returned to the school classes post cruise. At the High School, the basic oceanography lecture was further illustrated with experiments with density and mixing, demonstrating that if it was deemed 'uncool' to taste the solutions of water, one could still tell the difference by comparing the densities of the water. The dedicated support of BASC, Carla Willetto in particular, and the encouragement of the teachers (Shanna Johnson (Middle), Marti Rookala and Aimee Romeijn (Elementary); Tim Buckley and Leslie Pierce (High School)) were invaluable in making these visits a success.

Evening lecture

As part of a series of lectures from visiting scientists to Barrow organized by BASC, Woodgate gave an evening lecture at the Community Center - 'From the Pacific to the Arctic: Ocean Currents: - why (and how) we follow them.' - outlining the science and methods of the cruise.

Barrow Arctic Science Consortium

Another rewarding aspect of working in Barrow is the excellent, effective and enthusiastic logistical support provided by BASC in all aspects of pre-cruise planning, pre-cruise transfers and underway requests.

15. DATA ARCHIVING

Under an agreement between the SBI Project and JOSS (http://www.joss.ucar.edu), data from this cruise will be catalogued and archived by JOSS as part of the SBI data set archive. Mooring data will be transferred from the PIs to JOSS after it has been finally calibrated and quality controlled. Hydrographic data and ADCP data will be transferred in final form to JOSS after calibration and quality control by the service PIs. Ship's logs and underway data will be transferred to JOSS directly post cruise, with the exception of Terascan images which are also archived via Dan Lubin at UCSD. JOSS will obtain copies of these data directly from Dan Lubin. SeaBeam data will also be archived by JOSS and will be sent to NGDC for incorporation in the new IBCAO charts.

16. APPENDICES

Cruise Diary

MAY 2003
Mon/Wednesday19th - 21st Loading of SBI gear onto the Healy
Wednesday 21st SBI planning meeting on the Healy in Seattle

JUNE 2003
Friday 13th Healy sails from Seattle

SEPTEMBER 2003
Sunday 7th Woodgate to Barrow for pre-cruise outreach.
Monday 8th Meeting with Whaling Captains; Visits to Middle and Elementary Schools; evening lecture for Barrow Community. Schuller arrives in Barrow.
Tuesday 9th Talks to High Schools; Rest of science party arrives.
Wednesday 10th Pre-cruise meeting at NARL.
Thursday 11th Transfer of departing science party from ship and SBI science party onto ship along with SBI shipments and ship's mail and provisions. Helicopter transfers staged from the FAA building by the airport. All aboard by 1630. Science inbrief. Commence ADCP lines across Barrow Canyon while science team sets up. Unable to find Formalin for Ashjian - arrange for BASC to acquire some.
Friday 12th Complete ADCP grid across Barrow Canyon and recover BC1 late afternoon. Run ADCP lines up onto Hanna Shoal during night, returning towards Alaskan coast.
Saturday 13th Fly helicopter to Barrow to pick up Formalin. CTD test cast in am. Return to NW end of head of Barrow Canyon line. First cast c. 1600, but need to reterminate wire. Commence line proper ca. 2000. CTD with water sampling through the night. CTDs1-6
Sunday 14th Continue CTD line until ca. 1300. Return to BC1 and redeploy mooring ca. 1500. Run ADCP line across head of Barrow Canyon and up onto Hanna Shoal. Run for CS1 mooring. CTDs7-18.
Monday 15th Reach ice edge ca. 0400. On site at 0900 in light ice. Cal Cast for CS1. Mooring releases respond but mooring does not surface. After multiple attempts, set up for dragging operation. Move ship into ice to get stable platform to unpack dragging gear from the hold. Polar bear sightings with kills in ice. Survey in mooring position using WHOI program. Commence dragging operations at ca. 1800. Mooring surfaces at ca. 2000 after one complete loop of the site. Dragging gear and mooring on deck ca. 2200, just as light is failing. Move SW for CTD line across the slope. CTD19.
Tuesday 16th Commence CTD line with water sampling at ca. 0200 (10 stations across the slope) finish ca. 1700. Run ADCP lines in triangle across the slope to be at CS2 for Wednesday mooring. Little ice for all of this work. Boat drill mid afternoon. Evening lecture by Woodgate 'Why are we here?'. Delaney appointed Morale Committee Rep.. Ice berg scours found in SeaBeam data. CTDs20-29.
Wednesday 17th Onsite for CS2 ca. 0800, still dark. Calibration CTD cast. Start mooring recovery 0900, all on deck 1000. Set-up for CS2 deployment, and redeploy by ca. 1100. (NB Knudsen echo sounder off line for this deployment.) Proceed to CS1 and redeploy by ca. 1400. Move NE to northernmost end of CTD line across the slope. Start CTD line with water sampling at ca. 2330. CTDs30-31
Thursday 18th Continue CTD line with water sampling southwest/south across Chukchi Slope via moorings CS2 and CS1. Pause in CTD to clean O2 dispenser. Come out of ice. One

swimming polar bear. Test cast for VPR 1630 - deployment easy, but data stream issues. Second VPR test cast late evening. CTDs32-45.

Friday 19th *International Talk Like a Pirate Day*. Continue CTD line south with water sampling and VPR casts. Strange profiles in shallower water. Finish southward part of line at ca. 1430 (cast 56) and run CTD only (no water samples) across to Hanna Shoal. Again, unusual temperature structure over shallows. During night, divert from course due to charted shallows. CTDs 46-65.

Saturday 20th Continue CTD line (no bottles). Rosette wake having significant effect on traces so bottles removed from rosette, making traces much cleaner. Start taking chlorophyll samples to calibrated underway fluorometer. Pauses in CTD line due to need to pump waste waters. CTDs46-85

Sunday 21st Complete CTD line ca. 0400 and ADCP towards CC1. Seas building to ca. Force 5. On site ca. 1300 for calibration cast with bottle samples. Start recovery ca. 1400. Floatation only just sufficient on mooring and awkward to tag in rough seas. All on board ca. 1600. Move on to recovery Chinese mooring. Arrive ca. 1800, circle site, finally spot 12" white float, send small boat out to hook onto it. Recover safely, anchor included. Head west onto flanks for Herald Shoal and start CTD line with water sampling ca. 2200. CTDs86-93.

Monday 22nd Continue CTD line with water samples through the morning. Break off after cast 99 to return to mooring site and deploy CC1, do calibration cast. Return to line and recast at position of 99 as bottles were left open on cast 99. Interesting comparison of the 2 cal casts at CC1, and casts 99 and 101. Continue CTD section with bottles up onto eastern shoal. Pause in CTD line after cast 106 to allow for pumping of waste water. Resume CTD line with water sampling and run on into night. Receive email from Robert Suydam that fall whaling hunt will start off Barrow on 6th October and suggesting we work east of Barrow now, aiming to complete before the hunt starts. Second incident of virus scare on computer systems. CTDs94-110.

Tuesday 23th On completion of CTD line, head full steam for work area east of Barrow. Fly Leech and Johnson off into Wainwright. Run test Net Tow mid-afternoon. Traverse deep around Barrow. Another computer virus scare cuts off network for most of the day. Muenchow evening talk on 'Sonars and why Germany lost WW2'. CTDs111-117.

Wednesday 24th Arrive Beaufort line ca. midnight. Run one CTD as a SeaBeam calibration. Then start deep and run net tows at the mooring sites with ADCPs. By 7am, all net tows completed and back on site at BS8. Recover BS8 by 1330 (NB only slow capstan speed available). Proceed to BS7 and recover BS7. Steam to 2000m contour and run calibration casts for moored TS sensors. CTDs 118-119

Thursday 25th CTD problem causes second CTD cast (120) to be aborted. (Later discovered to have been set-up differently by previous watch.) Proceed instead to BS6 for net tow. Start BS6 recovery 0800, all on deck by ca. 1000. Go to BS5, communicate with releases but do not send release code (the argos sender on this mooring transmitted during the winter, so suspect a potential problem on recovery). Proceed instead to BS4 and recover. Proceed to BS3 and recover and finally BS2 and recover. Head back deep, 'lawn mowing' (i.e. running SeaBeam lines for bathymetry). Do one CTD cast at BS7, as TS-sensor from BS7 flooded during calibration cast. Proceed deep for more calibration casts. CTDs 120-122.

Friday 26th Complete second calibration cast, return to BS5 for net tow. Run ADCP calibration pattern around BS5 (to be compared later with mooring data). Due to increasing wind and sea state cancel mooring work for the day. Return to ARP site and survey in ARP still to be recovered. Return to 2000m contour and run ADCP line back in. Weather bad enough need to slow to 8 knots for ADCP and finally 6 knots for SeaBeam. Complete ADCP line despite bad weather. Run back out, stopping to run spatial SeaBeam surveys at BS2 and BS3. Run out to 2000m contour, then return towards BS7. CTD 123.

Saturday 27th At ca. 0200 recommence calibration casts for CTDs. Winds and seas dropping. After two calibration casts return to BS5. Start BS5 recovery ca. 0800, all on deck by 0930. Start

ARP recovery ca. 1030, all on deck ca. 1130. Proceed to BS1. Net Tow and then recovery of BS1 (1400-1500). ADCP section out to 2000m contour (ADCP lines run standardly at 10 knots.) Return to BS8 for more calibration casts. NB significant changes in halocline water structures during all these repeat casts, especially day to day. CTDs 124-127.

Sunday 28th After the 3rd calibration cast (ca. 0200) head back out to 2000m contour and commence full depth CTD line (no bottles) from deep to shallow (129-143). Very foggy. Continue CTDs all day and conclude line at ca. 2300. Run ADCP line back out. Attempt to compare ship's noise with and without bow thruster using Sonobuoy traces, but find individual recordings are not intercomparable. Ship's air temperature sensor breaks. CTDs 128-143.

Monday 29th Morning flight ops as required to maintain helicopter crew in training. Wet check releases. Return to 2000m and start another CTD section in (no bottles and casts only to 600m) at ca. 1500 (147-161). Due to complete at ca. 0600 Tuesday in time for mooring operations. However, problems with the moored profilers postpones deployments until Wednesday. Replan next few days of CTDing to account for this. CTDs 144-155.

Tuesday 30th *Hump Day*. Continue CTDing back shallow through the night. CTD bottom sensor problem on penultimate station of line (160) at ca. 0400. Complete section at ca. 0600 and move east to run CTD section shallow to deep there. Start this line (no bottles, 600m only) ca. 0800 and finish ca. 2100 (162-175). Move west of main Beaufort line and start another CTD line (no bottles, 600m only) there ca. 2300 (176-186). Moored profiler problem resolved. Start routine washing of transmissometer on CTD. Canadian vessel Laurier reported close by. Walrus following ship from stations 172-175 or more. Casts 172 and 174 used also as calibration casts for moored instruments. CTDs 156- 177.

OCTOBER 2003

Wednesday 1st Continue CTDing deep to shallow west of main Beaufort line. CTD hits bottom at ca. 0400 on cast 180, but no damage done. Weather worsening and setting ship up for CTD work more time-consuming. (4am, ca. 20k winds; 9am ca. 30k winds). Complete CTD line (186) ca. 1200 and head back towards mooring, necessary to tack as seas and winds so bad. After 2 hours WHOI decide not to deploy in this and so return shallow to start another CTD line (shallow to deep). Commence CTD line (no bottles, 600m only) (187-199) at ca. 1730. Stations 190 and 193 used as calibration casts for moored instruments. Evening session securing WHOI mooring gear on deck. CTDs 178-193.

Thursday 2nd Continue CTDing through night till ca. 0700. Interesting structure in AW must be viewed in conjunction with SeaBeam topography. Stop the line at 199 and return to mooring deployment at BS8. Resurvey the area. Start deployment at ca. 1000. All deployed by 1300. Finish surveying in at 1500. Proceed to BS7, repeat bathy survey, start deployment ca. 1630, all in water at ca. 1800, survey in until 2030. Move to ARP deployment and ping ARP until it reaches bottom. Wet test releases. Email with NSF and Barrow re completion date for work this side of Barrow. Schmidt evening lecture on acoustics 'Listening to Lisa's Whales'. CTDs194-199.

Friday 3rd ADCP through the night. Full day of mooring operations. Complete BS6 and BS5 with pre-deployment bathy survey, deployment, post-deployment surveying in. Deploy shallow ARP (ARP-S). Wet check releases. Return shallow to run another CTD line (no bottles, 600m only). Hit winch problems at ca. 2300. Ashjian talk on Plankton. CTDs none.

Saturday 4th Winch problem fixed at ca. 0400. Commence CTD line (shallow to deep, no bottles, 600m only) and complete stations 200-209 until requested to return to mooring deployments. Back at site 1530, redo bathy survey, start deployment of BS4 at ca. 1630. Complete deployment at ca. 1800, and survey mooring in. Run to 300m for wet checking releases. Run out to ARPW and deploy ca. 2200. ADCP the night. Radio contact with the Laurier, headed for Barrow Canyon.*Casino Night*. CTDs 200-209.

Sunday 5th Through the night ADCP from ARPW, out to 2000m, back in along the Beaufort line and out again and in again. At BS1 at 0800. Repeat bathy survey. Finish deployment of BS1 (tripod) by ca. 1000. On site at BS3 1100. More bathy survey. Start deployment 1330 anchor first since winch on top float (only anchor first deployment), completed 1430. Survey mooring in. Start deployment of BS2 1830, deployed 1930. Surveying in completed 2130. Start main CTD line with bottles and VPR casts. Worsening weather and first VPR cast, VPR swings into stern of ship. Winds now from the East. CTD 210.

Monday 6th Worsening weather cancels CTD work at 0230. Beat EW 10 nm line into and out of wind while waiting for weather to improve. Winds 45-50 knots, force 7 seas, taking occasional green water over bow. CTD 211.

Tuesday 7th Continue to wait out storm. Burning of DVDs for PacArea. Nice check of wind speed sensor, reading low when wind from aft. Winds dropping towards evening. Return to shallowest station to recommence section. Waters at first two stations exceedingly muddy. (NB these samples clog both nutrient and oxygen analysis.) Restart CTD section (bottles, full depth and VPR casts) (212-231) ca. 2100. CTDs 212-214.

Wednesday 8th Continue CTD and VPR section. Multiple problems with VPR not recording data. Trouble shooting continues most of the day. Repeat casts until successful. NB this section is not as synoptic as the others run. Organize bottle firing so as to hit the Tmax and Tmin layers. CTDs 215-223.

Thursday 9th Continue CTD and VPR section. Complete bottle sampling and VPR at station 226. After pumping, continue CTDing (no bottles, 600m only) northwards until time to turn for Barrow. L-ADCP also not run on these later stations. (Standard procedure so far has been L-ADCP on stations deeper than ca. 300m.) Conclude this CTD line (and work east of Barrow) at ca. 1600 and turn for Barrow, transiting deep again, skirting the hunting area and circling Barrow so as to be SW of Barrow for helicopter transfers on Friday. First whale reported from Barrow. Munger sonobuoys hear Beluga whales, but no Bowheads. CTDs 224-231.

Friday 10th *CO and XO for the day*. Transit west and south over night. Run ADCP sections across the southern end of Barrow Canyon. Roll out helis at ca. 0800 while still dark. Transfer off Swartz, Kemp, Schrawder and Ashjian to Barrow. Traffic heavy in Barrow. Visibility poor and helis need to land on instruments. Pick up two contractors for ship. Complete flight ops ca. 1300. Commence CTD section across mid Barrow Canyon (no bottles) (232-247). CTDs 232-245.

Saturday 11th Complete Barrow Canyon section and run wider spaced section up onto Hanna Shoal with bottles (245-253). Move to other side of shoal and commence CTD line off the slope towards the NNE (rerun of old Healy and Palmer sections). At first cast (254) ca. 1030, CTD wire damaged deploying in swell. Retermination of CTD cable takes till 1900. *Pizza Night by science party.* Continue CTD line with bottles, full depth (254-284). CTDs 246-258.

Sunday 12th Continue CTD with water sampling. Pause in section to allow for Oxygen analysis to catch up and ship to pump waste water. CTDs 259-276.

Monday 13th Continue CTD with water sampling. Vents left open on cast 280, so repeat top 300m for nutrients on cast 281. Bow thruster requires 1 hr of fixing. Last cast on line and deepest of cruise (ca. 3000m) sent down with ca. 130 styrofoam cups. Many eddies on this section. ADCP data apparently supportive of eddy circulations, but could also be tidal aliasing. CTDs 277-284.

Tuesday 14th Start running ESE CTD line (minimal bottles, 600m only) to do eddy census of slope region (285-297). Initially do XBTs between CTD casts forXBT/CTD intercomparison. Complete CTD line ca. 2000 and run two XBT lines (with casts every 2.5 nm) back WNW and returning ESE. CTDs 285-297

Wednesday 15th Complete XBT lines at ca. 1300 and resume CTD line with bottles (600m only after first cast) back south towards Hanna Shoal (298-317). Oxygen chemical issues. Further Bow Thruster problems. CTDs 298-305.

Thursday 16th Continue CTD section with bottles. Increase station spacing after station 313. More oxygen chemical issues and some samples wrongly titrated. Complete section up onto Hanna Shoal. Weather worsening. Do a few stations west of Hanna Shoal in an attempt to find the anomalous high fluorescence water there on the last section. No such water found,. Weather continued to degenerate. Bow thruster blows another fuse. End CTD work after cast 321. *Red socks basketball game.* Turn and run for Nome. Tail wind of 30 knots brings ship speed to a peak of 18.5 knots!! CTDs 306-321.

Friday 17th Packing and clearing up. Linder afternoon talk on photography. Woodgate evening talk on 'What were we doing here?'. Packing continues well into the night since, making this good time could mean arrival on Saturday rather than Sunday.

Saturday 18th Off Nome by early morning. Start transfers off ca. 1300 by helicopter (as dock frozen in) to Evergreen Helicopter Hangar. Final science party off late afternoon. Incoming crew for Healy arrive on evening flight and transfer to ship. Many of science party change flights and depart Nome. Healy departs for Juneau.

Sun/Mon 19th/20th Remaining science party depart Nome.

NOVEMBER 2003

Saturday 1st Healy returns to Seattle, going straight to Todd Shipyard.

Wednesday 5th SBI Offload in Seattle in Todd Shipyard

In-transit Reports from the USCGC Healy

Chief Scientist Report, September 10th 2003

Dear All,

Well, here we are poised in Barrow to join the ship. The science party arrived yesterday - the first load in a gap in the snow storm, the second in clearer weather. Today we feel the bite in the air, but the sun has been seen and the seas are coming down. Since I arrived on Sunday we have had wild, stormy weather. With the land being mostly a coarse-grained black sand, the waves crashing onto the beach look particularly menacing. Especially so as they wash away the road in front of you! We are staying a couple of miles out of town at NARL. The road in hugs the shore and everyday there are diggers pushing the natural sand into piles to hold back the waves. For the last few days, they've lost - we drive the inland road instead, longer and 'washboarded' - a vocative expression if you remember scrubbing clothes on boards by hand. I spent most of Monday and Tuesday telling school kids about physical oceanography, making them use their 'human salinometer' to taste the difference between Pacific and Atlantic waters, and playing demonstration games with some salt solutions, a glass jar and food colorings.

Today was final pre-cruise planning .. and tomorrow should (we hope) whisk the 20 science party and the 3000lbs of freight off to the Healy. So, with any luck, the next should be from sea! Flying up was like traveling 6 months in a day - from the summer of Seattle, to the Fall of Fairbanks, to the barren winter of Barrow. Enjoy the summer for us, and we'll hope for a more wintery than stormy autumn for the start of the trip.

Best wishes, Rebecca

Chief Scientist Report, September 14th 2003

Dear All,

Greetings from the Healy, somewhere off Hanna Shoal! We're all aboard, 3 days now and already things are slipping into a routine. Despite a large storm pounding the beaches off Barrow so hard it washed away the road early in the week, the weather calmed down enough for the helicopter transfers of all personnel and equipment (3000lbs science gear, 6000lbs stores) on the 11th. We sailed into calming seas, ADCPed the night away running across-canyon sections of Barrow Canyon and successfully recovered the Barrow Canyon mooring on the afternoon of Friday 12th. Saturday saw more ADCP sections whilst the CTD and chemists completed their set-ups and by Saturday night we were running the first CTD casts in a 17-station section (2 nm separation) across the southern end of Barrow Canyon. This morning completed the CTD section, and as I type we are steaming north towards the Chukchi Slope moorings, ETA Monday morning

All well, Rebecca

Chief Scientist Report, September 18th 2003

- running south along the Chukchi Slope line

Dear All,

Time flies, and we are making good progress. Monday morning saw us at the mooring site CS1, with some ice, but good open water. Though the mooring was in position and both releases perky, once released the mooring failed to come up. Time, thus, to dig out the dragging gear, and some hours later, on the first drag, the mooring came to the surface. The drag had caught the mooring and given it a sufficient shake to free it from whatever was hanging it up, since it surfaced normally and was on board by late evening. We can only speculate on improbable theories. It is a reminder that these things can take time. Post recovery, we ran northwest CTDing down across the slope, to catch the core of Herald Valley outflow, ADCPed back and fro across it, returning to the second mooring recovery yesterday. This went smoothly, both recovery and the redeployment of both the Chukchi Slope moorings, and by evening we were running north again to start our main line south through the mooring positions, CTD, ADCP water sampling and the occasional VPR cast, which is where you currently find us. Ice has been light light light, nothing to hinder our progress so far. Two pairs of polar bears and the remains of their hunt (Walrus?) indicate we are in the nutrient rich waters of the Pacific. One swimming polar bear today makes you ask the eternal question of how did it get there? The ship's ADCP is tracking well, the SeaBeam also. We'll finish this line, then head to the Central Channel mooring. Weatherwise, fog seems our biggest hazard, a small penance given what's happening on the east coast!

All well, Rebecca

Chief Scientist Report, September 25th 2003

- working the Beaufort line

Dear All,

Thursday 25th Sept and all well. You find us working the Beaufort line and having covered a lot of ground since last week. Last week we were up by the Chukchi Slope moorings in light, mostly negligible ice, and CTDing (and VPRing) south through the mooring line. We extended that section southeast to Hanna Shoal and back south towards the Alaskan Coast, giving us a quasi-synoptic slice through the central Chukchi Sea. We are still finding pockets of winter water, and comparison with the Palmer data of a few months ago gives interesting progression of features.

On reaching the coast, we deadheaded to our fourth mooring recovery, the UAF mooring in the Central Channel, another trouble free recovery and redeployment. Whilst in the area we took the opportunity to assist Chinese colleagues who deployed a surface mooring some months ago but, due to a large storm, were unable to recover it before heading south. We circled the site in Force 5-6 seas, visual contact being our only hope for recovery, since the mooring carried no acoustic mechanism. The large red top float and radar reflector was not to be found, presumably torn off by the storm. The amazingly sharp eyes of the US Coastguard did however locate the second float, the only remaining surface expression, a small, (14inch diameter) white sphere, hidden in a sea of white-caps! From there, the recovery went well, thanks to the dedicated boat and deck crews, and the instruments and the data are safely aboard, enroute back to the Chinese.

Mooring work in the Chukchi completed, we ran another closely spaced hydrographic section (CTD and VPR) through the Central Channel mooring, to the coast, and headed northeast to the Beaufort Slope line. We have been here two days, and so far have been remarkably lucky with weather. We recover moorings in the day and work net-tows and CTD casts (predominantly the calibration casts for mooring instruments to be redeployed) in the night. So far, six moorings are safely recovered. We aim to try for the remaining three tomorrow.

We have been working mostly in calm seas, no ice, little wind, few waves, northern lights on the clear nights and occasional sun and snow flurries in the day. It's not really very Arctic, but if it gives fair weather for the mooring work, that's fine too.

Rebecca

Chief Scientist Report, October 12th 2003

Dear All,

Sunday 12th October and all well. Many miles under the keel since the last report. We are now back in the Chukchi having completed the Beaufort Slope work we were engaged in when I last wrote. The remaining Beaufort mooring recoveries went smoothly. Bob has a terrific haul of data, with all his crawlers (the instruments that twice daily climb the length of his moorings recording T, S and velocity) working extremely well.

The WHOI team worked hard to get all the instrumentation turned around for redeployment. In the meantime we ran and reran the CTD section across the Beaufort slope, with accompanying ADCP lines and CTD sections offset to the east and to the west. The collection, (some 7 full or partial CTD lines and 18 ADCP transects) gives a marvelous picture of the evolution of the boundary current system under sustained easterly (i.e. upwelling favorable) winds. The variability in the Pacific waters is remarkable and uniquely documented by these surveys, which were frequently run at night to allow for mooring deployments in the daylight hours. We completed the deployments by last Sunday and started into the final, high resolution CTD line with chemistry and VPR casts, when the largest storm yet hit us. Forty to fifty knot winds and Force 7+ seas left us able only to ride it out. The Healy is a remarkably stable platform, so you needn't feel too sorry for us - just frustrating not to able to CTD the line. After two days of sitting it out, the seas calmed down enough to recommence the section, and by Thursday afternoon we were headed back again to east of Barrow.

You now find us working north again with another major section across the Chukchi slope, along the line occupied twice by the Healy last year and once by the Palmer this last summer. We find trapped waters over Hanna Shoal and are expecting the boundary current of the Pacific waters any cast now. We've had rough seas again, forcing a retermination of the CTD wire, but are back to a steady CTD routine for these last few days - we'll turn for Nome at the end of the week. We've sighted a few whales, another swimming polar bear, but really remarkably little - though the fog does little for the sightings and the northern lights, stars and sun are things of the past. Still, as long as the winds and seas stay down, that's the main thing.

All the best, Rebecca

Chief Scientist Report, October 19th 2003

Dear All,

Nome, sweet Nome, that's where you find us. All packed, disembarked and headed for home. The final week passed swiftly. We completed another two sections across the Chukchi Slope, and finding a variety of warm and cold cores of water, most likely eddies, ran a quick XBT survey to try and capture the eddy inventory of the slope region. A final southward leg brought us back up into Hanna Shoal with our enddate coming fast and the weather worsening. Still, the line was completed, and after concluding a few stations into the peculiar regime west of Hanna Shoal, we quit CTDing and hotfooted for Nome. The time of year necessitates leaving time for 10 knot transit in fog. However, good visibility and a 25 knot tail wind sped us to Nome at almost 18 knots(!!), allowing us to take advantage of a good weather window on the 18th Oct and get everyone and everything ashore before the weather broke.

The total work accomplished reflects strongly the admirable stamina of the team, the ice-free waters we encountered and the comparatively mild weather. We completed 13 mooring recoveries, and 15 mooring deployments, 321 CTD casts, including 953 (1044 Ed.) salinity samples, 948 (1036,Ed.) nutrient samples, 842 (839 Ed.) oxygen samples, 548 (656 Ed.) chlorophyll samples, 34 VPR casts, 11 net tows, 63 XBTs, 70 Sonobuoys drops (passive listening for whales), and 35 days of ADCP and SeaBeam data. These are all just statistics - sciencewise, in both water mass properties and water velocity, we have a substantial areal and temporal survey of the Beaufort Slope current, the shelf-slope transition over the Chukchi Shelf and Chukchi Sea itself. Together with the mooring data and the Palmer survey of early in the year, this substantial data set will go a long way to identify and quantify the many processes in this highly variable shelf-slope system.

It has been a successful, hard-working cruise. Our thanks go to all the crew of the Healy, especially the MSTs, whose tireless support and professionalism allow us not only to bring home this marvelous data set, but also to have had an enjoyable time collecting it!

Thanks to everyone for a great cruise,
Rebecca

UNOLS Report

UNOLS Post-Cruise Assessment Report

1) Ship Name: Healy
2) Cruise Dates: From: September 11, 2003
To: October 18, 2003
3) Chief Scientist: Rebecca Woodgate
4) Master: Captain Dan Oliver
5) Marine Technician: MSTSC Glenn Hendrickson + MSTs
6) Cruise Number: HLY-03-03 SBI Mooring Cruise
7) Type of Work: Mooring work, CTDs
7a) Funding Agency: NSF, ONR/Navy
8) Area of Operations: Chukchi and Beaufort Seas
9) Name of Person: Rebecca Woodgate
10) Your Institution: University of Washington
11) Your E-mail Address: woodgate@apl.washington.edu
11a) PI/Chief Sci. Email:
12) Your Position: Chief Scientist

13) To what extent were the planned science objectives of this cruise met?
rating: 100% or More
comment:
Objectives - 5 week physical oceanographic research cruise, including
- 13 mooring recoveries
- 15 mooring deployments
- CTD casts (target 90-150)
in a region with a climatological ice cover of 0-6/10ths.

Completion - 14 moorings successfully recovered
- 15 moorings successfully deployed
- 321 CTD casts, 34 VPR casts, 11 net-tows, 63 XBTs.

The cruise expectations were significantly exceeded, due to the dedication, enthusiasm and tireless efforts of the Healy crew and the science team and the exceptionally light ice cover in the region.

14) Rate how well the science party contributed to achieving the scientific objectives of this cruise (pre-cruise planning, communication, adequate personnel, equipment, attention to safety, organization, etc.).
rating: N/A
comment:

15) Rate how well ship operator pre-cruise activities (planning, coordination, and logistics) and shore support contributed to achieving the scientific objectives of this cruise.
rating: Excellent
comment:
The support we received from both the Science Liaison team and the crew of the Healy were excellent.

= The pre-cruise planning meeting on the Healy was very useful and we are grateful to the CO, XO and PACAREA Science Liaisons taking the time to come to project planning meetings pre-cruise.
= Some email queries to/from the ship got lost stressing the importance of a dependable email system (see below).
= A large amount of ship information is available on the web. This is a marvelous asset and an immense help for cruise planning. Small extensions to this documentation might include:
-a photo gallery of the main lab spaces
-a summary of routine ship evolutions (e.g. helicopter proficiency flights, pumping of grey water, etc.) that affect continuous science operations
-explanation of the rubbish sorting and burning routines
-clarification of expectations of cleaning etc. to be done by science party
-a summary of agreements for data archived for others than the onboard science party (e.g. the Terrascan data being sent to Dan Lubbin, SIO.) (This was not a problem for us, but it might be for others).
= the on-line shipping form is very useful, but appears to have problems with the attachments of MSDS forms
= one HazMat shipment of formalin was described as received by the ship but was never found on board
= clarification on what counts as HazMat for storage would be useful. Standard shipping guidelines appear to be more lax than USCG guidelines. Thus, one science team shipped small amounts of dry chemicals in with general freight and these chemicals had to be unpacked on the dock to be stored in the HazMat locker.

16) Rate how well the ship operator supplied scientific equipment and marine technicians supported this cruise (appropriate equipment, equipment operational and ready for cruise, calibrations, documentation, technicians trained and familiar with equipment).
rating: Excellent
comment:
The Healy is an extremely capable vessel with a skilled and enthusiastic crew. It was an honour and pleasure to work with such dedicated personnel and such state-of-the-art equipment.

The ship was exceedingly helpful, very supportive of the science and very responsive to all our needs and requests, successfully combining a highly professional work ethic with an enjoyable working environment.

MST support both during the cruise and before and after was excellent. It is amazing that so few people can do so much.

Computing support, a subcontractor to the USCG, however did not match these high standards on this cruise.

Ship Equipment issues
- the 153kHz ADCP does not give useable data.
- deck capstan had only one workable speed, which was restrictively slow
- tie down points on deck had to be drilled out before use
- illumination for aft-deck needs fixing
- air temperature sensor needs fixing
- documentation on limitation of wind sensors would be of help. (i.e. the issues of which wind-bird is recording, plus degradation of data when wind from aft.)
- moving the CTD console to nearer the winch control would be greatly advantageous for CTD operator/winch operator communications
- better drainage in the CTD sampling room would also be an improvement

- it would be helpful to have some simple navigation system available for science planning, e.g. working out "time to next station" and cruise planning. We rigged such a system in the main lab (laptop, GPS Antenna and simple navigation program, e.g. Nobeltec) ourselves. The CCTV repeater of the Bridge navigation system, though useful, is far from ideal for this purpose.
- a technical library on board would be useful, containing standard oceanographic and computing references.
- some SeaBeam transducers need fixing
- an upgrade of the SeaBeam processing computers would be advantageous.
- the ship's SeaBeam and ADCP were supported by the science party on this cruise. RDI do run ADCP courses which could improve the in-house expertise for this system.

Email setup

During the cruise, the science party used two email systems.
- Inmarsat was generally reliable, but having only two email drops a day greatly limited its effectiveness for time-critical work. Towards the end of the cruise, the ship implemented a third email drop a day, which greatly improved the usefulness of this system. It would be nice for this to be standard.
- the Iridium system was introduced as a system available 24/7 for SMALL text messages. For much of the cruise, it worked extremely well, although it required much baby-sitting on land and on the ship. The former meant it almost invariably failed at weekends.

The email systems caused much frustration during the cruise. Much of this frustration was based on expectations - e.g. knowing a 24/7 system was so close to being operational, yet being unable to use it effectively.

The other causes were:
- unreliability. Some email messages sent were never received. It is hard to document this effectively, but some examples exist of messages inexplicably disappearing.
- frequent downtime of the Iridium.
- teething problems with email addresses (e.g. one email username problem took 2 weeks to solve).
- awkward web interface for Inmarsat email.
- email privacy issues need to be clarified.

Computing issues

A contracted, non-CG person was onboard tasked with oversight of computing support.

The complexity of the job certainly requires a dedicated person, with broad technical ability, good communication skills, the ability to concisely and accurately convey technical information, and an understanding of the time-constrained needs of a science party.

Some specific problems were encountered:
- the back-up of cruise data provided at the end of the cruise was missing 2 days of data from the middle of the cruise. This was discovered post-cruise by the science party, and the missing data has been recovered, but we are fortunate that this was detected before the ship's systems were cleared.
- the take-home copy of the cruise data was provided on a variety of DVDs (-R and -RW). It would have been helpful to have these all the same format and also in a unix compatible form.
- the use of a webbased problem-reporting system was unusual for a ship-environment and appeared to hinder rather than help efficiency.

Several virus scares on the cruise severely disrupted both internal and external computing. To avoid the danger of a crippling virus attack, it would be worth where possible converting to a less vulnerable operating system, e.g. unix or linex.

17) Rate how well the scheduling of this cruise supported achieving the scientific objectives of this cruise (appropriate ship, year, season & dates, communications regarding schedules, online systems and scheduling process).
rating: Above Average
ship requested: Healy
comment:
The timing and working areas of this cruise were of concern to the whaling community in Barrow, who undertake a bowhead hunt each autumn. During this time, the bowhead whales migrate westward along the north coast of Alaska and the concern from the native communities was that the Healy working east of Barrow would divert the whales away from the coast.

Tom Weingartner, Terry Whitledge and others visited Barrow in Spring and Summer 2003 to discuss these issues and a tentative agreement was reached as to the most preferable cruise routing.

When I visited the whaling captains in Barrow, just prior to the cruise, new concerns prompted a revision of the cruise track, which was further rerevised during the cruise after input on the whaling hunt from Barrow. Whilst the final solution was satisfactory to all parties, it was not reached without compromises on both sides.

Timetabling the mooring cruise a few weeks earlier in the season would greatly alleviate these issues.

18) Rate the level of safety in shipboard and science operations (safety briefing and instructions, procedures & equipment).
rating: Excellent
comment:
The Healy is a remarkably stable platform. Mooring work went extremely smoothly. CTD work went very well, although deploying in rough weather did once kink the conducting cable necessitating retermination.

The science party were pleased to have the coring bucket removed from the CTD deck for this cruise.

All deck radio communications were done via the MSTs. For the rare occasions a scientist is on deck alone, they too should have a radio.

Very nice to have mustang suits etc. available for science team both for heli-transfer and for deck work. It would be helpful to list the range of sizes so that people with extreme size requests know to bring their own.

19) Rate how well the officers and crew and the manner in which the research vessel was operated contributed to achieving the scientific objectives of this cruise (communications, ship handling, deck procedures, attitude towards the science objectives, training, adequate number of crew, shipboard routine, etc.).
rating: Excellent
comment:
.or higher. The tireless energy, the enthusiasm and dedication to doing a good job on the science from all the crew, especially the MSTs, Ops and Captain made the cruise the great success it was.

20) Rate how well the research vessel and its installed equipment contributed to achieving the scientific objectives of this cruise (material condition, readiness, living conditions and habitability, condition of lab spaces, design, layout, deck equipment, winches, cranes, frames, propulsion, power, etc.).

rating: Excellent
comment:
The Healy is an extremely well equipped, spacious and comfortable research platform.
General Points
Staterooms very well equipped. Some (e.g. port aft cabins) would be improved with extra soundproofing. Mattresses could also be improved (e.g. currently are hard and with hollows in the center.)
It would be helpful to provide a checklist of expectations of science party involvement in rubbish burning and lab cleaning (during and at the end of the cruise).
Issue of cleaning sheets before leaving - for us, this wasn't a problem as we departed the ship in the afternoon. For early morning departures this could be an issue.
Medical requirement for the cruise was for each member of the science party to fill in a medical history form. No physical or doctor's note was required. Given the geographical remoteness of the operations, it would not be unreasonable to require a more stringent medical check.
The electronic medical form presented some problems. PDF format is only editable with the program Acrobat, a computer package which has to be purchased. Thus, Word or Ascii is a better format, and the form could also be improved for ease of filling-in. Electronic transfer to the ship was problematic, since the uncompleted form was very close to the maximum filesize accepted by the ship.

21) Number of science days lost:
weather: 2-3
ship: < 1
shipequip: 0
science: 0
comment:
2-3 days lost to autumn storms
Less than 1 day lost to ship's equipment - bow thruster problems.

Notes from the AICC Debrief

HLY0303 AICC DEBRIEF NOTES R A Woodgate, 8th Dec 2003
===
- SBI Mooring Cruise
- Sept 11th 2003 - 18th October 2003
- Barrow, AK - Nome, AK
=======================================

Chief Scientist: Rebecca Woodgate

TOPICS TO COVER IN DEBRIEF (MODIFIED FROM ANTARCTIC DEBRIEF QUESTIONS)
==

Summary: - a very successful cruise. We are grateful to the USCG for the extremely high standards of helpfulness, professionalism and enthusiasm shown by the crew of the Healy and the on-shore support.

1) HOW WERE COMMUNICATIONS WITH PACAREA (DAVE, APRIL, AND PHIL) AND THE SHIP (CO, XO, MSO, MSTC OR MST1) BEFORE THE CRUISE? WAYS TO IMPROVE?
Very Good.

Attendance of CO and XO at Spring SBI meeting was greatly appreciated. Pre-cruise meeting on the ship was also a great help, despite substantial crew change between this meeting and the ship.

Dave F was excellently responsive to all our pre-cruise questions and requests.

A large amount of ship information is available on the web. This is a marvelous asset and an immense help for cruise planning. Small extensions to this documentation might include:
- a photo gallery of the main lab spaces
- a summary of routine ship evolutions (e.g. helicopter proficiency flights, pumping of grey water, etc.) that affect continuous science operations
- explanation of the rubbish sorting and burning routines
- clarification of expectations of cleaning etc. to be done by science party.
- a summary of agreements for data archived for others than the onboard science party (e.g. the Terrascan data being sent to Dan Lubbin, SIO.) (This was not a problem for us, but it might be for others).

Ways to improve: - once the ship was underway, email communications were not as reliable as one would like and attachments and even entire emails would occasionally be lost. A more reliable email system would be a great asset.

2) ANY ENVIRONMENTAL OR PERMITTING AREAS THAT AROSE DURING THE CRUISE? IF YES, HOW SMOOTH DID THE PROCESS(ES) GO? FROM CG SIDE, DID THE SCIENTISTS FOLLOW PROCEDURES TO OBTAIN CLEARANCES, PERMITS ETC. SUGGESTED IMPROVEMENTS?

The timing and working areas of this cruise were of concern to the whaling community in Barrow, who undertake a bowhead hunt each autumn. During this time, the bowhead whales migrate westward along the north coast of Alaska and the concern from the native communities was that the Healy working east of Barrow would divert the whales away from the coast. Tom Weingartner, Terry Whitledge and others visited Barrow in Spring and Summer 2003 to discuss these issues and a tentative agreement was reached as to the most preferable cruise routing. When I visited the whaling captains in Barrow, just prior to the cruise, new concerns prompted a revision of the cruise track, which was further rerevised during the cruise after input on the whaling hunt from Barrow. Whilst the final solution was satisfactory to all parties, it was not reached without compromises on both sides.

Timetabling the mooring cruise a few weeks earlier in the season would greatly alleviate these issues.

A request was also made from Barrow that, unless safety issues dictated otherwise, helicopter transfers would route into Barrow from the southwest during times when whales might be present.

3) LOGISTICS/ CARGO- WERE THE SHIPMENTS ON TIME? WERE SPECIAL HANDLING REQUESTS MET? (FROZEN THINGS KEPT FROZEN, ETC.)

Generally very good. Loading and off loading went well.

Few issues:

- the on-line shipping form is very useful, but appears to have problems with the attachments of MSDS forms
- one HazMat shipment of formalin was described as received by the ship but was never found on board
- clarification on what counts as HazMat for storage would be useful. Standard shipping guidelines appear to be more lax than USCG guidelines. Thus, one science team shipped small amounts of dry chemicals in with general freight and these chemicals had to be unpacked on the dock to be stored in the HazMat locker.

4) CONSTRUCTION- WAS ANYTHING BUILT OR MODIFIED ON BOARD? HOW DID THAT GO? DAMAGE CONTROL/ SCIENTIST INTERACTIONS?

Nothing major built. Minor modifications went very well.

5) INFORMATION TECHNOLOGY- E-MAIL, COMPUTER, INMARSAT, RADIO SUPPORT?

Variable.

EMAIL - medium

During the cruise, the science party used two email systems.

- Inmarsat was generally reliable, but having only two email drops a day greatly limited its effectiveness for time-critical work. Towards the end of the cruise, the ship implemented a third email drop a day, which greatly improved the usefulness of this system. It would be nice for this to be standard.
- the Iridium system was introduced as a system available 24/7 for SMALL text messages. For much of the cruise, it worked extremely well, although it required much baby-sitting on land and on the ship. The former meant it almost invariably failed at weekends.

The email systems caused much frustration during the cruise. Much of this frustration was based on expectations - e.g. knowing a 24/7 system was so close to being operational, yet being unable to use it effectively.

The other causes were:

- unreliability. Some email messages sent were never received. It is hard to document this effectively, but some examples exist of messages inexplicably disappearing.
- frequent downtime of the Iridium
- teething problems with email addresses (e.g. one email username problem took 2 weeks to solve).
- awkward web interface for Inmarsat email.
- email privacy issues need to be clarified

COMPUTER SYSTEMS - good.

Most of the science party brought their own computers, and networked into communal drives and printers. Other than running short of printer cartridges, this seemed to work well.

COMPUTER SUPPORT - medium

A contracted, non-CG person was onboard tasked with oversight of computing support.

The complexity of the job certainly requires a dedicated person, with broad technical ability, good communication skills, the ability to concisely and accurately convey technical information, and an understanding of the time-constrained needs of a science party.

Some specific problems were encountered:

- the back-up of cruise data provided at the end of the cruise was missing 2 days of data from the middle of the cruise. This was discovered post-cruise by the science party, and the missing data has been recovered, but we are fortunate that this was detected before the ship's systems were cleared.
- the take-home copy of the cruise data was provided on a variety of DVDs (-R and -RW). It would have been helpful to have these all the same format and also in a unix compatible form.
- the use of a webbased problem-reporting system was unusual for a ship-environment and appeared to hinder rather than help efficiency.

Several virus scares on the cruise severely disrupted both internal and external computing. To avoid the danger of a crippling virus attack, it would be worth where possible converting to a less vulnerable operating system, e.g. unix or linex.

6) LABORATORY OPERATIONS- SCIENTIFIC SUPPORT FOR EVERYTHING FROM OPERATIONS TO HAZMAT TO FAMILIARITY WITH EQUIPMENT

MST support was EXCELLENT.

7) LABORATORY EQUIPMENT- COMMENTS ON MALFUNCTIONS, DESIRES FOR UPGRADES, NEEDED NEW EQUIPMENT

Lab equipment - very good

I. SEABEAM SPECIFIC QUESTIONS:

A. HOW MUCH REAL-TIME WATCHSTANDER EFFORT WAS REQUIRED?

Watchstanding was shared between the MSTs and Val Schmidt, LDEO. In shallow water (as much of the cruise was), the system frequently lost bottom and manual gating was used instead. This required more manual intervention. Failures of the Integrated Bridge System at least once a week (sometimes 3 or 4 times a day) also lead to system downtime.

B. HOW MUCH PING EDITING WAS DONE IN THE POST PROCESSING?

Other than to check data quality in specific areas, no ping editing was done on the ship.

IN BOTH CASES, WHO PROVIDED THE PEOPLE (CG OR SCIENTISTS?); WHO WAS RESPONSIBLE FOR TRAINING THE PEOPLE?

Val Schmidt, LDEO, provided the onboard technical expertise for the SeaBeam. He trained the MSTs to watch-stand so he could sleep. No scientist or CG personnel was available to train in ping editing.

Other SeaBeam issues

- some transducers need fixing
- an upgrade of the processing computers would be advantageous.

8) DIVING SUPPORT

Due to light ice and straightforward mooring recovery conditions, no diving necessary, but having the expertise available was a valuable backup.

9) SCIENCE TECHNICAL SERVICES- SEAWATER SYSTEMS, CLIMATE CONTROL ROOMS, WINCHES, ETC.

Generally very good. Few things:

- the 153kHz ADCP does not give useable data.
- deck capstan had only one workable speed, which was restrictively slow.
- tie down points on deck had to be drilled out before use
- illumination for aft-deck needs fixing
- air temperature sensor needs fixing
- documentation on limitation of wind sensors would be of help. (i.e. the issues of which wind-bird is recording, plus degradation of data when wind from aft.)
- moving the CTD console to nearer the winch control would be greatly advantageous for CTD operator/winch operator communications
- better drainage in the CTD sampling room would also be an improvement
- it would be helpful to have some simple navigation system available for science planning, e.g. working out "time to next station" and cruise planning. We rigged such a system in the main lab (laptop, GPS Antenna and simple navigation program, e.g. Nobeltec) ourselves. The CCTV repeater of the Bridge navigation system, though useful, is far from ideal for this purpose.
- a technical library on board would be useful, containing standard oceanographic and computing references.
- the ship's SeaBeam and ADCP were supported by the science party on this cruise. RDI do run ADCP courses which could improve the in-house expertise for this system.

10) SMALL BOAT OPS

Very Good.

Used for hooking line onto moorings during mooring recovery

11) HELO OPS

Very Good.

Used for transfer of science party to and from shore.

Note comments above about helicopter routing into Barrow.

12) FOOD SERVICE

Good.

13) HOUSING/ JANITORIAL

Very good.

Staterooms very well equipped. Some (e.g. port aft cabins) would be improved with extra soundproofing. Mattresses could also be improved (e.g. currently are hard and with hollows in the center.)

It would be helpful to provide a checklist of expectations of science party involvement in rubbish burning and lab cleaning (during and at the end of the cruise).

Issue of cleaning sheets before leaving - for us, this wasn't a problem as we departed the ship in the afternoon. For early morning departures this could be an issue.

14) SAFETY- PARTICULARLY DECK OPS (AICC WILL PROBABLY NEED TO CONSIDER BOTH SCIENTIST'S VIEW OF OPS, AND CG'S VIEW OF SCIENTISTS)

Very good.

The science party were pleased to have the coring bucket removed from the CTD deck for this cruise.

All deck radio communications were done via the MSTs. For the rare occasions a scientist is on deck alone, they too should have a radio.

Very nice to have mustang suits etc. available for science team both for heli-transfer and for deck work. It would be helpful to list the range of sizes so that people with extreme size requests know to bring their own.

15) ADMINISTRATIVE SERVICES

Very good.

More spare printer cartridges would be advantageous - as the last cruise of the mission, we were unable to use the main lab printer as there were no more spare printer cartridges.

Similarly, more DVD discs for cruise backups were required. (We imported extras from Barrow opportunistically during a mid-cruise transfer.)

16) MEDICAL- FOR ARVOC INCLUDES REQUIRED SUITES OF PHYSICALS

Medical requirement for the cruise was for each member of the science party to fill in a medical history form. No physical or doctor's note was required. Given the geographical remoteness of the operations, it would not be unreasonable to require a medical within the last 1-2 years.

The electronic medical form presented some problems. PDF format is only editable with the program Acrobat, a computer package which has to be purchased. Thus, Word or Ascii is a better format, and the form could also be improved for ease of filling-in.

Electronic transfer to the ship was problematic, since the uncompleted form was very close to the maximum filesize accepted by the ship.

17) TRAVEL- AS ABOVE PROBABLY MORE AN ARVOC ISSUE THAN AICC AS WE ALL MAKE OUR OWN TRAVEL ARRANGEMENTS

n/a

18) SHIP OPERATORS- INTERACTIONS BETWEEN BRIDGE AND SCIENTISTS,,NIGHTLY MEETINGS, ETC.

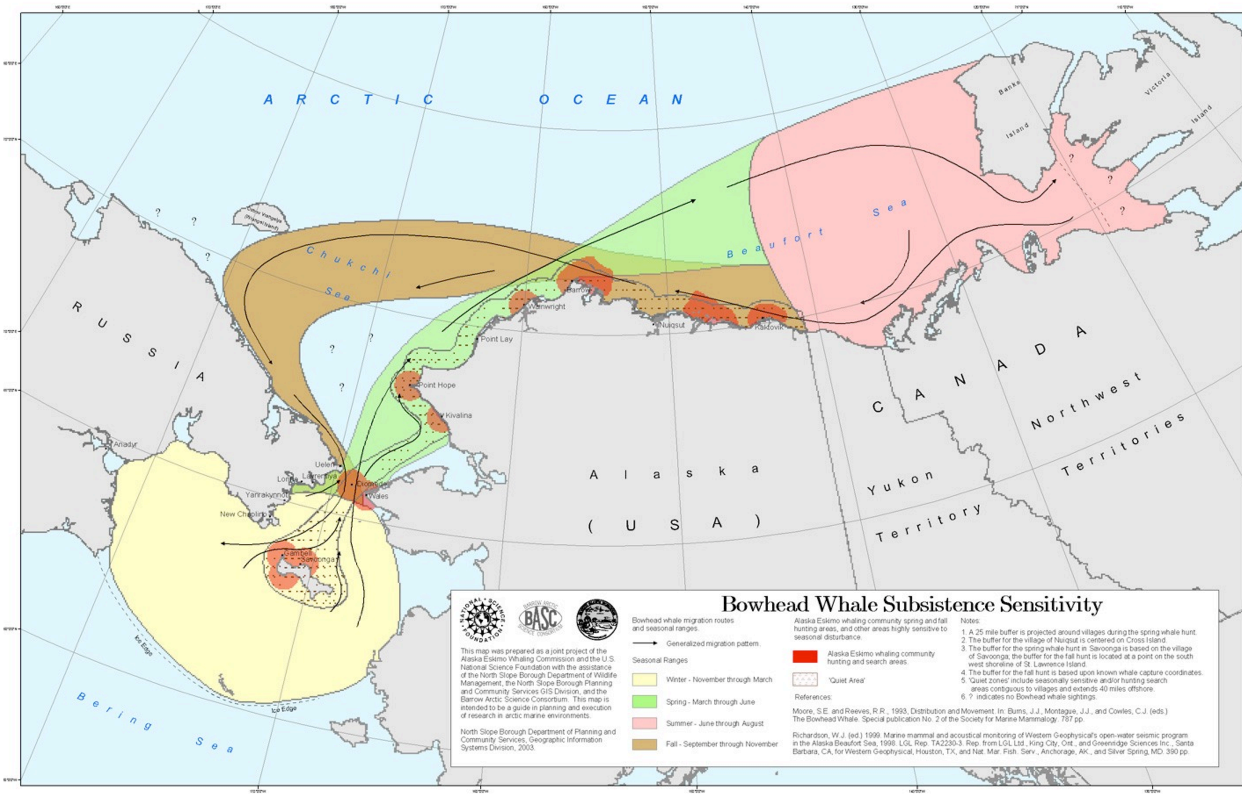
Very good.

The ship was extremely helpful, very supportive of the science and very responsive to all our needs and requests, successfully combining a highly professional work ethic with an enjoyable working environment.

19) ANY OTHER COMMENTS?

The Healy is an extremely capable vessel with a skilled and enthusiastic crew. It was an honour and pleasure to work with such dedicated personnel and such state-of-the-art equipment.

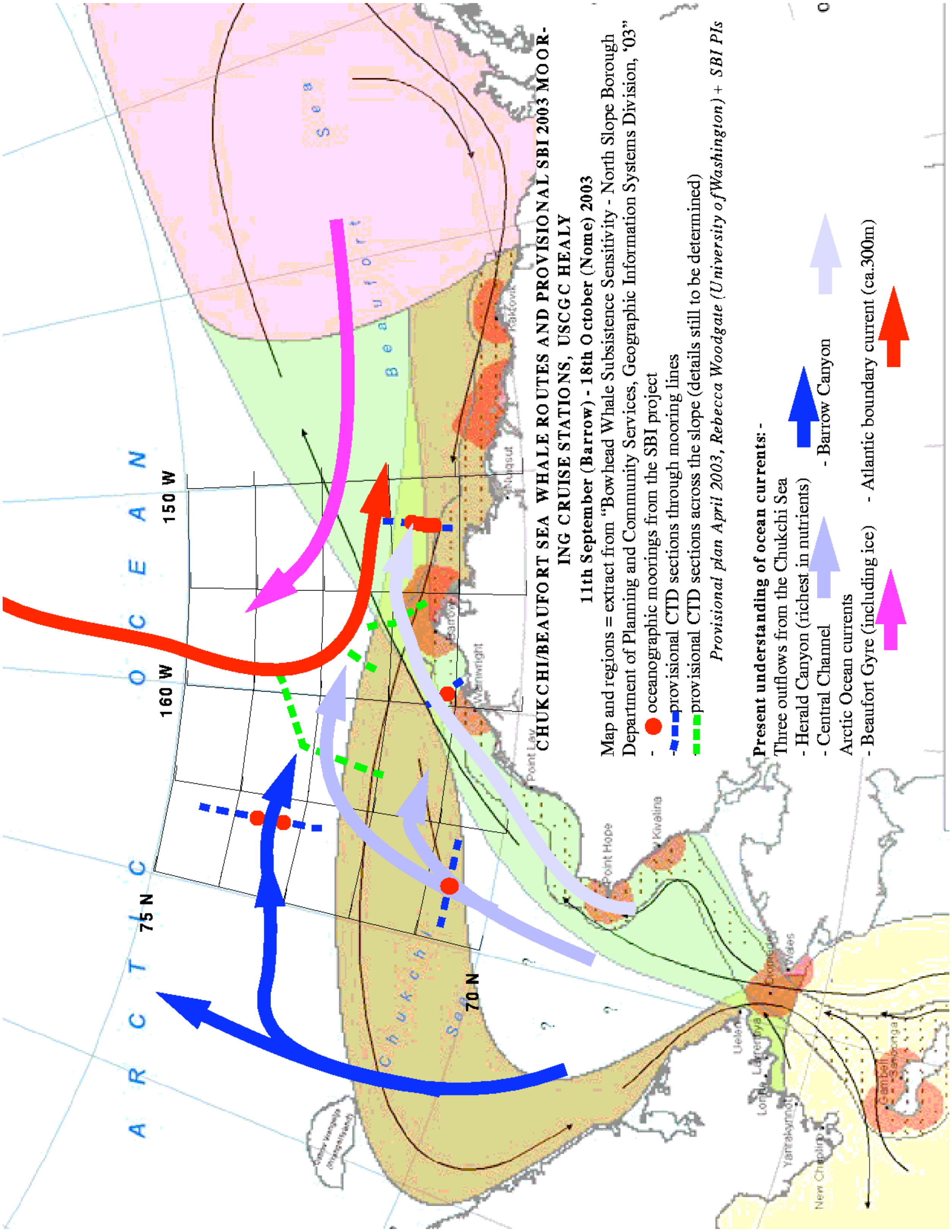
Whale Migration Chart



For original, contact Barrow Arctic Science Consortium.

Yellow = winter; green=spring; red = summer; brown = autumn.

Extract from the same chart, with the mooring positions and currents superimposed,



HLY-03-03 Science Party Group Photo

Standing, from left to right: Val Schmidt, John Kemp, Dan Schuller, Dan Torres, Rebecca Woodgate, Dean Stockwell, Rob Palomares, Sarah Zimmermann, Jeremy Kasper, Chris Linder, Marshall Swartz. Seated, from left to right: Ryan Schrawder, Andreas Muenchow, Jim Johnson, Martha Delaney, Carin Ashjian, Lisa Munger, Christina Courcier, David Leech, Bob Pickart.

(Photo courtesy of L.Hopson, BASC)

17. APPENDICES (EXTERNAL TO REPORT)

A: Preliminary Hydrographic Sections

B: Preliminary XBT Sections

C: Ice Charts

Event Logs (Excel files) for CTDs, XBTs, VPR and Nets

Schmidt Report on Multibeam Sonar Operations (SeaBeam)

Muenchow Report on 75kHz ADCP

Muenchow Report on 153kHz ADCP